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VIRTUAL REALITY
FOR PROFESSIONALS

FUJITSU CELSIUS workstations and NVIDIA Quadro GPUs are bringing products and buildings to life through Virtual Reality

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VR FOR DESIGN AND BEYOND

With new Head Mounted Displays (HMDs), powerful 3D graphics and exciting developments in professional Virtual Reality software, VR is set to explode in all areas of design, manufacturing and construction.

Virtual Reality as an aid to design, engineering, architecture and manufacturing has been around for decades. But it is only now that this exciting technology is set to explode.

2016 will go down as the year when everything changed. VR not only became more powerful, but the technology became affordable. It is no longer the preserve of large automotive and aerospace firms. Even small architectural practices can now get on board.

Head Mounted Displays (HMDs) like the Oculus Rift and HTC Vive may be driving this new VR revolution, but there have also been huge advances in 3D graphics technology and professional VR software. With powerful 'VR Ready' desktop workstations and optimised workflows to move design and engineering data from CAD into Virtual Reality, VR no longer needs to be a consultancy-led technology.

A PHYSICAL PRESENCE

Until you put on a VR headset for the first time, and fully immerse yourself in your 3D design, it is hard to imagine just how powerful VR can be.

VR can give an incredible sense of being physically connected to your virtual product or building. It can evoke a visceral response that simply cannot be matched by viewing a 3D CAD model or photorealistic rendering or animation on a 2D screen.

Even when scenes are rendered relatively simply, the feeling of immersion can be very convincing. However, as render quality increases, using technologies such as dynamic lighting, ambient occlusion and physically-based materials, the user can become even more persuaded that what they are seeing is real.

> **"VR can evoke a visceral response that simply cannot be matched by viewing a 3D CAD model or realistic rendering or animation on a 2D screen"**

But VR is not just a viewing experience. Users can interact with designs as they would in the physical world: car doors can be opened; light switches turned on; and engine parts grabbed and moved.

In addition, geometry doesn't have to be imported. With some of the latest VR software tools, users can model complex objects inside a fully immersive VR environment.

COUNTLESS OPPORTUNITIES

The applications for professional VR span many sectors, from automotive, aerospace and manufacturing, to building design and construction.

Architects can explore buildings before they are built, inside and out. Designers can interrogate and validate detailed engineering models before committing to costly physical prototypes.

VR can also have a huge influence on collaborative design review, or act as an incredible communication tool for clients or customers.

HYPE VS REALITY

As with many new technologies, VR has experienced its fair share of hype. And it will take time before there is mainstream adoption in the design, manufacturing and construction sectors.

But the market is predicted to grow fast. Goldman Sachs anticipates 'engineering' will take a $4.7 billion slice by 2025 with 'real estate' accounting for $2.6 billion.

Early adopters will benefit from being able to assess what works for them and develop and refine complex VR workflows. Those who wait for VR to go mainstream, and approach it from a standing start, could be left behind.

WHAT ABOUT AR/MR?

Virtual Reality (VR) may be grabbing most of the headlines, but there are also many important developments happening in Augmented Reality (AR) and Mixed Reality (MR).

Understanding the differences between the three technologies in the context of design, engineering and architecture is very important.

VR is a fully immersive, computer generated experience where the user is completely cut off from the real world. The digital experience becomes the user's reality - be it a building, car or heavy machinery that has not yet been built.

With **AR**, instead of experiencing the virtual world, it takes the user's view of the real world and 'augments' it with digital information. This could be assembly instructions for a production line or maintenance info inside a plant.

MR combines the best aspects of VR and AR, allowing users to see believable 3D virtual objects alongside physical objects. This could be a car in your driveway, or a spare part in your printer.

AUTODESK'S VR CENTER OF EXCELLENCE

In January 2017 Autodesk opened its VR Center of Excellence at its European headquarters in Munich, Germany. The VR Showroom gives customers from the automotive, design and architectural communities the opportunity to get hands-on with the very latest VR / AR and MR technologies.

