Virtual Reality's Place in ~~Industries~~ Industry [Title will be improved]

In this paper, I argue that virtual reality (VR) is an exceptional tool that will benefit many sectors. Virtual reality, within the context of this paper, encompasses everything related to displays that offer six degrees of freedom of movement through sensors; however, my main focus is on VR head mounted displays (HMD). In essence, these HMDs are displays with cameras that track head and body movement and mimic it into whatever program the display is running. These sensors allow for an experience with six degrees of freedom, using individual trackers for each hand and the head. Using these trackers, movement and rotation in 360 degrees combined with haptic feedback and a good audio system allows for a very immersive experience (Slawson, 2019). As an example of a VR program, medical students may have a program that allows them to perform a simulated surgery without any potential mishaps that may happen in real life (Roy et al., 2017).

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HMDs have progressed significantly in the past three years. Nowadays, anyone can have a wireless, high resolution, comfortable VR headset with no need for external cameras or setup. In the past, VR had not been sufficiently developed to be utilized effectively. VR needed large external cameras, an immensely powerful computer, and was hindered by a heavy cable connected to the headset ("First Look at The Rift," n.d.). Therefore, I argue for the potential of these VR HMDs, highlighting their advantages, and addressing their shortcomings.

I support my position on VR HMDs with the following three arguments. First, I argue that VR has limitless possibilities with training and education. Everything is inside the headset, so unrealistic scenarios that would have taken too many resources can be modelled with ease (Sampaio et al., 2010). Second, I argue that the convenience factor of a VR HMD makes it a desirable choice for various sectors. Specifically, I discuss how training programs can omit space, resources, environment, equipment or even instructors when using a VR

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HMD (Farra et al., 2015). Finally, I discuss virtual reality's adaptability in various situations and how it can be used in creative and unique ways. I give examples of its potential within the medical sector, where it has helped mental health issues such as dementia, and strengthened stress resistance for the military (Pallavicini et al., 2016). While these techniques are fairly new, VR has been used to improve patients' health, both mental and physical ("Virtual Reality in The Healthcare Industry," 2017).

I also explore the arguments against using VR HMDs. Mainly, the argument centers on the idea that these HMDs have been untested for long-term health issues (Hoffman et al., 2008), the state of the technology in 2021, and the logistics of producing and distributing enough VR setups to support mass-market usage (Gilbert, 2021). While these arguments have merit, I show, for example, that the state of the technology has improved vastly in recent years and is now in an acceptable condition to start exploring virtual reality's full potential.

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This paper is of foremost importance because the concept of VR as a whole will inevitably be revolutionary. Before long, many institutes will rely on VR systems for their training and education programs. This approach to VR systems is because nothing can come close to the experiences that can be provided in virtual reality ("Immersive Technologies," 2020). Additionally, VR has been gaining traction in many other sectors because of its potential for creative applications. As an example in the tourism industry, hotels including Atlantis Dubai and Grand Oasis offer 360 degrees VR tours (Aubert, 2020). This ease of use and usefulness combined will undoubtedly make many sectors adopt VR systems to accomplish their goals. Overall, virtual reality is an exceptional tool that can be employed by many sectors to profound effect because of its potential for training and education, its convenience factor compared to traditional alternatives, and its adaptability allowing creative and unique usage.

Why Virtual Reality Should Complement Traditional Alternatives

Virtual Reality

Overall, virtual reality is a viable tool because it has potential for training and education, the convenience factor it provides and its adaptability.

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Virtual Reality's Potential for Training and Education

Virtual reality as a tool for training and education in many different sectors is a viable alternative to conventional methods. First, virtual reality offers training programs that previously might have been inaccessible or hard to emulate. For example, a study for disaster training conducted by Farra et al. (2015) has been reported to have increased knowledge retention rates with the usage of VR. The author further explains how traditional disaster training does not encompass the real feeling of a disaster as students know that it is just a training drill, except VR alleviates some of that feeling. Additionally, failure-states or things such as improper experimentation of machines that may lead to too many additional costs can be encouraged in VR. The study conducted by Roy et al. (2017) highlights how VR can be used as a completely risk-free environment for learners and provides five different programs tailored to different applications for dental education.

