WHITEPAPER RESOURCE Real World Solutions with Virtual Reality

Written by Michael Otey



A BWW Media Group Brand





Virtual Reality (VR) has become a vital technology for many businesses today. First used primarily as a business tool in such industries as oil and gas and in automotive design, VR was initially expensive and relegated to large corporations that could afford such systems. Later, as low-cost high fidelity headsets became available VR technology became more accessible to professionals and consumers where it was then used to enhance entertainment and games. VR and the tools to create VR content have quickly evolved.

Today, VR is definitely not just about playing games. VR has become a vital technology for many businesses and its unique capabilities provide businesses the ability to visualize environments, test scenarios, and see how things are going to work in the real world in ways that are not possible without VR. VR is being utilized for a surprising number of vital business functions today. Even so, it is a leading-edge technology that requires the right enabling tools and technologies. In this white paper, you'll get an overview of VR technology and see how it's a vital part of many industries today. You'll also learn about the essential hardware, software and workflow components that comprise today's modern VR solutions.

VIRTUAL REALITY TODAY

First, let's take a quick look at the background of VR and then catch up on the state of VR technology today. A few years ago, VR was only used in niche areas—it was expensive and cumbersome to use and view. VR is essentially a computer-generated simulation of a three-dimensional image or environment that can be can be explored and interacted with by the user in a seemingly real way using a specialized VR display device called a head mounted display (HMD). Powerful computer hardware and software graphics programs create and render the VR environment, which is then output and experienced by the user via the VR headset or other VR devices. You can see an example or two of today's modern VR headsets in Figure 1.

In the 1990s, VR began to get its first widespread use as gaming manufacturers like Sega created the first releases of consumer VR products. Apple and Nintendo soon followed up with their own consumer VR entertainment products. The use of VR in the gaming industry continued to expand



Figure 1 - Virtual Reality Headset

during the 1990s and several popular games including <u>Descent</u>, <u>Star Wars: Dark</u> <u>Forces</u>, <u>System Shock</u> and <u>Quake</u> begin incorporating VR support. Continuing improvements in the VR device technology and the reduction of costs propelled VR into many other industries. While there are now more VR games than ever, VR technology is being used in businesses of all types. Some notable technology companies that are currently making substantial VR development efforts include Intel, DELL, NVIDIA, Google, Apple, Amazon, Microsoft, Sony, HTC, and Samsung.

VR is a rapidly evolving technology and the broad definition of VR encompasses a few different types of VR including Augmented Reality (AR) and Mixed Reality (MR). Traditional VR began as an experience where you are completely insulated from the outside world in a computer-generated 3D environment that you experience through the headset. An example of the traditional VR is through video games like PlayStation VR where you interact in an immersive experience by moving a character or object through a completely generated environment. AR takes a bit different tack. AR allows you to see the physical outside world through your headset, and you add computer-generated graphics in that headset. Its ability to incorporate real world and digital components enables augmented reality to be used for fashion as well as troubleshooting and diagnosis, where components like a graphical display or control pad can overlay a physical machine or entity. IKEA provides an AR catalogue that enables shoppers to visualize how certain pieces of furniture would look inside their home. MR provides yet another type of VR experience. Like AR, MR typically describes the ability to visualize and manipulate virtual 3D objects in a physical real-world setting. MR enables seamless integration of real and virtual environments. MR can also enable multiple users to simultaneously experience and interact with the same 3D object, such as a car, from multiple individual perspectives where they can all dynamically collaborate on the object. Microsoft's HoloLens is an example of an MR device and it has applications that perform holographic Skype-like communications, 3D computer design, games and decorating.

APPLICATIONS FOR VIRTUAL REALITY

While games and entertainment are definitely a big part of the VR market today. VR and its variants like AR and MR are rapidly expanding into other areas. VR technology has become more accessible and the price point for VR technology has continued to drop. Today many businesses are moving to adopt VR solutions for their businesses. The new capabilities that VR brings to the enterprise can really revolutionize the way we do business in many industries. VR can enable faster time to market as well as provide the ability to more accurately and rapidly design many different kinds of products. Let's have a closer look at some of the benefits that VR brings to different businesses.