The state of the art facilities, which show off the latest Autodesk VRED and Autodesk Stingray professional VR software tools, are being powered by FUJITSU CELSIUS workstations .This includes three FUJITSU CELSIUS M740 'VR Ready' workstations with dual NVIDIA® Quadro® P Series GPUs for HTC Vive head-mounted displays (HMDs).

For more information see youtu.be/E5H3c1euX9o

IMAGE COURTESY OF AUTODESK

WHAT IS A HEAD-MOUNTED DISPLAY (HMD)?

A head-mounted display (HMD) is a Virtual Reality headset that is designed to give a fully immersive VR experience. The wearer gets a real sense of presence – of being inside the virtual world – and typically feels completely cut off from the real world.

With an HMD, each eye sees its own display optic, which shows a slightly offset view of the same computer generated 3D model. This 'stereoscopic' effect fools your brain into thinking it is seeing 'life-sized' objects, and there is an incredible sense of scale and depth.

Virtual objects can be viewed from any angle, simply by moving your head. All movements are tracked by the HMD and bespoke trackers. As soon as you change position, the view of the virtual world updates 'instantly'.

Entry-level HMDs use a smartphone to process the views, but the more advanced HMDs — those suitable for professional applications — rely on a powerful workstation with a high-end professional Graphics Processing Unit (GPU).

The Oculus Rift and HTC Vive Business Edition are the standout devices from a new generation of affordable HMDs that are suitable for professional use. Both headsets feature 2,160 x 1,200 resolution displays (1,080 x 1,200 per eye), which refresh at 90Hz.

The low latency and high refresh rate of these HMDs is important for a realistic VR experience and to help eliminate feelings of nausea or motion sickness which can be experienced by some users.

The accuracy with which both devices are tracked is also critical for a good VR experience.

When the Oculus Rift first launched it was generally used when sitting down. However, both the Oculus Rift and HTC Vive now offer the flexibility of a standing, 'room scale' experience. This means the user can literally walk through a building or around a car.

Users typically interact with the virtual world using a pair of VR controllers (one for each hand). These can then be used to move, point at, mark up or create virtual objects or to teleport around the virtual world.

Both the Vive and Rift are tethered to a workstation via a chunky cable. However, wireless adapters are starting to emerge, including the TPCast for the HTC Vive.

HTC Vive Business Edition headset

ARCHITECTURE, ENGINEERING, AND CONSTRUCTION (AEC)

Virtual Reality allows architects, engineers, contractors and clients to 'live' inside a building before it is built. The feeling of presence, scale and connection simply cannot be matched by traditional design viz mediums.

The possibilities for VR in Architecture, Engineering and Construction (AEC) are countless – from bringing clarity to design review and solving construction and serviceability issues to revolutionising client communication and producing enthralling sales and marketing experiences.

The single most compelling reason for using VR in the AEC sector is the sense of presence, proportion and scale that you get from wearing an HMD. It can make you feel that the virtual building is truly real. The physical connection can be so strong that some users experience vertigo in potentially perilous situations.

This connection can be a hugely powerful asset. VR for design review can reveal issues that simply would not have been spotted with 2D drawings or 3D models. Architects can be encouraged to try out new ideas and get timely feedback on what does and does not work. Clients are able to understand exactly how a proposed building might function.

Taking a 3D BIM model into a VR environment has traditionally been a highly skilled process. Specialist VR agencies earn their keep through their knowledge of VR game engines (such as Unity or Unreal Engine), geometry and lighting optimisation. Scenes can be customised so clients can explore different design options, materials and lighting without leaving the virtual world.

Enscape places a big emphasis on visual quality. Image courtesy of Read | Thomas.

Point cloud of NVIDIA's new Silicon Valley HQ used to track construction progress in VR

But for VR to go mainstream in the AEC sector, it has to be quick and easy for non-expert users to move between BIM and VR. The good news is, this is already a reality.

Autodesk Revit Live is a cloud service that is designed to take your BIM model from Revit to an interactive VR environment in two clicks. Desktop software tools Enscape and IrisVR Prospect offer a similar push button approach through Revit plug-ins. IrisVR Prospect also supports other 3D applications, including SketchUp and Rhino (through Grasshopper). Mindesk also has a push button workflow from Rhino to VR.

