

Disrupting Reality: Taking Virtual & Augmented Reality to the Enterprise

From touchscreen encounters to “real-world, real-life” immersive experiences, virtual and augmented reality signal a new way of working, communicating and collaborating across the enterprise.



Executive Summary

Ready Player One, an upcoming Steven Spielberg movie, is set in a dystopian future where people spend most of their days inside a globally networked virtual universe, Oasis. The game's "real world" environment and immersive experiences are so absorbing that players prefer them to real life - so much so that the game's virtual schools have replaced traditional brick-and-mortar structures. While this depiction of the future may seem bleak, advancements in alternative reality technologies - virtual reality (VR); augmented reality (AR), its relatively younger cousin; and their hybrid, mixed reality (MR) - may very well see 2018 audiences watching *Ready Player One* using VR head-mounted devices (HMDs).

For over 60 years, technologists have sought to create VR experiences that stimulate multiple human senses. In their earliest forms, these efforts depended on bulky, unwieldy devices that offered limited content, such as Sensorama, invented by Morton Heilig in 1962.¹ Over the past two decades, rapid advancements in computing technology and the rise of video games helped make VR devices smaller and more immersive. Using biological circuits and silicon sensors, today's HMDs trick the human brain into visualizing an imaginary world as real. Yet unlike PCs, which were first used to fulfill demand from large enterprises, VR and AR headsets, like smartphones, are expected to appeal equally to consumers and enterprises.

Awareness of VR and AR business and consumer solutions has reached a crescendo - resulting in optimistic projections for the market opportunity and a growing list of applications across industries. As SMAC stack (social, mobile, analytics and cloud) technologies democratize computing power and information access, VR and AR hardware and software will strengthen enterprise-to-employee and enterprise-to-consumer connectivity and interactions, including employee collaboration, training and marketing.

Today, the principal platform for virtual reality is the smartphone, thanks to its small form factor, light weight, reasonable cost, high-resolution displays and powerful computing capabilities.

Looking ahead, the possibilities seem infinite. For example, today's workstations could give way

to virtual work areas with multiple displays and real-time access to enterprise data, irrespective of where an employee is physically located. Similarly, customers could use HMDs to explore a company's products and services in depth within a highly personalized, fully immersive environment free of real-world distractions.

Enterprises looking to adopt VR and AR will need to focus on upgrading their technology infrastructure and creating an ecosystem of VR-related applications. They will have to develop a set of best practices for new users and a change management program to help employees become comfortable with the new hardware and software.

HMDs' ability to track and understand user behavior will fuel the development of strict policies for protecting data and guarding privacy. At a broader level, companies will need to overcome some fundamental challenges, such as the current high price tag of HMDs, a fragmented (but growing) market of developers, and a lack of industry standards - all critical for large-scale adoption.

This white paper explores all of these issues and includes a roadmap to help enterprises navigate the process of weaving AR and VR into the fabric of their businesses.

A Groundswell of Expectations

Investments in alternative reality technologies have shown steady growth. As of Q4 2015, VR and AR saw six straight quarters of investment growth.²

In a recent report, Goldman Sachs predicted that the VR and AR hardware market will touch \$80 billion by 2025.³ Citibank expects the market for VR hardware, networks, software and content to reach \$200 billion by 2020.⁴

The high expectations of alternative reality are driven by the variety of offerings developed and in development by tech giants and startups alike. One estimate puts the number of companies working on VR hardware and content at 230.⁵ However, this landscape is not limited to virtual and augmented reality alone (see Figure 1, next page).

In terms of devices, industry favorite Oculus Rift offers a conventional headset. Google Cardboard (a successor to Google Glass, which went back to

The Alternative Reality Landscape

	Virtual Reality	Augmented Reality	Mixed Reality
What it Does	Changes reality by placing the user in a 360-degree imaginary world.	Visible world is overlaid with digital content.	Like AR, but virtual objects are integrated into and respond to visible surroundings.
Where it Stands	Has been around for a long time; most famous example is Oculus Rift. Hundreds of companies are working on prototypes.	Introduced in the form of Google Glass. Now several companies are developing prototypes.	Magic Leap and HoloLens are leading research and development.
Market Opportunities	Videogames, theme parks, entertainment apps, video, collaboration, employee training, simulation exercises	Games, theme parks, simulation exercises, employee training, commerce	Enterprise-focused applications
Biggest Players	Oculus RV, Samsung Gear VR, Sony, HTC	Vuzix, Skully, Epson	Microsoft, Magic Leap