BENEFITS OF VR FOR DESIGN

VR enables you to visualize products more effectively. This is especially important when designing large products like airplanes and automobiles. It's difficult to understand scale from viewing a model on a standard computer screen. VR makes design decisions more efficient by replicating life-sized models. Standard computer displays are not as natural and intuitive. The ability to realistically view a model from many angles allows designers to get a better grasp of the spatial concepts and to be more productive. Designers can use VR to verify that parts fit together as intended. The more realistic the VR experience is, the more successful the implementation. Manufacturing companies report that the use of VR vastly reduces costly design mistakes. Life-sized models also enhance the design review process through realistic collaboration. Likewise, product assembly can be enhanced by allowing teams to virtually step through each stage of the assembly process. Safety training is more effective in VR because it is a more realistic experience.

COMMERCIAL VR IMPLEMENTATIONS

VR is at an inflection point and the adoption of VR is expected to dramatically increase in many industries. You can see the projected VR hardware and software forecasts from 2014 through 2020 in **Figure 2.** ABI research estimates that the VR market for hardware is projected to be \$45B by 2020, while the software market is projected to grow to \$35B. In Figure 2 you can see the biggest segments of the market are projected to be 1) industrial at 35.5%, followed by 2) healthcare at 18.5% and 3) military at 10%. Gaming and entertainment expected to only make up 8% and 3% of the market, respectively, by 2020. Let's dig into some of the industries where VR is being used today and look at how VR is used to enable business tasks that they couldn't otherwise do.

INDUSTRIAL

In part because of its design benefits, VR is projected to have a huge uptake in industrial uses. Product design teams viewing their models in an immersive VR environment can more easily recognize potential problems during design. They can also place themselves inside large products like planes, trains and automobiles to experience a more intuitive perspective of the model, which can help improve designs. In addition, training workers on assembling products in VR prior to taking on the physical task can lower costs and save time. In the construction industry, VR can be used to show customers through a building during the planning phase even before the build has been constructed. For office design, VR provides spatial awareness, showing how furnishings and office equipment can fit into a planned space. VR can also be used for training

Commercial VR Market Forecast



Figure 2 - The forecasted VR Market from 2014 through 2020

and emergency procedures. For instance, firefighters could use VR to practice emergency procedures within designed houses and buildings. Design companies like Autodesk have incorporated VR into their computer-aided design products, enabling designers to create rapid prototypes and promote faster project review in VR design environments.

HEALTHCARE

VR also has huge potential in the healthcare space. VR is used as a diagnostic tool in conjunction with other technologies like MRI scans to enable doctors to better diagnose patient issuesIn many cases, VR can improve the outcomes of surgical procedures. VR is also used for robotic surgery where the surgical procedure is performed by a robotic device that is controlled by a surgeon, enabling better ability to see the site along with improved precision, flexibility, and control during the operation. Some universities are currently using VR to treat Post Traumatic Stress Syndrome (PTSD) symptoms, enabling patients to learn how to cope with their symptoms in a safe environment. VR also facilitates treatment for mobility-impaired patients by simulating the experience of walking, which helps stimulate the brain centers associated with walking.

MILITARY

All branches of the military use VR for training purposes as an aid to realworld training. VR is used for battlefield

simulation to enable soldiers to learn how to react in an appropriate manner for combat situations or other dangerous settings without the risk of serious injury or death. It is used for training scenarios in which they are able to experience potentially dangerous situations but still remain within a controlled environment. VR is used for vehicle simulation like flight simulators to enable personnel to learn the basics of piloting expensive aircraft and other vehicles without the risk and expense of crashing them. VR training has also been used in recruitment situations to enable the potential candidate to interactively experience introductory content.

RETAIL

VR is used in a variety of different roles in the retail industry to provide enhanced customer experiences. For example, in London's <u>Westfield mall</u>, customers use headsets to interactively experience the latest fashion collections. North Face provides a VR environment that allowed customers to experience Yosemite National Park and scenes from Nepal as they were shopping. <u>IKEA</u> provides a 3D VR kitchen exploration experience that enables customers to walk around a virtual kitchen and perform basic kitchen tasks like opening doors, drawers and recycling.

