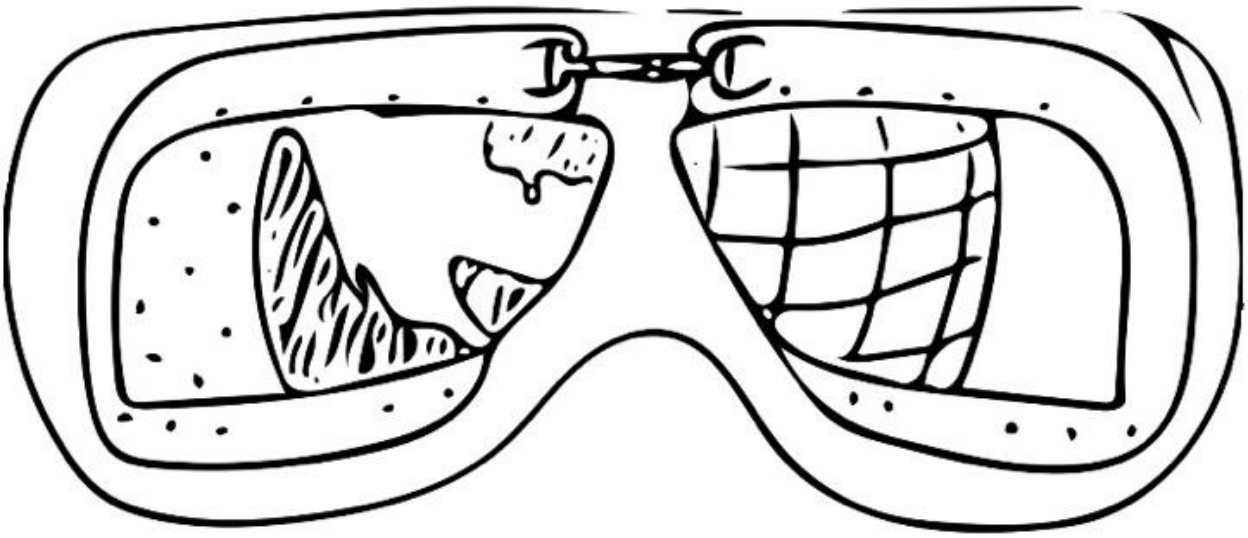
(Not So) Distant Worlds



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"Protect the Transport" blinks green on my heads-up display, stealing my attention from the millions of stars glimmering from what feels like inches away. I twist my ship to face the massive star cruiser. A sense of urgency falls over the scene as enemy fighters flash out of hyperspace, weaving between asteroids to prey on the exposed transport. A volley of lasers from my own small fighter turns two of them into fiery globes. The other three break off from their course to the transport, turning their sights toward me. One splits left and tries a flanking maneuver. I spin sideways and loop-the-loop, catching it in its own trick and destroying it with another round of blazing bolts. A well-placed missile from one of the remaining two enemies drops my shield, but I wheel around and end it with one of my own, rocketing straight through its burning wreckage. I'm too busy giggling from joy to notice the last foe. We run headlong into one another and simultaneously ignite in glorious, scientifically inaccurate flames.

"Holy shit!" I say impulsively. But it isn't fear or disappointment that invites the oath. Rather, as I pull the Oculus Rift headset from my face, I wear a fat childish grin. I just got to blow up space pirates from the cockpit of my own spaceship.

Humble Beginnings

Throughout our growth as a species, we've used stories to pass along knowledge, ethics, and history. Stories offer a form of escapism which can be described as thoughts, ideas, and knowledge embodied with visceral information. Over the past centuries, technology has expanded this cultural practice to radio, television, and – most recently – virtual reality. Previous electronic media paint vivid settings for their audiences to achieve this, but they offered limited stimuli with regards to actual sensory detail. For decades, television was restricted to light and color with very little effect on the embodiment of information. Even before that innovation, radio could only produce audio. Providing immersion through VR is the next stage in our evolution as storytellers. The expansive applications of VR don't lie solely in narration, however. Recent research and development shows that the technology can be applied to the fields of medicine, military, and general job training. Implementing VR can improve

both the productivity of professionals and the happiness of people around the world.

