The Enterprise Applications of Virtual Reality

Emerging Technologies and Applications of Virtual Reality for Business

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High Level Description

In 1968, Ivan Sutherland and Bob Sproull introduced the Sword of Damocles, the first virtual reality head-mounted display.\textsuperscript{1} The technology was revolutionary, immersing users in an environment in a way never before seen. It was heralded as the future of display, however for nearly fifty years, virtual reality languished with only incremental improvement and innovation.

Today, nearly five decades later, virtual reality is enjoying a renaissance as substantial leaps forward in mobile technology have once-again sparked imagination into what is possible in virtual environments, and the possibilities appear more real than ever. By some accounts, the Virtual/Augmented Reality market is projected to reach $150B by 2020.

\textbf{Virtual/Augmented Reality Revenue Forecast ($B)}

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\includegraphics[width=\textwidth]{virtual-revenue-forecast.png}
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Digi-Capital Forecast of Virtual/Augmented Reality Market\textsuperscript{2}

While much of the public focus has been on entertainment, the prospects for altering the way we work are potentially even more disruptive.

\textsuperscript{1} Sutherland, I. E. (1968). "A head-mounted three dimensional display". Proceedings of AFIPS 68, pp. 757-764

Evolution of Virtual Reality Technology

Several advances in technology over the past five years have made the prospect of widespread adoption of virtual reality seem more possible, if not inevitable, than ever before.

Once critical advancement has been the development of low-cost high-quality mobile components, thanks to the pervasive adoption of smartphones. The Oculus Rift, the VR device created by the startup Facebook acquired in 2014 for $2 billion, is powered by many of the same parts present in a typical smartphone or tablet, including the 7-inch display and accelerometer sensors for detecting head movement.3

Another important advancement in virtual reality technology has been around motion sickness. Motion sickness in virtual reality occurs when the on-screen graphics do not keep pace with a user’s head movements. When there is a lag between movement and graphics – known in the VR world as motion-to-photon latency – a disconnect arises between what the eye sees and what the brain expects to see, and motion sickness often occurs. In order to create an experience free of motion sickness, VR headset manufacturers needed to create an extremely low-latency technology. Experts suggest that a refresh rate of below 20 milliseconds will be required in order to accurately render an environment that does not make users sick. Early attempts at virtual reality headsets in the 1990s, such as the Nintendo Virtual Boy, could not achieve these rates, and often left users feeling dizzy and nauseous. Powered by much-improved mobile processing technology, the latest version of Oculus delivers a

refresh rate of ~13 milliseconds, which for most users should be sufficient to overcome the motion sickness challenge.\(^4\)

**Emerging Applications of Virtual Reality**

While much of the focus on virtual reality has been on the consumer side, enterprises are beginning to see the potential for virtual reality to revolutionize how companies operate, particularly in how they teach, communicate, and build.

**Training**

One of the most salient applications of virtual reality for enterprises is in training. The use of virtual reality in training extends back to even the 1930s, when air force pilots trained on flight simulators built by the Link Company. Though these systems lacked video, they were effective in teaching thousands of pilots to fly at night in safe conditions with the benefit of only using flight instruments for navigation. Training using virtual reality provides the benefit of teaching students in immersive, real-world situations, which has been proven to provide better learning outcomes than basic 2D or classroom instruction. One such study found that when welding students were taught using virtual reality, they were found to have a 41.6% increase in overall welding certifications earned when compared with a group that underwent traditional welding training.\(^5\)

Not only does virtual reality have the potential to provide better training outcomes than traditional methods, but it also provides a much safer environment to learn skills like flying, combat, or surgery, making it a particularly interesting technology not only to military institutions, but also hospitals. In a review of 592 cataract operations that was published in the Journal of Cataract and Refractive Surgery,

\(^4\) Oculus Rift Development Kit 2, https://www.oculus.com/dk2/

ophthalmology residents who had used a virtual reality simulator during training performed such operations more rapidly and with fewer complications than students who went through traditional training.⁶

Ophthalmologist practicing cataract surgery on Eyesi ophthalmic surgical simulator⁷

**Case Study: National Grid**

Though much of the early focus on training with virtual reality has been in military and surgical settings – unsurprising given the difficulty in learning these skills on the job – companies are beginning to see the benefits that virtual reality can have on their training programs as well.