TOURISM AND MEDIA & ENTERTAINMENT

In the travel industry, VR is used to allow people to experience places that they've

never been to before, providing realistic experiences with the goal of increasing travel sales. For instance, Marriott Hotels provides their Vroom Service VR app that allows you to view and experience select travel destinations including Chile, Rwanda, or Beijing. U.K. travel agent Thomas Cook partnered with Samsung to produce short visual travel brochures that are viewed using Samsung Gear VR headsets. In the entertainment industry, SeaWorld uses VR to enhance the experience of their Kraken Unleashed roller coaster ride, providing for their customers the experience of an underwater adventure filled with virtual sea creatures.

JAGUAR LAND ROVER USE VR FOR DESIGN AND LAUNCH OF THE PACE CONCEPT

Jaguar Land Rover, the UK's largest automotive manufacturer, pioneered a VR launch event for their new all-electric I-PACE Concept November 2016. Instead of presenting a mountain of PowerPoint presentations, the new car information was presented through the medium of VR. The launch put 66 people in the VR environment that spanned London and New York. Live video was beamed into the HTC Vive headset and everyone in the VR environment was seeing it simultaneously. The participants could see one another in the VR environment and each participant had their individual view of the car model that they could zoom in to, rotate, and explore while the live video was being streamed.

Russell Hall, Head of Interactive at Imagination, who help create the launch, explained their push behind the VR experience: "This was really pushed on by the ambition of this car and with Jaguar's redefining moment, we really had to meet it with a concept that was as redefining as well."

The event was a unique VR experience and it marked the first time that VR has been used in this way for a major vehicle global launch event. Unlike watching a movie where everyone sees the same thing, the VR environment enabled everyone to have a different individual experience. The car itself was also designed using a 3D VR design process with one team designing the interior of the car while another team designed the exterior. The interior design team was able to work as if they were really inside the car—visualizing the interior in real space as they worked out where everything was going to go. Dell supplied their Dell Precision Workstations for the design-and- build phase as well as for the actual launch event. Jaguar Land Rover is also rolling out VR Experience packs across more than 1,500 retailers in 85 markets that enable customers to use VR to experience life-sized car models.

LHB EMPLOYS VR FOR STREET RECONSTRUCTION

An Architectural/Engineering firm based in Duluth Minnesota, LHB used VR to design a major thoroughfare reconstruction project for the City of Duluth. This project was intended to revitalize over a mile of Superior Street, one of the city's oldest and most iconic streets. The goals were to improve the street, the traffic control system, and the below-ground utilities, and to provide a better pedestrian experience. It was vital for LHB to be able to demonstrate their designs to the different stakeholders in a meaningful and understandable way. Buyin from the stakeholders was essential in order to save time and lower project costs.

Dan Stine, BIM Administrator for LHB, said, "We quickly realized that virtual reality was the way to go because it creates a realistic interactive environment that accurately mimics the final project."

LHB used high-end design and modeling applications like AutoCAD, Civil 3D, and Revit running on Dell Precision Tower 5000 Series workstations with VR Ready NVIDIA Quadro P5000 graphic cards to create and render a VR experience for a one-block area of Superior Street. NVIDIA Quadro GPUs provided high performance real-time VR modeling and rendering along with certification assuring they were compatible with LHB's design and modeling applications while delivering responsive and immersive VR experiences. The VR experience was delivered on Oculus Rift and HTC Vive headsets.

"Traditional fixed-angle renderings still have their place but having VR allows our clients to freely explore project in progress," Stine said. "This technology is so successful that we have constructed VR lounges in our offices to increase collaboration between staff and clients."

CREATING VIRTUAL REALITY SOLUTIONS

VR is a resource-intensive technology and it requires computer systems that are specifically built for the task along with specialized VR accessories. About 80% of a typical VR creation workflow is like a traditional design computing workflow where most of the creation is performed using powerful workstations and the designs themselves are stored on back-end servers. In the last 20% of the workflow, the designer then begins to check the output of their work on VR headsets. Then they essentially iterate between design and output until they get to the end VR goal. Ideally, in the future much of the design work will be performed within the VR headset itself, but that is still a future goal for now. As you might expect, graphics processing is extremely important to both the design and final rendering of the VR experiences. Today's recommended graphics capabilities are very high—90 frames per second at 90Hz for an optimum VR experience, which is typically viewed on a VR headset.

