Virtual Reality

History

Over the last five decades, virtual reality has evolved from gimmicky devices to true immersion. The next generation can expect to see virtual reality grow in daily use just as the previous generation saw the internet explode. During this fast pace of change, there will be shifts in societal interaction, how we learn, and how we are entertained. This paper will address how virtual reality came to be, current technology, and what the future may offer.

Due to virtual reality's multi-faceted use as a buzzword, it's important to define virtual reality. The definition states it's a 3D computer generated world that can be interacted with and explored. However, the buzzword has been used for things such as 3D movies and interactive video games. To help clarify we can break it down into two categories, immersive and non-immersive[i]. Non-immersive virtual reality can be a flight simulator game or a 3D reconstruction of a lost city. Immersive virtual reality needs more than a virtual world, it needs it to be realistic and you need to be able to interact with it. Richly detailed graphics, the feeling of presence, and the ability to affect your environment are all crucial to achieve true virtual reality. But before virtual reality was even a term, devices were being invented to create this incredibly new experience.

Around 1960, Morton Heilig created the Sensorama. Its purpose was an amusement ride. The Sensorama showed a 3D film riding through the streets of Brooklyn. Wind on the face, vibration of the motorcycle seat, a 3D view, and a smell of the city all helped create an illusion of being in the film. This was done by strapping three cameras on a person riding a motorcycle. This was a crude attempt at creating an immersive experience and failed horribly in the market place. [ii]

In 1963, Ivan Sutherland, called the father of graphics, created the Sketchpad. This program allowed a user to draw lines with a lightpen and modify them later. This was the beginning of computer graphics which is an essential component of virtual reality. In 1968, Sutherland attempted to improve flight trainers with the support of the DoD. In this effort, he created the first headset device that allowed users to move their head and change their view. It was so heavy, they called it "The Sword of Damocles" and it had to be suspended from the ceiling. The graphics were wire models of rooms and it was not interactive. However, this program showed the future possibilities of virtual worlds. [iiiiv]

"As is the case with other technological advances, much of the initial development of virtual reality was funded by the military. By 1972, the General Electric Corporation had built one of the first computerized flight simulators, using three screens surrounding the training cockpit to provide a 180-degree field of view that simulated flying conditions." In 1982, Thomas Furness III, who had extensive experience developing visual displays for the military since 1966, created the prototype Visually Coupled Airborne Systems Simulator. VCASS allowed pilots to see a virtual display and real world at the same time. "Donning a specialized oversized helmet, pilots were presented for the first time with an abstract view of flying conditions instead of a reality-based image. Since they were unable to see anything but the computerized cockpit's field of view, pilots became totally immersed in the graphic representation. "[vvi] Later on, Furness went to create the SuperCockpit and the Darth Vader helmet in the 1980s.[vii]

Another pioneer was Frederick Brooks who began experimenting with tactile feedback in the early 1970s. He knew it was difficult to achieve immersive virtual environments without feeling real

objects. At The University of North Carolina, his team "modified a mechanical controller for a robotic arm previously used in radioactive material handling. Motors were added to the Argonne remote manipulator (ARM). The motors would be activated by the virtual environment to create forces on the controller. UNC used this in their GROPE-III system to help chemist "feel" the attractive and resistive forces of molecules reacting and bonding to each other. The chemist could use the forces and torques to learn how to make new chemical compounds."[viii]

In the 1980s, popular media started to show the possibilities of virtual reality. Star Trek featured a holodeck, and Tron, a cult classic movie, took place in a video game. With an increase in graphics power, gaming and its virtual worlds took off. 3D graphics engines were developed, and the internet's bandwidth increased in speed and affordability, both critical factors for virtual reality. One notable VR community is Second Life where people can interact and create objects for each other. Many MMORPGs (Massive Multiplayer Online Role Playing Games) were also used as virtual communities. With advances in computer graphics and lots of hype, some companies attempted more immersive forms of virtual reality. These attempts were easily dismissed by the consumer market. The problem was that realistic VR environments cost tens of thousands for the hardware alone. Virtuality, a VR gaming machine for arcades, was a complete failure due to its high price, poor controls, low resolution, and jerky gameplay. $3 for a few minutes in an unrealistic computer simulation was considered a poor choice of entertainment in the arcade. Nintendo's Virtual Boy was its lowest selling console ever.