Source: Cognizant Research Center Analysis
Figure 1

It is hard to predict which player will emerge as the leader, but the diversity of efforts bodes well for the alternative reality market.

the drawing board) offers a low-cost cardboard VR headset that utilizes smartphone displays. Microsoft's HoloLens⁶ - the first fully self-contained, holographic computer - superimposes 3-D digital images on top of real-world visuals.

Amid moves by tech giants, Magic Leap, a startup focused on mixed reality, has emerged as an industry favorite. The company, which is partially backed by Google, is working on what it calls a mixed reality light field, a technology that projects digital images onto the human retina through a transparent lens.⁷ This creates a 180-degree field of view (much wider than any other current mixed reality headset) that's closer to how humans see the real world; 3-D merges digital images with real-world surroundings seamlessly. It is hard to predict which player will emerge as the leader (and thereby help create industry standards) but the diversity of efforts bodes well for the alternative reality market.

The Impending Enterprise Reality Shake-Up

Facebook's acquisition of Oculus VR in 2014⁸ was a strong signal that VR headsets were moving from the realm of science fiction into the mainstream. Most mobile and video-game manufacturers soon followed with their own offerings. Amid these disruptions, the enterprise opportunity was largely missed.

Today, all of that is changing. A major reason is that VR eliminates the need for a person to be physically present in environments that depend heavily on "hands-on" expertise, such as health-care, manufacturing, and utilities. For example, a 3-D rendering of patient images, product designs and factory layouts allows people and facilities to be remotely monitored and attended to as needed, in real time.

Nevertheless, virtual reality has its limitations. Rather than providing a truly immersive experience, it completely blocks a person's immediate surroundings - requiring them to remain in place. Although headset manufacturers are working to overcome VR-induced sickness

and nausea, it is still a problem for some people. This is where AR headsets have an advantage; they merge a person's present surroundings

The flexibility offered by augmented reality makes it a frontrunner in the race for enterprise adoption over the long term.

with 3-D images to create a continuous view of both the virtual and real worlds. Furthermore, unlike VR devices, AR headsets do not require users to stand in place; they can move around and remain productive while attending to other tasks. This is one reason why - despite being behind VR on the current development curve, AR is expected to have a bigger impact on the enterprise market.

According to ABI Research, AR headsets will deliver \$46 billion in revenue by 2021, whereas VR will generate \$15 billion. AR will focus primarily on the enterprise, while VR will emerge as a consumer play.⁹

However, hurdles involving display technology and real-time processing and calibration of physical environments must be overcome first.¹⁰

Enterprises are already experimenting with both variants. A 2016 survey by Tech Pro Research¹¹ found that 77% of respondents had first-hand VR/AR experience, while others were considering adopting either of the two technologies (see Figure 2). The flexibility offered by augmented reality makes it a frontrunner in the race for enterprise adoption over the long term.

However, both VR and AR will drive take up of HMDs as a new computing platform, much like mobile computing drove advancements in the smartphone.

The Age of the Headset

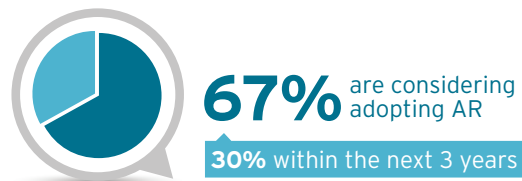
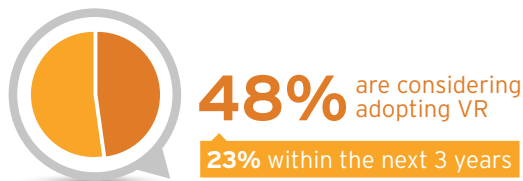
The impact of AR and VR is will likely be profound for people and processes across industries. Given the flat-out pace of the digital world, HMD headsets have the potential to ease process bottlenecks and save time and money by reducing the need for physical premises and presence - improving the effectiveness of employee training and engagement programs, and enabling a better understanding of employee and consumer behavior.