VR GRAPHICS

Well known for their high-performance graphics cards, NVIDIA has embraced



Figure 3 - VR graphical requirements

VR technology. NVIDIA Quadro VR Ready <u>GPUs</u> provide the graphical computing power required for VR design work. We are now at an inflection point for immersive visualization. Today's VR headsets have dramatically lowered the cost of VR, and now VR is essentially available to everyone. The technology provides great new capabilities, but the computing demands are significant. VR is now possible in large part because of the latest generation of powerful GPUs that allow a smooth and immersive experience. Traditional rendering for video requires about 30 frames per second or 60 megapixels per second. VRis seven times more demanding (3x fps (30 -> 90), 2x from stereo), requiring a minimum of 90 frames per second, up to 450 megapixels/ second, and VR output needs to render for both eyes rather than just a single image like standard video. Good VR experiences also demand very low latency. To handle this intense workload, NVIDIA created their line of Quadro Pascal GPUs. The NVIDIA Quadro P5000 and P6000 are based on the company's advanced Pascal architecture. NVIDIA uses a 16-nanometer manufacturing process and the highspeed 10 GHz G5X memory to provide extreme graphics performance. The Pascal architecture delivers two features that are specifically designed for VR: simultaneous multi-projection and preemption. Multi-projection enables the GPU to render both eyes in one geometry pass, essentially doubling the performance for VR. Pre-emption provides the ability to change the context at the pixel level to enable fine granularity, improving the responsiveness for VR. Figure 3 shows a comparison of the graphics requirements of a standard display alongside the much higher demands of a VR system.

Let's take a closer look at some of today's virtual reality solutions. The VR experience essentially consists of the VR headset that is used in conjunction with systems

designed for VR consumption and more powerful systems designed for VR creation. Dell and NVIDIA provide VR solutions for the office and on the road including workstations, servers, and storage.

THE VR HEADSET

Today's Head Mounted Displays (HMDs) essentially take the place of a computer monitor. The HMD device needs to provide high resolution and the ability to process up 90 frames per second for an optimum experience. Two of the popular VR headsets available today are the Oculus Rift and HTC Vive, which are shown in Figure 1. They range in price from about \$400 to \$800. The headsets are tethered, meaning that they must be physically connected to a host computer. As you might expect, they have a number of similarities including:

- 110-degree field of view to provide an immersive experience
- Embedded sensors for 360-degree motion tracking
- 2160 X 1200 resolution (1080 X 1200 per eye)
- 90 Hz refresh rate
- Adjustable headset strap

They each have a few differentiating features as well. The HTC Vive provides a front-facing camera to include real-world elements in virtual view but it does not come with headphones. The Oculus Rift does not have a built-in camera, but it does include stereo headphones on the headset itself.

CONSUMER VR SOLUTIONS

Consumer VR includes non-business uses such as gaming, personal entertainment, leisure (such as travel or photographic content viewing) and personal or hobbyist VR content creation. Consumer VR content creation is not as resource-intensive as professional VR content creation. For personal use - where uptime, enterprise management, and long-life availability are less critical – the VR tasks can essentially be performed by high-performance home gaming systems. Personal VR systems can make do with consumer-grade graphics cards. These systems don't require the maximum levels of performance and availability. Typically, they only need to actively work with VR content for a couple of hours at a time. These systems have high-performance, consumer-grade components. Here GeForce is an excellent solution. They can support VR experiences for hobbyists and consumers that don't require professional ISV certifications. To insure a good VR experience, a VR system designed for personal use should have at least the following:

- Intel Core i5-4590 or AMD FX 8350, equivalent or better
- NVIDIA GeForce GTX 1060 equivalent or better
- 4GB of RAM at a minimum with 8GB recommended

Dell's <u>Alienware</u> line of gaming systems is well-suited to the personal use of VR.

These are high-performance gaming systems designed with VR in mind and they pass the Oculus Ready and Vive Optimized certifications. The Alienware line provides amplified graphics, optional liquid cooling and high-performance SSD storage. The Alienware 17 line can deliver an excellent mobile VR experience.