Not only is virtual reality usable in training, but also VR is a natural fit for education. Virtual reality conforms to the 70-20-10 Model for Learning and Development developed by Lombardo and Eichinger because VR learning modules are primarily designed to give hands-on experiences. According to the model, 70% of learning is from hands-on experience, while the remaining 20% and 10% are divided into discussion and formal learning respectively ("The 70-20-10 Model," 2020). In addition, virtual reality provides an increase in retention and satisfaction for people who use it. According to "How Walmart Embraces Immersive Learning," (2019) "[A]ssociates using VR training reported 30% higher employee satisfaction, scored higher on tests 70% of the time, and logged a 10% to 15% higher rate of knowledge retention than before VR." This increase in retention and satisfaction rates will naturally lead to improved results. Additionally, using VR also leads to higher test scores, as

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according to Virvou and Katsionis (2008) 74% of the people who achieved high scores chose VR as the medium. Lastly, VR is not limited to just increased knowledge or satisfaction. VR can also be used for dexterity-based training applications. For example, the study conducted by Bhagat et al. (2016) reported a statistically significant difference between the control group and the group that used VR for training in live firing exercises. Therefore, VR can be useful for training for precise maneuvers such as operating a vehicle or firing a weapon.

In addition to virtual reality's position for training and education, there is untapped potential with combining VR and artificial intelligence. Some researchers started adding simple AI with VR training modules to help streamline the process. Artificial intelligence enables the use of analytics and allows for dynamic changes to the module to be more personal. For example, AI can detect a wrong procedure attempted in a training module and show the user a recording of a successful attempt alongside providing verbal feedback on what went wrong based on where the user failed (Slawson, 2019).

The previous reasons combined with the current lockdown makes VR a viable alternative for e-learning. Students can enter virtual classrooms exactly like their real counterparts and interact like in real life except using VR headsets. Additionally, virtual reality can be used to circumvent issues provided by traditional electronic learning such as decreased satisfaction and retention rates. According to Means and Neisler (2020), student satisfaction went down 30% and 42% of the students classified being motivated as a major problem after universities started remote learning because of Covid-19. Furthermore, Monahan et. al (2008) reported that levels of communication and social interaction was increased in VR. Therefore, having a semblance of a real classroom experience in VR will help alleviate some of the shortcomings of traditional e-learning and place students in a more familiar environment.

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Virtual Reality

Virtual Reality's Convenience Factor Compared to Alternatives

In terms of convenience, VR beats many alternatives. There are three major areas in which virtual reality has an advantage. The efficiency in terms of initial and running costs, the intuitiveness and ease of use, and the option to experience things that may be too risky to attempt otherwise all make virtual reality a good pick over alternatives.

First, the initial cost of buying the VR setups and the negligible cost to cover unforeseen repairs are much lower than traditional equipment. For example, the cost for training on operation of an industry-grade milling machine would need instructors, the machine, maintenance on the machine, materials for the students, and finally safety equipment (Cole, 2017). Conversely, VR will just require programming a scenario that features a working milling machine and animations on how to use it. In fact, VR applications for mechanical and electrical engineering education have already been reported as successful (Kamińska et al., 2017).

Second, virtual reality experiences are widely regarded as intuitive. They are easier to navigate, understand, and digest ("An Intuitive VR," n.d.). This intuitiveness even leads to its utilization in unexpected ways such as IKEA providing an application that combines IKEA's furniture catalog with a user's home to produce accurate previews of what a final room may look like ("10 Applications of AR/VR," 2021). Finally, this intuitiveness is a major factor in the increase of retention and satisfaction rates (Hughes, 2020).

Third, one unique position for VR is that it is completely risk-free. Risk-free is referring to the fact that everything happens inside a headset, so using VR for dangerous experiences or anything that may present a safety risk can be performed without worry. As an example, skydiving or mountain-climbing for recreational purposes, but more practical examples include surgery training or shooting practices. All of these may have remarkably high risks in real life but no risks whatsoever in virtual reality.