Virtual reality is an emerging technology that uses sensory illusions to portray vivid simulated environments to users. Visual perception in humans is notoriously fickle, and therefore aspects of an image can be manipulated to make someone believe false information. An early example of this is the stereoscope, invented in 1838, which allowed people to view two two-dimensional pictures presented individually to each eye as one three-dimensional scene. The concept was used in later designs, eventually leading to modern headsets like the Google Cardboard and Oculus Rift. These empower the user to embody the visual information more than any image seen on a typical screen, allowing for unique opportunities in professional job fields.

Before the technology to create more convincing simulation devices arose, people dreamed of the possibilities that such devices would provide – and often with surprising accuracy. "Pygmalion's Spectacles" by Stanley G. Weinbaum predicted a pair of goggles that would let the wearer "experience a fictional world through holographics, smell, taste, and touch" (Virtual Reality Site). As is often the case in historical science fiction, the story accurately predicted future technological trends.

Figure 1: 1838 – first stereoscope. Only about 200 years of inventing to go.

The first "true" virtual reality machine was Morton Heilig's Sensorama, invented in the mid-1950s. The Sensorama was an arcade style theater cabinet built to stimulate all senses, and included speakers, a stereoscopic display, smell generators, fans, and a vibrating chair. The elaborate design was both unwieldy at the size of a fridge and severely limited in terms of technology – offering only films that were shot and produced by the creator and

limited to a forward-facing visual display without 360º range of vision.

Modern VR headsets, while not as extensive, aim to achieve the same goal: immerse users into the world of the narrative being told – whether a fictional story, a hands-on instructional video, or an intense action video game. Today, advances in computer graphics and processing speed allow for a wide variety of simulations. Soldiers can train in highly realistic combat scenarios that offer no risk of death. Doctors can practice simulated surgery without harming the patient (and with unlimited do-overs). Bedridden patients in a hospital can take a "stroll" outside to relieve some stress.

Vacation from the World

Perhaps as a result of the extraordinary strides VR has made in recent years, its arrival has also brought a fair amount of apprehension. People have argued it might separate us further from reality, that its invention may permanently disconnect portions of society from the rest, and that it might even be used to serve more sinister purposes. Dissenters have even hypothesized that it will be the first step taken towards a future without privacy checks or social interaction. This dark side to virtual reality stems from our fear of losing control – that we could one day become willing servants of our own entertainment. Aldous Huxley's dystopian novel *Brave New World* predicted the "feelies," in which people could watch movies and simulate the senses of the characters via electrical stimulation. While impressive, feelies were shown to lack art and substance – depicting only sex or other pleasurable acts as a means to keep the people of the society brainwashed and materialistic.

Figure 2: What? Brainwashing? Not happening here, no sir.

More concerns arose following a VR demonstration by Facebook founder Mark Zuckerberg. A photo was captured of Zuckerberg walking down the auditorium aisle amidst hundreds of people wearing VR goggles, completely unaware of his presence. What was intended as a cool, unique look into the power of VR became a near panic for the public. Critics described the scene as Orwellian, even dystopian – believing it to foreshadow a future of isolated people, each tucked away in their own false reality. Zuckerberg responded to the condemnations by addressing past problems with evolving media, expressing that every new technology is thought to pull humans away from the world. This extends to television, video games, and even books. "But humans are fundamentally social," he continued. "…if a technology doesn't actually help us socially understand each other better, it isn't going to catch on and succeed" (Time). The purpose of this storytelling technology is to capture the imagination of its viewers, in order to inspire and innovate. Those who would recede from the world and permanently lose themselves to it would do so regardless of the technology available – people have chosen such a path with every generation of media. A person's immersion into storytelling is not dependent on the immersion of the technology, it is dependent on the person.