National Grid, an electricity and gas company based in the UK and northeastern US, has begun using virtual reality as an integral part of the

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technical training curriculum. National Grid’s virtual reality training allows students to simulate real-life decisions, such as what tools will be required or a task or what safety gear is needed, before facing those decisions for real in dangerous jobsites.

“With VR, we’ve been able to move from a PowerPoint presentation to a hands-on model”, said Patrick Hallihan, Senior Training and Engineering Instructor at National Grid. “[we] teach students how it works without having to climb to the top of a utility pole. The technology is familiar to many of our students, as they grew up with virtual world computer games.”

National Grid has engaged a variety of third party experts in implementing and improving their virtual reality training systems. The company brought in Premtech, an engineering and design consultancy, which has helped National Grid import their 3D models into a gaming engine called Unity, which creates a realistic virtual reality environment without having to build an engine from scratch. National Grid also brought in Virtalis, a leading virtual reality advanced visualization company, to help build a library of interactive virtual reality models to be incorporated into the training.

Beyond the clear safety benefits of virtual training, National Grid has also been able to realize substantial cost savings from reduced needs to travel for training. According to the company, the savings from reduced travel and hotel costs defray the cost of a virtual reality headset (around $300) after just one training session.

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9 National Grid, Out of This World, March 11, 2015 http://www.nationalgridconnecting.com/out-of-this-world/
Manufacturing

An emerging area of application for virtual reality is in manufacturing. Virtual reality provides a natural extension of the CAD (computer-aided design) manufacturing process. Using virtual reality technology, manufacturers can create 3D, virtual prototypes to test the viability of new objects before going to the trouble and expense of making physical models of them. This allows manufacturers to identify potential problems faster and less expensively than with traditional physical prototypes, which allows manufacturers to shorten development cycles.

Case Study: Ford Motor Company

Since 2000, Ford has been using various forms of virtual reality to aid in manufacturing, however in 2006 Ford doubled down with the launch of the Immersion Lab, a facility devoted to allowing designers and engineers to test...
various design and manufacturing options using virtual reality, making Ford the first car company to pioneer the technology in production.

In the Immersion Lab, Ford engineers put on a virtual reality headset and can walk around, inspect, and even sit inside virtual renditions of car prototypes. In addition to the Oculus VR headsets, each immersion viewing room features a huge power wall with a 15x9 foot screen displaying at 4K resolution, which allows other engineers and designers (often as many as 30 to 40 at a time) to view the demo, with executives around the world often connecting as well.\(^\text{10}\) Ford uses the technology to examine the car inside and out, and any tweaks are automatically fed directly into its Autodesk CAD system.

The Immersion Lab is being used throughout the Ford product line, and is now a significant driver of input in the product development process. For the new Ford Mustang for example, engineers changed the fit and finish of the dashboard and windshield wipers based on their VR immersion tests, so that they are hidden from the driver’s view when they are at rest.\(^\text{11}\)


Beyond the benefits of increased speed and efficiency, virtual reality testing also unlocks a variety of benefits not possible in the real world. Virtual reality allows designers to perform rapid A/B tests of different configurations of the vehicle during a single session, which would require multiple vehicle models or time-consuming reconfiguration in the physical world. Virtual reality also increases the safety of testers, for instance when testing a vehicle configuration with a drowsy or inebriated driver. Furthermore, virtual reality allows for greater consistency in testing, allowing Ford to isolate variables like sunlight or temperature.

Some of the challenges that Ford has faced in implementing virtual reality, according to Elizabeth Baron, head of the Immersion Lab, have been simulator sickness (though she has found this to be less of an issue with improved technology), lack of acceptance by all decision makers (though this has improved as the cost and efficiency benefits of virtual reality have become evident to all
stakeholders), and the amount of time it takes to render accurate virtual models (Ford has gone from two weeks to 4-8 hours to create a virtual model).