Pairing VR with a physically-based renderer, on the other hand, requires a lot of processing time, but brings very high-quality and accurate imagery to the world of VR, which is ideal for polished presentations and simulations.

Navigating around a building in VR can be done in a number of ways. For a sitting experience use a game controller or keyboard. For a room scale experience walk around the building, then teleport larger distances with a VR controller.

Users don't have to keep their feet on the ground. For NVIDIA's new Silicon Valley HQ, for example, site managers can track construction progress by flying around point clouds that have been scanned periodically by automated drones.

VR interaction can go beyond a simple viewing experience. Users can access head-up display toolboxes to control layers, mark up models or explore daylighting with time and date sliders.

Software is also emerging that enables architects to design in a fully immersive environment. ArchiSpace, for example, includes a number of 3D modelling tools for use directly inside VR, as well as the ability to place and scale 3D objects.

Finally, co-presence allows multiple users to exist in the same VR environment. Participants don't have to be in the same physical location. A New York-based architect, for example, could collaborate on the same virtual building with a London-based engineer and Munich-based cladding contractor.

PRODUCT DEVELOPMENT AND MANUFACTURING

VR can promote a holistic development process, where design, engineering, manufacturing, operations and maintenance can all be optimised, long before committing to costly physical prototypes or production tooling

IMAGE COURTESY OF AUTODESK

Factory simulation in VR

While the automotive, aerospace and heavy machinery sectors continue to drive adoption of Virtual Reality in design and manufacturing, the combination of low cost HMDs and powerful GPUs means VR is now expanding into many different areas.

VR is being deployed at all stages of product development, from 3D conceptual design and virtual prototyping to factory planning and interactive marketing.

It allows products to be experienced at human scale before they are built, often in context of where they will be used. This can encourage designers to explore bold new ideas and give them the confidence to make the right decisions early on.

With a focus on render quality, VR can aid aesthetic decision making. Here, the use of physically-based materials, dynamic lighting and ambient occlusion can help make products look incredibly real. Shadows and reflections are convincing and react instantly as the user moves position. In addition, anti aliasing, which smoothes the jagged edges of diagonals, can aid perceived quality assessment.

Functional and ergonomic aspects of products can also be validated. Realistic mock-ups can include motion simulation so users get a physical behavioural experience as well as a fully immersive and realistic visual experience. Parts can be 'virtually' assembled and disassembled for serviceability checks or training. Manufacturing processes can be simulated to make the production line safer and more efficient.

VR can promote a holistic development process, where design, engineering, manufacturing, production, maintenance, overhaul and repair can all be optimised, long before committing to costly physical prototypes or production facilities. This can significantly reduce change orders, time to market and in-the-field operations.

Smoothing the path between CAD and VR is essential for adoption to go mainstream. Powerful professional VR tools such as moreViz, TechViz XL, ESI Group IC.IDO, Virtalis Visionary Render and WorldViz Vizard offer CAD to VR workflows for traditional high-end CAD tools such as Siemens NX and Dassault Systèmes CATIA.

Dassault Systèmes is collaborating with HTC to drive VR into the enterprise space. PTC has similar aspirations.

Siemens PLM Software is working with UK VR specialist, Masters of Pie, on Project Dolphin, which uses the JT format to take data from CAD to VR.

Autodesk is delivering advanced VR capabilities through its product visualisation and virtual prototyping tool, Autodesk VRED, which can import many of the leading CAD file formats. The software places a big emphasis on visual quality and collaboration. Designers, engineers and other stakeholders are able to participate in interactive design review sessions, even from different geographic locations.

NVIDIA is working on Project Holodeck, a 'photorealistic' collaborative VR environment that features anatomically correct avatars, sound and haptics.

Enterprise VR solution specialist WorldViz is also focusing on collaboration, with a new communication platform in development, codenamed "Skofield".

Virtalis is bringing its high-end VR knowledge to the mainstream with its new VR4CAD tool which is designed to help firms easily connect design data sets with VR.

Custom CAD to VR workflows also exist for mainstream CAD applications. Data from Autodesk Inventor and Dassault Systèmes SOLIDWORKS, for example, can be brought into the Unity or Unreal Engine game engines via neutral file formats such as OBJ. Mindesk also has a push button workflow from Rhino to VR and the promise of more CAD software support soon.