Figure 3: Patients who can't physically leave the hospital can explore digital environments

Despite the dark future that critics predict, the applications of virtual reality also demonstrate that its benefits vastly outweigh its risks. Cedars-Sinai Hospital in Los Angeles has adopted a virtual reality treatment program that allows disabled patients to experience pleasing – and most importantly, distracting – virtual environments. Patients who can't walk can instead take a helicopter over Iceland, or a submarine to the Marianas Trench. By conducting the project, doctors and researchers seek "to improve the quality of care, the experiences that our patients have, but also to reduce the cost of care" (VR World). VR, in this case, improves the lives of people in a fundamental and tangible way. Further, VR has been lauded as the next stage in the evolution of multimedia. *House of Cards* star Kevin Spacey, who has always pushed for new and adventurous experiments in the entertainment industry, is advocating public acceptance of virtual reality technology. In a talk at the AT&T 2016 Developer Summit, he called it a "quantum leap" forward for storytellers – just as the motion picture was a century ago (GeekWire). Spacey referenced one of the first motion pictures, screened in 1896, which depicted a lifelike train hurtling at the audience. Many screamed as they ran from the theater, convinced it was real. "But in VR, there is no way to hide from that train. Virtual reality is completely immersive. You step through that widow and you are in a different world." Much like the profession of acting, virtual experiences let a human being experience life from a new perspective, and thereby come to gain empathy and a new understanding of humanity. Rather than isolate us to our own distant worlds, it may give us insight into each other's.

Virtual Spaces

VR was first introduced to me through a web design project I conducted for the Virtual Reality Club at UC San Diego, a group dedicated to integrating this growing technology into society. To become more acquainted with the club and its goals, I interviewed several of the members in charge of funding and research. The club, formed in fall of 2015, hopes to become a center of research for VR in the UC system. Most members join because they believe in VR's unbounded potential in our society.

To reach this point, VR at UCSD aims to expand by several hundred members over the course of the next few years, open roads into industry and research, and gather funding for promotion and progress in the ever-expanding world of VR technology. Students from various educational backgrounds – including physics, electrical engineering, and computer science – have flocked to the club, fascinated by the prospects of virtual reality and eager to help it become a commonplace device. While the club tends to attract those involved in more scientific areas of study, its members remain open to anyone wishing to learn more about VR and its applications, offering workshops and talks from experts in the field. Its main goal is to inspire people to become interested in VR, and so its methods revolve less around recruiting qualified individuals than including anyone willing to contribute and learn.

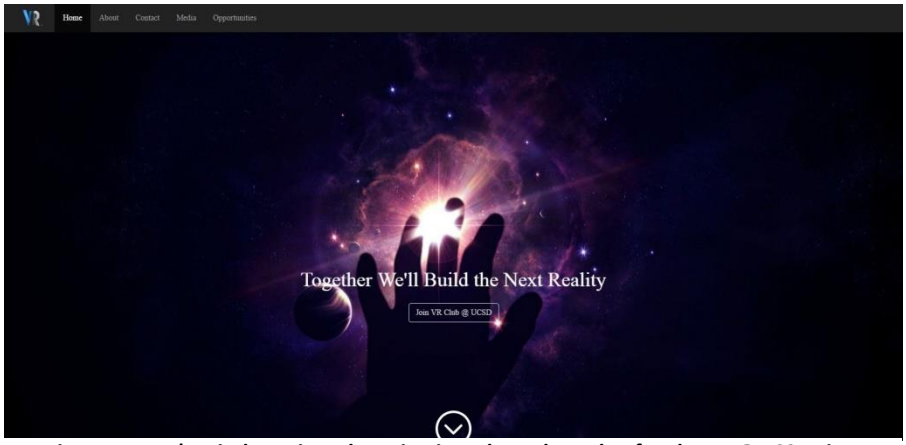

Figure 4: **Don't mind me, just throwing in a shameless plug for the VR@UCSD site.**

UCSD itself is also involved in the advancement of VR technology, having recently constructed the StarCAVE – something that sounds straight out of an old science fiction book. The StarCAVE is a pentagonal 3D virtual reality environment, which can project high-quality videos and images onto screens covering the inside. Though it sounds incredibly fun, its purpose is far more scientific, as it "allows groups of scientists to venture into worlds as small as nanoparticles and as big as the cosmos" (UC San Diego News Center). Users can also wear 3D glasses in order to improve depth of vision within the environments – giving them the power to "fly" around a synthetic molecule or strand of DNA and view it from any angle. Even more recently, "A virtual replica of Calit2's headquarters building at UCSD, Atkinson Hall, has been used by neuroscientists who want to know if the human brain operates differently in virtual reality versus reality in 'wayfinding'

situations". The possibilities it offers demonstrate amazing applications in biology, neuroscience, structural engineering, and archaeology, among many other fields of research. This technology will expand far beyond its current capabilities – which even now are extremely impressive. As with all technologies, however, it must overcome some massive hurdles before it will be suited for common use.