Increased Communication & Collaboration

Enterprise communications were last disrupted by the smartphone, which replaced physical buttons with a multipurpose touchscreen that allows users to move beyond phone calls and text messages. The iPhone, as Steve Jobs famously announced at its 2007 launch,¹² merged the iPod, the mobile phone and an Internet communications device into one product - making way for today's hyper-connected world. VR and AR will take this to the next level by making communications hyper-real. For example:

- A video call could take place in a simulated conference room that looks exactly like a physical meeting room. Only in the virtual conference room, attendance would not be dictated by physical space. Teams and individuals in different geographic locations would be able

Adopting VR & AR: What Enterprises are Doing



Top 3 areas of interest for using VR



Top 3 areas of interest for using AR



Response base: 205
Source: Tech Pro Research
Figure 2

to talk face-to-face, exchange virtual notes and make presentations in a shared environment without the need to be in the same physical space, and without having to travel to the meeting destination.

- Much like the iPhone removed the need for physical buttons, HMDs could create virtual buttons for any application incorporated into it. People traveling to a foreign country could translate sign boards and food menus in real time, hands-free.
- Similarly, English-speaking employees would be able to talk effortlessly with their Chinese counterparts, with the headset providing real-time translation. (This capability applies to various languages).

A Smarter, More Engaged Workforce

According to recent Gallup research, engaged employees are involved in, enthusiastic about and committed to their work. The research also showed that employee engagement is strongly connected to factors that are essential to a company's financial success, such as productivity, profitability and customer engagement.¹³ However, Gallup found that 87% of the global workforce is either not engaged, indifferent to or actively disengaged with their employer organizations – costing billions of dollars annually in the U.S. alone.^{14, 15}

Gamification (adding game elements to training and other processes) is one approach enterprises are using to address this issue. (For more on this topic, read our whitepaper “[Gamification 3.0: Meaningful Insights for Businesses Across Industries.](#)”) These initiatives could benefit from VR/AR. Researchers at Iowa State University found that users across demographics, when instructed through AR, experienced a 90% reduction in errors when assembling a mock airplane wing.¹⁶

Employee engagement also requires enterprises to make the most of employee interactions across the organization – collecting their feedback on a regular basis and understanding the talents and needs of each person. A VR/AR solution can fit nicely into these efforts. For example, VR and AR headsets could provide employees with a host of tools, such as training videos, visualized data and multiple desktops for performing various activities. For example, AR can be used

to teach complex maintenance procedures for factory equipment – overlaying animation-based instructions and reference materials directly onto the physical gear. (For more on this subject, read our whitepaper “[Augmented Reality: A New Workforce Mobilization Paradigm](#)”). The engrossing nature of these headsets could also serve as a medium for sharing leaders' visions for the enterprise.

Learning from Behavior

VR and AR headsets are designed to track user behavior to generate rich behavioral data. For employers, this provides an opportunity to more fully understand employee and customer patterns and tailor the user experience to match expectations. Additionally, since the headset acts as the center of the user's connected world experience, it can be linked to other wearables, such as smart watches and health trackers, to improve the quality of user data.

Branding & Marketing

A marketing message delivered through a VR or AR headset is likely to be highly effective for the simple reason that the experience is richer, highly personalized and devoid of any distractions. Not surprisingly, major brands such as Volvo, Coca-Cola and McDonald's have rolled out VR-centered marketing campaigns.¹⁷ In November 2015, *The New York Times* gave away 1.3 million Google Cardboard VR boxes to its subscribers,¹⁸ allowing them to experience news with 360-degree video. Given that it is still early days for the technology, this is an impressive list that is likely to keep growing. As more brands realize the power of immersive VR experiences, more people will probably have their first VR experience delivered for free through similar marketing plays.

Manufacturing

Thanks to the Internet of Things (IoT), manufacturing is already transforming. Sensors installed on the factory floor and on machines are creating opportunities for manufacturers to monetize software and data, improve operational efficiencies to save costs, and revamp their supply chains.¹⁹ VR and AR are expected to save time and money in areas such as collaboration, digital prototyping, design reviews and client presentations.²⁰ Using virtual reality demos, The Ford Motor Company has streamlined its manufacturing process and made it safer – resulting in a 70% drop in worker injury rates and a 90% reduction in ergonomic issues.²¹

As AR and VR technologies advance, data-driven collaboration among designers and engineers could open up new areas for heightening efficiencies.