> **"Digital mock-ups can include motion simulation so users get a physical behavioural experience as well as a fully immersive and realistic visual experience"**

While VR is not currently suitable for detailed 3D modelling, software like Dassault Systèmes Dream Sketcher is demonstrating how VR can be applied to 1:1 scale conceptual 3D sketching. At the other end of the product lifecycle, Zerolight develops virtual car showrooms for leading car manufacturers such as Audi and Pagani, where customers can interact with and configure cars instantly, in incredible detail.

WORKSTATIONS FOR VR

Virtual Reality is extremely computationally intensive, as every frame must be rendered in real time. As a result, it is essential to match your HMD with professional VR-optimised workstation hardware.

Latency throughout the entire VR system must be low in order for the HMD's display to respond almost instantly to head movements. The workstation must also deliver a consistent 90 frames per second (FPS) or more, which is almost four times as much as the accepted minimum 24 FPS for 3D CAD work on a 2D display.

If latency is more than 20 milliseconds or the workstation cannot maintain 90 FPS, the VR experience can be compromised. Users can become disorientated, as what they are seeing on the HMD is not completely in sync with their head movement in the real world. Worst of all, this can lead to feelings of nausea or motion sickness.

The responsibility of delivering extremely high refresh rates lies with the Graphics Processing Unit (GPU). VR needs an extremely powerful GPU — much more powerful than one typically used for 3D CAD.

VR not only pushes the computational limits of GPU hardware, but can place huge demands on GPU memory size and memory bandwidth. Complex 3D geometry and textures need to load into GPU memory quickly and then stay there so they can be accessed quickly.

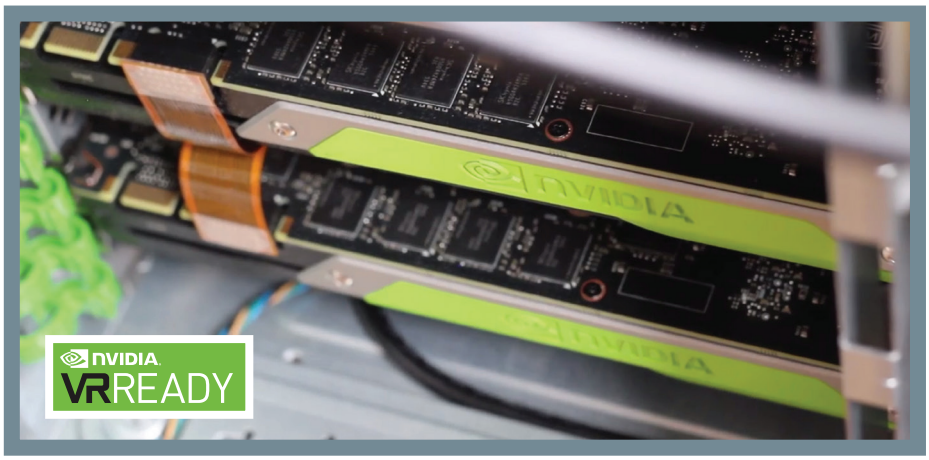


IMAGE COURTESY OF AUTODESK

To help professionals choose workstation hardware for the best VR experience, GPU manufacturer NVIDIA has developed the NVIDIA VR Ready program. Any workstation that bears the 'NVIDIA VR Ready' badge is deemed to satisfy or surpass the minimum recommended hardware specifications.

This includes one or two NVIDIA Quadro P4000, P5000 or P6000 series GPUs (see below), an Intel Core i5-490 / Intel Xeon E3-1240 v3 or greater CPU, 8GB+ RAM and an HTC Vive or Oculus Rift HMD.

If the workstation is to be used for VR content creation (in addition to VR consumption) as well as for other design viz workflows, then you may need to consider a workstation with even more power.