At its current state, high-performance VR is not readily applicable to games or many other forms of entertainment due to its extremely high commercial cost. And, despite its exponential progress over the past decades, it is still plagued by a multitude of issues that hold it back from its full potential. "After a while, you just notice that there's something *off* about it," says an associate of the VR Club, after he shows me the abilities of the Oculus Rift headset.

Ear-ly Problems

That "off" feeling is more than the simple paranoia of the user, and the answer lies in our biology. In recent years, companies like Virtuix and Infinadeck have begun development on omnidirectional treadmills – devices that allow a user to navigate a 360° space while wearing a virtual reality headset. The combination gives people the power to freely explore any virtual environment, which now even includes adventures outside the average person's reach. One of the oldest known cities is the two thousand year-old Petra, a massive set of ruins in Jordan. Google has completed imaging that now allows users to "explore" these ruins for themselves using a headset and treadmill to navigate the three-dimensional digital space – which, despite being composed entirely of static images, can completely immerse those who wish to take the trip.

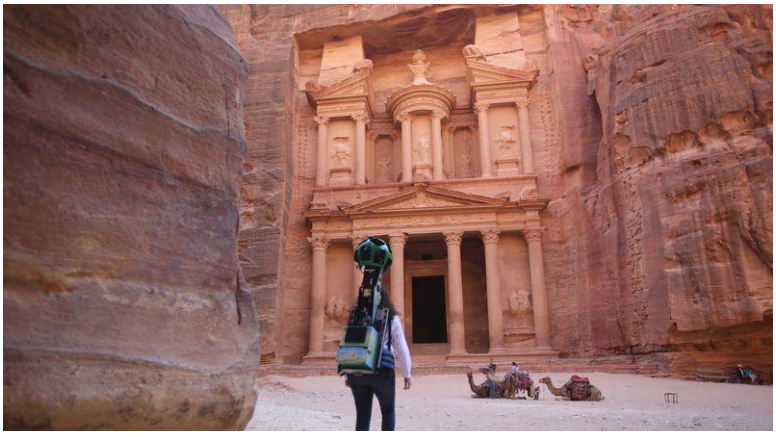

Figure 5: Time and people pose a threat to ancient sites like these, but with imaging and VR, they can be digitally immortalized.

In spite of the impressive combination of vision and movement, users have difficulty adjusting to the virtual environment – some even feel nauseous by

the end of the experience. These issues arise out of a failure to fool our highly evolved perception.

While we see walls and floors moving around us, we can't physically detect the motion due to a lack of stimulation to our inner ear organs. The vestibular system, which lies deep in our inner ear, contains a series of globular organs that roll with our worldly orientation. These stimulate hair cells that communicate to our brain the direction of our current movement. A treadmill paired

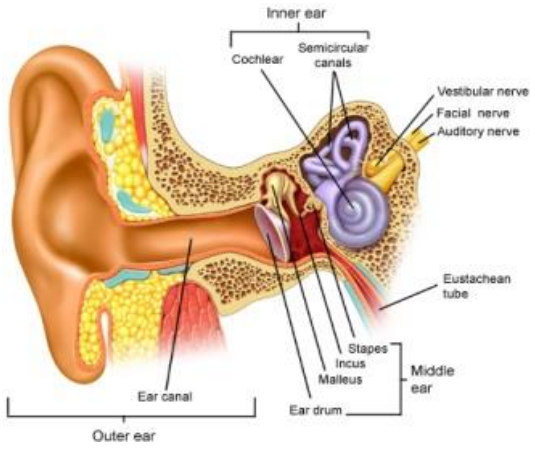

Figure 6: The inner ear system is evolved to work with other senses to form a complete image of the world. When pieces of the picture are removed, we experience physical confusion.

with virtual reality goggles gives us visual and auditory input – feedback that informs us there *must* be motion happening – while the lack of actual acceleration fails to stimulate the vestibules, which in turn say that there is definitely *not* motion happening. This sensory confusion actually demonstrates the inverse of car sickness, in which we feel momentum of the vehicle moving forward, but don't perceive it while engrossed in a book or phone screen. Both phenomena create a conflicting response to the image of "reality" presented, which is the cause of our natural aversion to the experience and even physical sickness.