Healthcare

From 3-D operating room simulations to decentralized mental health treatments, VR and AR are expected to have wide-ranging applications. These advancements are predicted to generate \$2.54 billion globally by 2020, according to one estimate.²² For example, in April 2016, the Royal London Hospital broadcast a surgery for colon cancer, streamed live to VR headsets and smartphones using 360-degree cameras.²³ The idea is a simple yet powerful way to transfer knowledge and skills. Similarly, virtual organ models could allow surgeons to better prepare for delicate surgeries. For amputees, the headsets hold promise for dealing with phantom limb pain.²⁴ As connected care becomes the norm, VR and AR solutions - combined with big data analytics, sensors and artificial intelligence - could upend evidence-based medicine and the way care is delivered.

Retail

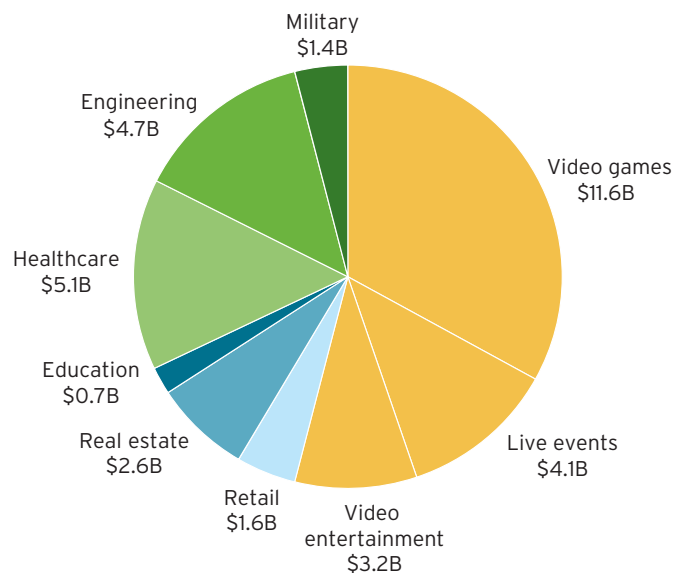
For retailers, VR and AR headsets can be a tool for squeezing the most value out of the data gathered from social media and mobile apps. Consumer shopping patterns can be used to create virtual tours tailored to the expectations of

different customer segments. Shoppers can use the headsets to experience a new product or service without being physically present in a store. They could watch a fashion show in real time, use their HMD to see how they would look in a particular outfit, or how a room renovation would look before they decide to move forward. (For more on the digital retail theater concept, please read "[The Digital Retail Theater: Shopping's Future.](#)") The operational benefits could be equally attractive for retailers. For example, using HMDs, store personnel could track hands-free sales across multiple stores to make inventory adjustments in real time, or assist customers by visualizing the exact location of individual products.²⁵

Entertainment

Goldman Sachs expects video games, live events and video entertainment to form the biggest chunk of software revenue from VR and AR by 2025 (see Figure 3). This should not come as a surprise. For creators and players of video games, VR headsets are a boon, since they create new possibilities for immersive content. *Thunderbird: The Legend Begins*, a puzzle game designed exclusively for VR, is one of the many examples of this trend.²⁶ AR-based video games could merge the user's immediate surroundings into the game. Audiences watching live events could experience the thrill of the venue without leaving their homes. Movie makers are also on board the VR bandwagon - creating

Projected Revenue Prediction for VR & AR by Sector



Source: Goldman Sachs Global Investment Research
Figure 3

VR experiences for movies such as *The Avengers: Age of Ultron*.²⁷ In the near future, stories will be told in a 360-degree format that allows viewers to watch the plot unfold all around them, and view a scene from any angle they choose.²⁸

Education

If tablet devices made learning interesting for school-goers, VR and AR could revolutionize the education market through immersive learning in both primary and higher education.²⁹ Google's *Expeditions*, for example, is a VR platform that allows students to take guided tours of cities around the world, as well as stars and planets. Subjects such as astronomy and medicine could be taught much more effectively through 3-D graphics and 360-degree videos.