Multiple GPUs can be used to accelerate physically-based renderers such as NVIDIA Iray (found in SOLIDWORKS Visualize and Siemens NX Ray Traced Studio) or Chaos Group V-Ray RT for Autodesk Revit, 3ds Max and others. Physically accurate VR, which brings the accuracy of physically-based rendering to interactive VR, also relies on multiple GPUs to render the multiple panoramic images for each viewpoint.

CPUs with more cores can also be used to reduce render times in physically-based renderers like Luxion KeyShot or to accelerate CAD to VR workflows, including data import / geometry optimisation and light baking.

NVIDIA QUADRO GPUs FOR OPTIMISED VR

NVIDIA's ultra high-end Quadro GPUs are designed specifically for demanding VR workflows. The Quadro P4000 (8GB), Quadro P5000 (16GB) and Quadro P6000 (24GB) are the latest GPUs to get NVIDIA's 'VR Ready' seal of approval.

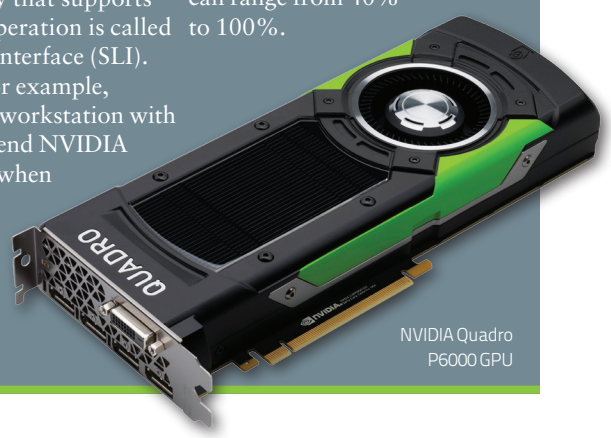
According to NVIDIA, the NVIDIA Quadro P6000 delivers up to 80% more performance than the previous generation Quadro M6000, based on an internal NVIDIA VR benchmark.

The dual height, 250W GPU features 24GB of GDDR5 memory, which is an important consideration for professional VR. Complex engineering geometry and detailed textures can take up a lot of GPU memory. Indeed, NVIDIA has shown how some VR workflows are already pushing the limits of GPU memory by filling all 24GB with a fully detailed Nissan Maxima automotive model. Memory can be a big differentiator over consumer focused GPUs.

For the most demanding VR workflows, it is also possible to use multiple GPUs together, either by assigning each GPU to a specific eye or rendering different parts of the display. The technology that supports this mode of operation is called Scalable Link Interface (SLI).

ESI Group, for example, recommends a workstation with two ultra high end NVIDIA Quadro GPUs when running its IC.IDO software on an HTC Vive.

Autodesk also supports NVIDIA VR SLI for Autodesk VRED and has found that the performance improvement of two NVIDIA GPUs over one can range from 40% to 100%.