Very much in the theme of Heilig's Sensorama, to fully trick the human senses, future VR devices will be required to address many senses rather than sight and hearing alone. Feel, smell, air movement, and – most importantly – motion sensation must be simulated if the virtual space is to earn the title "reality".

An Alternative Reality

However, VR isn't the only technology seeking to immerse people with visual and sensory tricks. Augmented reality (AR) devices blur the line between reality and computer graphics by adding "graphics, sounds, haptic feedback and smell to the natural world as it exists" (howstuffworks.com). While we haven't yet reached the future that Minority Report or

Google Glass envision, AR has nevertheless had a profound impact on the direction of technology. As early as 1990, "assembly workers at Boeing were wearing see-through head displays that superimposed computerized images of where to place the wires on the 777 aircraft, which saved them from looking back and forth at their manuals" (theatlantic.com).

The ability to insert computer-generated graphics into the physical world is something predicted in science fiction. *Minority Report* depicted gesture-responsive computers with floating holograms for interfaces, and the novel *Rainbow's End* portrayed a future where virtual overlays are dominant in society. The current existence of touch screen interfaces has already begun the trek towards entirely gesture-based ones.

While augmented reality technologies might be a bit further from commercial use than those of virtual reality, they offer powerful advantages due to their ability to project onto the physical world. Rather than generate an entirely new virtual environment, AR can to modify the world in such a way that it entertains or informs its user. This demonstrates the usefulness of a virtual "assistant" that can be easily and widely integrated into everyday tasks – including communication, professional work, gaming, and information visualization (theatlantic.com). As a result, many programmers and engineers have begun abandoning VR development and research for this far more applicable alternative.

Figure 7/8: While today we must use a hardware medium, such as phones or goggles, to view Augmented Reality images…

...future generations might have the power to apply AR to a multitude of locations through glass and glasses.

With the growing utility of haptic controls and brain-machine interfaces –

both for human communication with machines and virtual spaces – we could see exciting new devices that give people greater control and knowledge of their environments.

Haptic devices, such as gloves and controllers, are the main form of interaction with virtual and augmented reality. Current technology allows for these tools to detect their locations in physical space, which can then register in the projected virtual environment as cursors or rendered hands. This empowers users with gestural interaction on screens or in simulated surroundings. Because of the dexterity of our hands, we can use such devices on a far more complex level compared to traditional button-operated controllers. However, even these devices offer their limitations. Modern research attempts to address these issues through improvements to haptic devices, as well as development of new modes of interaction.

Brain-machine interfaces may prove to be our next step in the evolution of interface design. Through decades of brain imaging, recording, and mapping, neuroscientists have locked down certain parts of the brain that can communicate certain feelings or intentions. By reading brainwaves through scalp-level electromagnetic detectors, new devices can interpret these thoughts from their wearer and translate them into action commands. Its advantage over most other forms of interaction comes from the use of one's "inner voice" over other, more physical forms of interaction (gadgets.ndtv.com). Haptic gestural interfaces rely on one's hand movement, which restricts their usefulness in the physical world (and might embarrass the more self-conscious users in public spaces). Voice also limits the usability of the technology, as it could easily be interfered with by others in the environment, and could even confuse the user's intended target of speech; when directed at their friends or coworkers, for instance. Eye-tracking, though impressive, is simply too difficult on the human level. Concentration on multiple, extremely close targets can be difficult and – whether possible or not – will interfere with the most valuable sense available to humans. As a result, it is most effective for one to "think" actions into execution, which will require years of research to further implement in AR technology.

Onward!

The search for our next reality began with VR, but research and development trends show that AR will likely provide the more beneficial advances to our interactions with the world. Creating virtual worlds began as an experiment into how we might be entertained or improved through immersion in some new space – through which we might learn about ourselves or about the existing world. The stories we are told in VR become embodied, as if we experience the events on a deeper scale than through a more detached medium. There is no doubt that it provides a unique and potentially perspective-changing experience. VR itself, however, is too isolated in its own sphere to improve our interaction with the world itself. Augmented reality is the solution to this roadblock – rather than changing the world around us, it extends our mental self and thereby the way we experience the world.

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