These virtual reality initiatives have made a meaningful impact on Ford’s production cost, speed and efficiency. According to Ford’s Vice President of Engineering, virtual prototyping have shaved six months off the product development timeline, and have resulted in millions of dollars of savings.\(^\text{12}\) Since launching the lab, Ford has steadily increased its commitment to using virtual reality technologies as an integral part of the manufacturing process. In 2013 alone, Ford designers have worked in 135,000 unique model details across 193 virtual vehicle prototypes.\(^\text{13}\)

**Communication**

Another key application of virtual reality is in enterprise communication. Communication has been constantly reinvented by technology – from teleconferences to videoconferences – however despite the progress, these technologies are not able to fully replicate the experience of a face-to-face meeting. According to the Global Business Travel Association, Americans alone are expected to spend over $310B on over 490 million business trips in 2015, with well over $1T being spent worldwide.\(^\text{14}\) The reason for the massive amount being spent on business travel is clear – businesses are still seeing a return on investing in business travel for the benefit of face-to-face meetings. A study by

\(^{12}\) IEEE VR Keynote Speech (Presented by Elizabeth Baron), April 3, 2009


Oxford Economics found that every dollar invested in business travel results in $12.50 in added revenues and $3.80. Furthermore, in a survey of business executives, 63% of respondents found virtual meetings less effective than in-person meetings with current customers, and 85% found them less effective with prospective customers.\textsuperscript{15}

Virtual reality has the potential to improve the efficacy of virtual meetings by recreating an experience much closer to the experience of a face-to-face meeting. When asked about the potential for virtual reality, Oculus CEO Brendan Iribe responded “We really believe the ultimate application for this is actually

\textsuperscript{15} Oxford Economics, The Return on Investment of U.S. Business Travel, 2010
social communications. That's where it's long-term going to go…it can fundamentally change communication”.16

Best Practices with Virtual Reality Implementation

There are several insights that companies can draw from the successful implementation of virtual reality at companies like Ford and National Grid

• Focus on Easy, Quantifiable Wins First: When Ford first introduced virtual reality as part of the production process, many stakeholders were initially skeptical, and viewed the technology as little more than a novelty. Once the data came back that virtual reality could shave months and millions of dollars off the product development process, everyone was bought in. According to Baron, virtual reality is now an accepted, established part of Ford’s product development process, and most decision makers now trust virtual prototyping. Teams implementing virtual reality at other companies can help convince skeptics by demonstrating quantifiable evidence, even at a small scale, that the technology can improve quality or save time and money.

• Bring in Third-Party Experts to Assist: When National Grid implemented virtual reality, they didn’t do it on their own. They brought in third party experts like Virtalis and Premtech to help get everything up and running. Most companies won’t have employees in-house with virtual reality expertise, and bringing on third-party experts can help companies

bridge this knowledge gap and ensure that the technology is implemented efficiently.

- **Don’t Do it All at Once**: When Ford launched virtual reality, they didn’t go fully-virtual right away. They began by only supplementing physical models in certain scenarios. Gradually, as the technology gained wider acceptance, they increased the number of situations virtual models were used in, and were able to scale down their use of physical models. Companies implementing virtual reality should identify specific use cases where virtual reality can supplement existing processes, and then gradually increase those use cases as the company gains more experience using the technology, and as it becomes more widely accepted company-wide.

**Conclusion**

After five decades and countless false starts, reductions in motion-to-photon latency, improvements in frame-rates, and dramatically reduced costs of mobile processing technology have propelled virtual reality into the mainstream. For the first time, companies are now getting onboard and recognizing the potential for virtual reality to transform the way they do business.

The most fertile and near-term opportunities for virtual reality to disrupt business appear to be in training, communication and manufacturing, where companies like Ford and National Grid are already using virtual reality to improve the way they build cars and train their people. This technology is already driving millions of dollars of savings, and is enabling things that were never before possible, like the ability to put anyone in the world in the driver’s seat of a prototype car. There’s no telling where the future of virtual reality will take businesses, but one thing appears to be clear: virtual reality is here to stay.
About the Center

The Glassmeyer/McNamee Center for Digital Strategies at the Tuck School of Business focuses on enabling business strategy and innovation. Digital strategies and information technologies that harness a company's unique competencies can push business strategy to a new level.

At the center, we foster intellectual leadership by forging a learning community of scholars, executives, and students focused on the role of digital strategies in creating competitive advantage in corporations and value chains. We accomplish this mission by conducting high-impact research; creating a dialog between CIOs and their functional executive colleagues; and driving an understanding of digital strategies into the MBA curriculum.

We fulfill our mission by concentrating on the three following areas:

**Scholarly Research**
Connecting practice with scholarship anchored on IT enabled business strategy and processes.

**Executive Dialog**
Convening roundtables focused on the role of the CIO to enable business strategy.

**Curriculum Innovation**
Bringing digital strategies into the classroom through case development and experiential learning.