NVIDIA Quadro P6000 GPU

VR READY FUJITSU WORKSTATIONS

	FUJITSU CELSIUS H970	FUJITSU CELSIUS W570power+	FUJITSU CELSIUS M740	FUJITSU CELSIUS R940
Recommended configurations from DEVELOP3D & AEC Magazine	17.3-inch VR-ready mobile workstation to support immersive VR workflows wherever you go	Entry-level VR-ready, single CPU, single GPU workstation with a 21 litre, space-saving microtower design	Mid-range, single CPU, dual GPU VR-ready workstation with a near-silent noise emission of 20 dB(A)	High-end VR-ready workstation with triple GPUs and dual CPUs for demanding multithreaded workflows
Processor	Intel® Xeon® E3-1535M v6 (3.1GHz up to 4.2GHz) (4 cores)	Intel® Xeon® E3-1280v6 (3.9GHz up to 4.2GHz (4 cores)	Intel® Xeon® E5-1630v4 (3.7GHz up to 4.0GHz) (4 cores) for CAD-centric VR workflows Intel® Xeon® E5-2687Wv4 (3.0GHz up to 3.5GHz) (12 cores) for viz-centric VR workflows	2 x Intel® Xeon® E5-2643v4 (3.4GHz up to 3.7GHz) (6 cores) for CAD / viz VR workflows 2 x Intel® Xeon® E5-2687Wv4 (3.0GHz up to 3.5GHz) (12 cores) for high-end viz / VR workflows
Graphics	NVIDIA® Quadro® P4000 (for entry-level VR workflows) NVIDIA® Quadro® P5000 (for mid-range VR workflows)	NVIDIA® Quadro® P4000	NVIDIA® Quadro® P5000 (for mid-range VR workflows) 1 or 2 NVIDIA® Quadro® P6000 (for high-end VR workflows)	NVIDIA® Quadro® P5000 (for mid-range VR workflows) 1 or 2 NVIDIA® Quadro® P6000 (for high-end VR workflows)
Memory	32 GB or 64 GB DDR4, 2,133 MHz	32 GB or 64 GB DDR4 ECC 2,400 MHz	32 GB or 64 GB DDR4 ECC 2,400 MHz (maximum 256 GB)	64 GB or 128 GB DDR4 ECC 2,400 MHz (maximum 1 TB)
Storage	512 GB or 1TB PCIe-SSD, NVMe, M.2 module, SED	256 GB or 512 GB PCIe-SSD, M.2 NVMe + 4 TB HDD SATA III, 7,200 rpm, 3.5-inch, business critical	512 GB or 1 TB PCIe-SSD, M.2 NVMe + 4 TB HDD SATA III, 7,200 rpm, 3.5-inch, business critical	512 GB or 1 TB PCIe-SSD, M.2 NVMe + 4 TB HDD SATA III, 7,200 rpm, 3.5-inch, business critical

With professional grade NVIDIA Quadro GPUs and Intel Xeon CPUs, FUJITSU CELSIUS workstations are optimised to deliver a realistic and comfortable VR experience.

Engineered and built in Germany, FUJITSU CELSIUS workstations have gained a reputation for being reliable and whisper quiet, thanks to advanced thermal management. A screwless access system also makes them highly serviceable, which helps minimise downtime when upgrading components.

Comprehensive ISV certifications help ensure professional 3D CAD and BIM applications run smoothly.

Fujitsu offers three desktop workstations that are NVIDIA 'VR Ready': the single processor, FUJITSU CELSIUS W570power+, the single processor FUJITSU CELSIUS M740, plus the dual processor FUJITSU CELSIUS R940.

The FUJITSU CELSIUS W570power+ stands out for its 21 litre, space-saving microtower design. It can be configured with the VR-Ready NVIDIA Quadro P4000 (8GB), which is ideal for entry-level VR workflows and high-end 3D CAD workflows. The machine offers a choice of Intel® Xeon® E3-1200v6 series or Intel® Core™ processors with up to four cores.

The FUJITSU CELSIUS M740 and FUJITSU CELSIUS R940 are better suited for more demanding design visualisation and VR workflows. Both machines can be configured with one or two high-end 'Pascal' NVIDIA Quadro P5000 (16GB) and NVIDIA Quadro P6000 (24GB) GPUs.

In terms of CPUs, the FUJITSU CELSIUS M740 features a wide choice, including a number of Intel Xeon E5-1600 v4 Series models that have the high frequencies that 3D CAD and VR software demands.

The FUJITSU CELSIUS R940 can be configured with two Intel Xeon E5-2600 v4 Series CPUs, which gives designers, engineers and architects access to more CPU cores for taxing multi-threaded processes such as ray trace rendering or data import. The CELSIUS R940 can also be configured with a third NVIDIA Quadro GPU which can be used to further accelerate applications that feature NVIDIA Iray GPU rendering.

Designers, engineers and architects can also take VR wherever they want with the FUJITSU CELSIUS H970 mobile workstation. This CAD- and VR-optimised laptop boasts extremely powerful 3D graphics. It can be configured with the 'VR Ready' NVIDIA Quadro P4000 or NVIDIA Quadro P5000 GPUs.

There's a big choice of processors including the powerful Intel® Xeon® E3-1500M series CPUs with support for up to 64GB of ECC memory.

CHECKLIST - VR FOR PRODUCT DEVELOPMENT

WORKFLOW

Software

VR needs dedicated VR-capable software. VR is not possible inside CAD software. Software should be chosen according to intended use. e.g. Autodesk VRED for aesthetic evaluation (very high-quality real time rendering) or IC.IDO for physics-based digital mockup. Also the ease with which it is possible to move from CAD to VR.