PROFESSIONAL VR SOLUTIONS

Professional level VR systems require the highest levels of power, fidelity, and stability in order to provide the most detailed immersive VR experiences possible that are required for commerical VR uses. Complete data fidelity is required for surgeons to use VR to rehearse difficult surgeries to identify potential issues ahead of time. The ability to load entire designs lets engineers evaluate complex designs, such as automobile interiors to determine usability and esthetics at full scale in lifelike environments prior to building costly prototypes. Professional VR is used by businesses to speed up time to solution and time to decision, critical to maintaining a competitive advantage in today's business environment. Professional graphics cards, such as NVIDIA Quadro, provide the capabilities and features required for demanding professional VR workflows.

Professional level VR systems need more cores, more powerful graphics cards with higher frame buffer rates, and they need 24 X 7 levels of availability. Designed to provide the most powerful and scalable experience, Dell Precision Workstations are designed for professional VR solutions. For high performance rendering and display these systems can have GPUs with up to 32GB of frame buffer memory and CPUs

CPU	
	Intel Xeon [®] E5-1600 or E5-2600 1.6Ghz 4C min when using HTC
	Vive
	Intel Xeon [®] E5-1600 or E5-2600 2.5Ghz 4C min when using Oculus
	Rift
NVIDIA Cards	
	NVIDIA [®] Quadro [®] P6000
	NVIDIA [®] Quadro [®] P5000
	NVIDIA [®] Quadro P4000
Memory	
	16GB + additional as needed for workload size
Storage	
	256G SSD (SATA) Min

Table 1 - Recommended VR Configurations for DELL Precision Towers

with up to 22 cores per CPU. They provide high-performance, professional-grade components built for reliability, speed and manageability. They provide commercial grade level of VR creationand consumption.. The Dell VR-Ready platforms include the Dell Precision Tower 5000 Series, Dell Precision Tower 7000 Series, Dell Precision Tower 7000 Series. Table 1 lists the recommended VR-Ready configurations.

The <u>Dell Precision 7720</u> mobile workstation can provide a professional level mobile VR solution. This 17" laptop is available with a Xeon processor, can support up to 64GB of RAM, 4TB of storage and comes with either an 8GB NVIDIA Quadro P4000 or a 16GB NVIDIA Quadro P5000 GPU, and it is built specifically for acting as a VR-ready workstation. The Dell Precision 7720 is capable of creating and displaying VR content wherever you go.

Server components like Dell PowerEdge can also be very important as VR workflows generate very large amounts of data that needs to be stored and later served back to other systems that are part of the VR workflow. The building and construction phase of AEC workflows in particular generate large amounts of data. High-performance servers with fast storage are connected to the creation platforms that can then render down solutions for the consumption platform.

VR FOR REAL WORLD SOLUTIONS

VR is more than games and entertainment. It already provides vital solutions for many different types of businesses today and the use of VR will continue to expand in the near future. VR is not a destination. It's a journey. As technology progresses, resolution will improve and designing in VR won't require a mouse and computer. They will be replaced by a native VR design experience with natural hand movements. While VR opens up amazing new possibilities, it also requires a lot of computing power. There's nothing worse than showing an inadequate VR solution to customer where the rendering can't complete because the system doesn't have the power to perform the rendering in the required time. For instance, a virtual room that has only three walls where there should be four is not an adequate VR experience. With games, the designers can choose not to incorporate objects in the VR rendering space. VR systems that use real production objects don't have that luxury. Instead, the customer controls what needs to be rendered. Which means that you need to have VR creation systems with enough graphical power to provide rapid content creation with smooth, realistic VR experiences with no lag or latency. The Dell Precision workstations with NVIDIA graphics are purpose-built for commercial VR creation and they provide the performance and reliability that's required for professional VR work.

Learn more about how you can implement VR and about VR-Ready systems, check out www.dell.com/vr and www.nvidia.com/quadrovr.

You can also schedule a personal VR learning experience at one the DELL VR Centers of Excellence around the world. Dell has eight VR Centers of Excellence worldwide, one in Austin, Santa Clara, Limerick, Frankfurt, and Singapore, and three in China. You can bring your VR solutions in and try them out.