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Adaptability of Virtual Reality

As mentioned previously, VR is mainly limited by software. This flexibility gives it unmatched adaptability when compared to other, more grounded, alternatives. VR experiences can range from miniscule one-scenario applications to ambitious, extensive, and free-form simulators. One such simulator is Microsoft Flight Simulator 2020, which covers every point in earth using Bing Maps technology with an unbelievably detailed flight simulation experience (Jensen, 2020). At the other end of the spectrum, programs such as DentSim serve an extremely specific purpose (Roy et al., 2017).

Virtual reality is not limited to hands-on experiences such as Microsoft Flight Simulator 2020 either. Some creative usage includes shopping centers that incorporated VR as a shopping list experience which then experienced a higher sales rate ("Are Retailers," n.d.) and museums who sell virtual tickets to their collections in a digital environment ("Museum VR," 2021). Viewing should not be limited to recreational purposes either, as visualization in a fully three-dimensional virtual environment as well as the time saved by using such visualizations can be greatly beneficial for workplaces. As an example, civil engineers can use VR modelling software for visualizing environments for professional practice in both architecture and engineering (Sampaio et al., 2010). This type of visualization can be extended to many other practices as well.

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One more factor that lends to adaptability is that a VR headset is a universal setup. For most applications, the headset and the available controllers without any additional equipment are everything needed. However, more detailed experiences can choose to include additional hardware if desired for a more immersive experience. For example, many Flight Simulator 2020 users buy their own flight sticks for added complexity instead of opting to use the universal controllers (Minor, 2020).

Another recent development in VR applications leads to its use for mental and physical health and therapy. A study by Inman (1997) found that using VR to help educate

disabled children can be successful. The authors reported a correlation between time spent in their custom VR scenario and driving skills. VR is also used by the US military to combat stress and increase stress prevention in programs named Stress Management Training (SMT). According to a meta-study performed by Pallavicini et al. (2016), VR-based SMT programs can reduce subject emotional responses to negative stimuli, can assess resilience and identify the root issue for stress as well as provide interactive environments. Finally, VR can be used to treat dementia or at a minimum lessen its effects. A study by Kim et al. (2019) meant to explore mild cognitive impairment concludes that "VR interventions, particularly of the semi-immersive type, are useful for people with MCI or dementia" (para. 4). Therefore, VR can actually have a profound effect in treatment.

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Why Virtual Reality Should Not Be Considered

The argument against virtual reality centers on two key points. First, its undiscovered long-term health problems. Second, the current stage of technology is considered inadequate. Additionally, complaints against mass-market adoption statistics exist

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Potential Long-Term Health Issues

Critics of VR argue of the potential ~~of~~ for long-term health issues. Both undiscovered physical and mental problems may arise from the excessive use of VR. First, having wireless devices with heavy bandwidth attached to the face for extended periods of time can have long-term issues. Second, strain and other potential eye disorders are discussed. Finally, addiction is also a common topic when it comes to VR entertainment. Addiction has long been explored by numerous credible mental health experts, and it is an extremely dangerous mental health problem.

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Most of the aforementioned health issues have been resolved. Eye disorders coming from VR and even standard computer monitors have long been discovered to be limited to strain and irritation from dryness ("Safeguarding Your Sight," n.d.). Additionally, wireless

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waves have been reported to be insignificant except devices that use heavy-bandwidth Bluetooth for extended periods of time, which researches say may have some potential long-term effects (Ries, 2019). VR setups mostly use only small-bandwidth Bluetooth for the controller tracking and sometimes Wi-Fi technology for PC-VR communication.

Addiction is indeed one of the most dangerous things when it comes to virtual reality. VR entertainment, like regular computer entertainment, is filled with dopamine releases that encourage repeated use. This issue is not limited to VR only but also to general computer usage and even many other aspects in life. There is nothing that can be improved in VR technology that combats this mental health issue, it is instead left to mental health experts and addiction treatments.