The VR boom and bust of the 1990s led to a quiet period in the 2000s. Brooks said, "VR has crossed the high pass from almost works to barely works." [ix] The latency, rendering models, and display all needed slight improvements. Companies chose to invest in lower end graphics systems such as PCs or consoles. Over time, these graphics cards have become powerful enough to deliver photo-realistic environments. Due to the low cost of this technology, VR started to become more viable by the early 2010s.

In 2012, VR enthusiast collector Palmer Lucky was working in USC's mixed reality lab. John Carmack, who created the First Person Shooter genre with the 3D games, Doom and Quake, wanted to make VR goggles. (He also dabbles in private rocket ships). A chance meeting in a forum led to the Oculus Rift. Carmack borrowed Palmer's headset and added some duct tape along with other enhancements to create a demo. The prototype at E3 sparked a new wave of VR fervor. Palmer dropped out of college and launched a Kickstarter campaign for the Oculus Rift. Initially hoping to get 100 enthusiasts, his goal was not to make a penny but to pay for all the parts, manufacturing, shipping, and to have $10 left over for a pizza and beer party. In 24 hours, 2,750 people raised $670,000 and within 3 days it went over $1,000,000. Oculus Rift went from 10 to 100 employees and sold to Facebook for $2 billion.[x] The Oculus wasn't the only R&D department looking to make a consumer friendly device. Valve, which owns the top PC selling platform Steam, is also in the mix. They plan to release their Vive headset by Q4 2015 as a PC gaming headset. Besides the Oculus, its major competition will be Playstation VR made by Sony. Both the Oculus and Playstation VR plan to release their headsets in the first half of 2016.[xi] Lastly, Microsoft will release their own form of VR with augmented reality glasses called the HoloLens.

Current Technology (October 2015)

To compare these devices will prove very difficult as they are all still prototypes that have been displayed in controlled settings. However, it is important to look at their current projected specifications, their intended goals, and the likely market they will capture. The Oculus Rift, owned by Facebook, aims to be an all in one device. Their mission, according to Facebook's VP of engineering and co-creator of Second Life Cory Ondrejka, is to make the world more connected and more open. They want people to communicate and share no matter the distance and to be more intimately than a cell phone or web page.[xii] With 360 degree sound, 100 degree vision, gyroscope, accelerometer, magnetometer, two screen high resolution, it will be the baseline set for future VR headsets. The technical specifications allow an immersive experience even if you are riding a roller coaster during an earthquake. With sound and sight taken care of the last issue is touch. Oculus includes an Xbox controller but will also offer two wireless controllers. These specialized controllers will allow you to reach out into virtual space, move your virtual body, and more. [xiii]

To truly be a sandbox device, the Oculus Rift will need the support of developers. To date, the Oculus Rift has sold over 100,000 developer kits in over 130 countries. Facebook has signed a deal with Microsoft so it will have full Windows 10 compatibility. There will be limited Xbox One support which may attract more early adopters. This user base will give it an early jump start in this VR race. Due to its financial backing of Facebook and its first mover advantage, the Oculus will be the front runner for VR enthusiasts for years to come.

The HTC Vive, developed by Valve and HTC, is trying to capture the PC VR gaming market. With a resolution of 1080x1200px per eye, its graphics will be on par with the Oculus. It will also have a similar tether system, an HDMI cable, connecting the headset to a PC. A negative is that it is still a bit bulky and cumbersome to wear. One unique feature is its Lighthouse technology where it tracks a user in a room. In a 15 sq foot room, sensors will track your physical movement. This allows a person to get up, walk around, and interact with a lot more space. Valve is hoping this unique feature sets it apart from the other devices. As with the other major VR devices, it will feature wireless controllers to facilitate movement. The game platform that will be used is Steam VR. There is already a long list of titles which should support the Vive on its launch. However, the question remains is how well will these games work with VR controls.[xiv]

Early reviews of the HTC Vive have been very favorable. Most reviewers are saying this is the first consumer VR device to truly deliver "presence". This is thanks to the dozens of sensors that dimple the headset. The motion tracking is freakishly precise, graphics are realistic, and the ability to walk around is a game changer. This has all the pieces in place to make it the best VR device for gamers.