Hurdles to a Virtual Future

If the disruptive power of VR and AR HMDs matches that of the PC and the smartphone, so do the challenges. Given the flurry of activity in this space, it is important that these issues be tackled effectively to ease the path to widespread adoption:

- **Price and apps:** Top-end consumer HMDs such as Oculus Rift and HTC Vive Price are currently priced at \$599 and \$799, respectively.³⁰ These headsets must be tethered to computers capable of running high-end VR software, which adds to the cost. Cheaper HMDs that use smartphone displays are currently limited by the poor battery life of most smartphones and the low quality of displays (although display manufacturers should close the quality gap over time). Importantly, VR headset manufacturers are still awaiting the launch of an *Angry Birds*-style blockbuster app that appeals to users across demographics, thereby pushing uptake. Meanwhile, Microsoft's HoloLens developer kit is currently priced at \$3000.³¹ Magic Leap is yet to announce prices, but in all likelihood its HMD will be expensive.
- **User experience:** Although VR headsets have become more user-friendly, headset manufacturers are still competing to make people feel more comfortable with these devices. Users of Oculus Rift and HTC Vive, for example, must tether their headsets to a computer. This requires them to remain

stationary while bearing the weight of a device that weighs close to 500 grams³² - a little over one pound - making it difficult to use the headset for long periods of time. In this case, AR headsets have a distinct advantage, but are likely to be similar in design to the now-shelved Google Glass. Nevertheless, both VR and AR headsets will have to deal with the fact that one size does not fit all.

- **Standards:** Although invisible to end users, common standards have been at the heart of the computer and smartphone revolutions. To enable widespread enterprise and consumer uptake, VR and AR will need similar universal standards that allow developers to make applications that are open and interoperable across different headsets. For VR alone, the current HMD market is filled with companies working on software and content;³³ however, there is a mix of proprietary and open approaches. VR has a long way to go before it can support a simple plug-and-play capability. Efforts such as OpenVR by Valve are steps in the right direction.³⁴

Transforming Enterprise Reality

For enterprises looking to incorporate AR and VR into their processes, those that have taken concrete steps to digitize, such as rewiring the enterprise around the SMAC stack, are primed to make quick and long-lasting gains, since these technologies are foundational to both AR and VR. Although these technologies are at a nascent stage and need to mature before becoming a heavy-duty computing platform, they will be a key component of the future digital enterprise. With this in mind, companies will need to ensure a reasonably smooth transition by thinking through how and where to integrate their existing technologies with AR and VR, and properly train and reskill employees to benefit from them.

To enable this, consider the following:

- **Create the necessary infrastructure.** The content-heavy nature of VR and AR means that

Just as the smartphone drove the need for on-demand access to mobile apps, VR and AR will require a backbone of resources that ensures users have access to relevant content around the clock.

VR and AR headsets will have to deal with the fact that one size does not fit all.

enterprises will need to add more computing power, network bandwidth and data storage capacity to their existing IT infrastructure to accommodate new hardware and software.

VR will be a great medium for videos and meetings, while AR is better suited for processes that require users to move around, on a factory floor or in a retail store.

- **Create a supportive ecosystem.** Just as the rise of the smartphone drove the need for on-demand access to mobile apps, VR and AR will require a backbone of resources that ensures users have access to relevant content, and can connect and collaborate securely around the clock.
- **AR, VR or both.** The future of VR and AR in the enterprise is unlikely to be binary in nature. Enterprises should prepare to incorporate the best approach for a particular process. For example, VR will be a great medium for videos and meetings, while AR is better suited for processes that require users to
- **Manage change.** For enterprise users, moving to a headset-oriented workplace from a PC-oriented environment that has existed for decades will need some getting used to. More important, since users will include both millennials and older generations, companies will need to undertake training and change management that accommodate the needs of all as they become accustomed to the new technology and a new way of working.
- **Address data privacy and security.** The use of HMDs only intensifies the need for data privacy, since VR and AR headsets are capable of tracking user behavior down to the minutest detail. While this is necessary in order to “hyper-personalize” the user experience, it can also raise privacy issues, especially in consumer-facing applications. Users should be made aware of and have a say in what information is stored, with appropriate steps taken to ensure the safety of enterprise data.

Footnotes

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