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Current State of Technology Needs Improvement

Some people argue that the current state of virtual reality is not enough for mainstream application. First, the resolution of consumer-grade VR headsets is not on par with the latest, state-of-the-art monitors. For example, the Oculus Quest 2 released earlier this year uses two 1,832 × 1,920 LCD displays whereas most of the latest computer monitors can easily reach 3840 x 2160 pixels and some high-end monitors even reach 7680 × 4320 pixels (Lang, 2020). Second, the framerate of even the most recent VR headsets rarely exceeds 100 frames per second ("The Importance," n.d.). This high framerate without AI extrapolation combined with the heavy graphics card requirements for the latest technology results in loss of performance. Third, VR headsets that do not use external mounted cameras still have some blind spots. These blind spots are mainly the area ten centimeters below the headsets and the last 60 degrees of body movement behind the headset. Fourth, the current software support is often regarded as poor by VR enthusiasts (REF). These enthusiasts complain that the initial

setup and updating VR software as well as diagnosing issues can be unintuitive. Evidently, all of this combined demonstrates that VR technology needs improvement.

Even with all of these issues, VR has reached an acceptable performance for daily use. Previously, the issue of resolution was crucial because of headaches caused by poor resolution or framerate. The 80+ frames per second combined with AI software to extrapolate additional frames is more than enough to reduce motion sickness to a bare minimum ("The Importance," n.d.). The resolution is more than adequate, and it does not cause any strain issues. In fact, the latest generation of headsets have more pixels per eye than 65% of monitors used primarily for gaming according to a survey conducted by Valve (Downie, 2020). Any further issues will soon be resolved, as the advent of Deep Learning Super Sampling is going to reduce performance needs across the board for all graphics heavy applications ("NVIDIA DLSS 2.0," 2021).

Apart from performance, the blind spots with inside-out tracking still exist. Moreover, it seems that there have been no major improvements in the latest generation, but those blind spots are considered not important because even the most niche applications almost never use those areas. For software, Facebook has dedicated one fifth of its employees for VR (Byford, 2021), which will inevitably mean improved software. Furthermore, software is bound to improve as it currently is one of the barriers that discourage the general public of setting up their own VR setups (REF).

In addition to the current hardware and software limitations, critics also argue that VR is nowhere near mass-market adoption. They base their arguments around the fact that only a few companies produce headsets, and those companies are not supported by major technology companies. Additionally, they argue that the current number of VR headsets in the market is not enough for the logistics required for mass market distribution.

It is true that VR in the past few years did not have such a strong market presence. While the numbers in the past few years were not adequate, VR is expected to reach a market

size of 72.8$ billion U.S. dollars by 2024 (Gilbert, 2021). Gilbert also notes that in 2020, the market was worth 12$ billion U.S. dollars up with a growth of 54% from the previous year. Additionally, VR is expected to reach 43.5 million units sold by 2025. Finally, VR is currently being adopted by major players in the technology field. Companies such as HP, Lenovo, Valve, Facebook, Sony, HTC, and Samsung actively contribute to the latest advancements in VR (Stein, 2021).

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Conclusion

Virtual reality should complement traditional alternatives because of its potential for training and education, its convenience, and its adaptability. Virtual reality's application in training and education is providing a highly satisfactory and effective way for both hands-on training and theoretical education. VR's convenience factor also rises above most traditional alternatives, to the point where it is starting to shake up industries in highly creative ways. VR's adaptability is really limitless, as it is only limited by what current generation hardware can support.

Now, with the Covid-19 global lockdown is a perfect time to start introducing VR. It can be established as a means to connect with other people without the risks of the virus travelling. At its current state, the best pick for a personal or professional VR headset is the Oculus Quest 2. Other alternatives include the Valve Index, the HP Reverb 2, and the HTC Vive Pro. With the $300 price-point for the Oculus Quest 2 ("Oculus Quest 2," 2021), VR has been exploding in popularity for personal use. News discussing the fifth generation are exciting, and many improvements to resolution, computer power and eye tracking are expected. Lastly, practicing safe practices such as taking regular breaks and taking breaks immediately if motion sickness occurs is essential for the best experience.

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An EXCELLENT 'working draft.'
You have established your ideas well.
Nice use of sources.
Although there are comments - none significantly affect grading FOR THIS STAGE OF THE WRITING PROCESS.
You will - however - have to address all those comments (including your own) for the 'Final Draft' to maintain the grade.
Nicely done! :)
VERY nicely done!!! ☺

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