The Playstation VR, developed by Sony, will work exclusively with the Playstation 4. For Sony, this will lock customers into their console and boost sales of both devices. The strategy for them is giving developers a defined platform and giving their customers a consistent experience. When it comes to game development, a single piece of hardware is a huge advantage. This gives programmers the ability to push the hardware to its limits without adverse effects. In comparison, the HTC Vive and Oculus Rift will play on millions of different PC configurations that will all give different performances. Another positive is that there is less chance of random bugs for users. On the flip side, developers will have to stay within Sony's rules which could be an issue down the line. If a VR experience is deemed not

appropriate, Sony could ban their game. Another downside is the Playstation 4 is already showing its age vs newer PCs which can result in developers abandoning the platform for newer technology.

Looking to release in the first half of 2016, the Playstation VR will include a second box to connect to the Playstation 4. A nice feature of the box is an HDMI out so others can see what the user is experiencing. [xv] The specifications state it will have a resolution of 960x1080 per eye and 100 degrees of field of view.[xvi] This will make it on par with the Oculus and HTC Vive. With strong backing from Sony, impressive reviews, and a consistent user experience, I expect the Playstation VR to perform well and make an immediate impact on the VR world when released.

The HoloLens, developed by Microsoft, will have a primary goal of enhancing business and education software. While it uses much of the same headset technology as its peers, it chooses to display an augmented reality instead of an isolated virtual reality. This rectangular view, similar to a heads up display in a car or plane, is powered by a CPU, GPU, and HPU (Holographic Processing Unit). This field of view may be limited but it promises to open up a new world to users. It does this by being a self-contained computer. That means you can take it anywhere with no need to be tethered to a PC or console. To allow apps easy transition across devices, the HoloLens will use a modified Windows 10 operating system to run its applications. Its rollout will be done methodically over many years. At first the HoloLens will be available to developers in the middle of 2016, then to enterprises, and finally to consumers.[xvii]

Unlike google glass, a device meant to limit the need to pull out a smartphone, the HoloLens has grand ambitions. It wants to be the go-to device for businesses to interact with software. For architects, they can draw up realistic 3D prototypes that can be shared with clients. Artists can draw up 3D models and export them to 3D printers. Teachers can quickly display pictures and videos to speed up the learning process. With the help of Windows 10, it can be used for entertainment with video players attached to virtual walls, Skype, and even the windows start menu that can be accessed with an air click.[xviii] Microsoft isn't stopping there as they have teamed up with NASA to provide HoloLens to astronauts. A heads up display can bring crucial information to the Space Station without much weight. [xix]

The Microsoft Hololens may be considered the best headset to date. It recognizes the user's voice, eye movement, and hand gestures to help interact between the real and virtual world. The biggest feature is that it's all done without a cable attached. How important this turns out to be is the big question that remains. [xx]

The Future

In the next two years, the future of VR headsets will be dependent on how well this technology transitions from lab to home. Computers can now render detailed images with low latency. No longer are pictures pixelated or frames rendered too slowly to cause blurring on the screen. Faster and more accurate sensors can detect our movements. New headsets use small OLED screens for each eye with slightly different angles to create a 3d effect. These new technologies give VR a chance to be affordable at a reasonable price for consumers. However, hundreds of tiny problems remain to complete the experience. How well each problem is tackled will be paramount to the overall experience. On top of that, each company will need developers that provide properly designed experiences. Any failure in this

execution can make a user sick or make the tech useless. However, in the coming years these devices will be updated and at some point it will go from early adopters to mainstream use.

For most of its history, virtual reality has been centered on military training and space shuttle missions. However, when VR takes off these new devices will bring a wide array of new uses. For architects, customers will be able to walk through their designs to see if it works for them. Virtual cities, real models of current cities and entirely fictional cities, will be made for cheaper forms of travel and exploration. A history teacher can explain the importance of the Declaration of Independence as students watch our founders sign it. Autistic kids can have a teacher that is infinitely patient. Therapists can meet with their patients in a safe, intimate, and convenient way for both parties.[xxi] And businesses can train their employees with virtual demonstrations on how to use equipment. This is only the start and as the software and hardware improve, it's impossible to tell how far reaching this will become over the decades.

The future of virtual reality will bring changes to our society and not all of these changes will be for the better. The most extreme downsides of VR were laid out in sci-fi books The Unincorporated Man and Summa Technologiae. In The Unincorporated Man, VR exploded in use across the first world. The experience, VR devices connected to the brain, made VR as real as the physical world. The user could command an army of dragons, live on Mars, or save the titanic; the possibilities and programs were endless. However, as VR became cheap and the only entertainment people needed, society broke down. First people stopped hanging out with their friends and then with their family. The world economy broke down as tourism, consumer goods, dining out, and new clothes were worthless compared to the VR experience.

In this dystopia, the first world sank into VR while the third world broke out into war. Feeding tubes kept people connected to their machines while their bodies weakened. When famine broke out, VR suicide, a program of pure happiness, became popular. This breakdown in society led the government to issue a set of VR commandments. These included to accept no reality except reality and absolute pleasure corrupts absolutely. Only when VR was banned, and its underground use all but stamped out, did society slowly come back.

Stanislaw Lem, author of Summa Technologiae, described virtual reality this way: "The more realistic the virtual world the machine creates, the more imprisoned we are in our imaginations. As our embodied selves, we interact with a world we know only in part, and which operates independently of our desire. In contrast, the virtual worlds we encounter are human constructions. Fabricated from our dreams, they are worlds in which nothing can be hurt or destroyed because nothing really exists. In short, they are worlds in which nothing really matters."[xxii]

These doomsayers' scenarios may seem farfetched but we do have some warning signs. There have been parents who have neglected their kids to the point of death while playing MMORPGs. When a person becomes fully engrossed in a virtual reality, they neglect their responsibilities in reality. As virtual reality becomes more real, we should be mindful of these adverse consequences and find solutions to negate them.

The likely scenarios are more cheerful and exhilarating. Engineers are already imagining the future ten years from now. "Think about watching a sporting event where you're sitting on the field, or concert where you're on stage and can switch between that or being above stage and it's a fully immersive

experience. I think that's where it starts to become a mainstream thing, where everyone has VR in some flavor."[xxiii] The possibilities are endless. The movie theatre experience, and other gatherings, could soon become obsolete. Instead of seeing a film with strangers, people will see it in a virtual movie theatre with their friend's avatars. That way they can talk during the film or mute the annoying person who is ruining the experience.[xxiv] Even weddings may completely change with VR. Instead of getting a text with a picture of the event, something that captured a tiny moment from a single perspective, a VR room could be setup for people who cannot attend. With 3D cameras, everyone can show up virtually to witness the event with full sound, depth of the scene, and even comment as things occur. For people who can't afford to attend destination weddings, this may be the low cost solution of the future.

The many upsides of VR heavily outweigh the likely downsides of VR. It would be impossible to imagine 10 years ago how cell phones would be used today or how the Internet would evolve from the 1980s. Today VR has similar upside. VR at its best shouldn't replace real life, it should supplement it, improve it, and give us abilities we could only dream of previously. If you can think of it, VR can make it. "It's a medium for progress, not the progress itself."[xxv] To quote Zuckerberg, "Every 10-15 years a new major computing platform arrives, and we think virtual and augmented reality are important parts of this upcoming next platform."

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[i] http://www.explainthatstuff.com/virtualreality.html
[ii] http://www.scienceclarified.com/scitech/Virtual-Reality/Airplanes-to-Arcades-The-Development-of-Virtual-Reality.html
[iii] http://techland.time.com/2013/04/12/a-talk-with-computer-graphics-pioneer-ivan-sutherland/
[iv] http://www.i-programmer.info/history/8-people/329-ivan-sutherland.html?start=1
[v] By 1972, the General Electric Corporation had built one of the first computerized flight simulators, using three screens surrounding the training cockpit to provide a 180-degree field of view that simulated flying conditions.
[vi] http://www.academia.edu/11402876/Virtual_Reality_History_Applications_Technology_and_Future
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[xxv] http://www.theverge.com/a/virtual-reality/intro