Autodesk VRED is tuned for very high-quality visuals

Data pipeline

Some VR applications offer automated 'push button' workflows to import CAD data. Others require manual preparation of data. Automated workflows make things easy but lack flexibility. Manual or semi-automated workflows give the most freedom and can help you get more out of your workstation hardware, but it can be time consuming and requires specialist skills.

Geometry should be optimised to improve performance (CAD data is very heavy).

Materials can be mapped from CAD appearances or applied inside the VR application.

Lighting can be automatically taken from CAD or set up in VR. In some applications, lights can be baked into the scene to improve performance.

Consider import and re-use of non-geometric information. e.g. CAD, PLM and IoT meta data.

Build in interactivity. e.g. product animations physics-based mechanisms and design variants.

Workflow should be 'non-destructive', so a lot of manual re-work is not required for every iteration.

Consider where content might be used beyond its primary application. e.g. by consumers on low-cost 'mobile' VR headsets or tablets.

Consultancy

VR can be complicated, but help is at hand. Consultancies can define custom product development workflows between CAD and VR, configure hardware or create visually rich and functional VR experiences. e.g. client presentations and car configurators.

HARDWARE

Workstations

Choose between a desktop or mobile workstation. Desktop workstations can offer higher-end performance and greater expandability. Mobile workstations allow you to easily take VR anywhere - to the boardroom or a client office.

To view VR content you need a high frequency CPU (3.0GHz or higher). To create VR content some applications can benefit from a CPU with lots of cores. e.g. for data import or light baking.

Workstation GPU

GPUs that are traditionally used for 3D CAD are not powerful enough for VR. Instead you need a GPU that is 'VR Ready'.

The NVIDIA Quadro 'Pascal' P4000, P5000 and P6000 are 'VR Ready' and also optimised and certified for 3D CAD applications, so designers get the best of both worlds when using CAD and VR. Consumer GPUs are not certified for 3D CAD.

NVIDIA Quadro 'Pascal' GPUs have large amounts of high-bandwidth memory, which is important for loading up huge engineering datasets quickly. Consumer GPUs do not have as much.

GPUs should be matched to VR workflows. More powerful GPUs are required for larger datasets, enhanced realism (physically-based materials, dynamic lighting and ambient occlusion), and smoother lines with Anti-Aliasing, which is important for styling.

Some VR applications can harness the power of two GPUs (each GPU renders its own eye).

Head Mounted Displays (HMDs)

For a fully immersive VR experience there are currently two main options (HTC Vive or Oculus Rift). In general, the HTC Vive offers a more polished, room scale experience, while the Oculus Rift is known for its ease of setup and portability. The HTC Vive can also offer a cable free experience with the new TPCast wireless adapter.

Oculus Rift headset

ENVIRONMENT / SETUP

Choose your experience

Choose between a seated experience or a roaming 'room scale' experience.

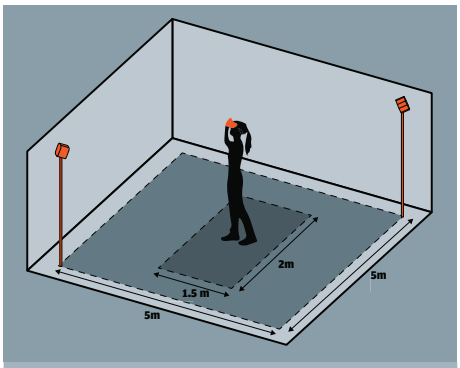
A seated experience is good for jumping quickly between CAD and VR for design validation or when creating a VR experience.

A 'room scale' experience is good for design review or for customer presentations. Explore a car from any angle or walk around a factory assembly line and teleport larger distances.

Seated experience

For setup, place movement sensors on a desk (Oculus Rift) or on camera tripods or wall mount bracket behind the desk (HTC Vive). Interact with keyboard, mouse or VR controllers.

Multiple sensors in the same design office can cause interference, so there are some challenges to overcome for mass adoption. Interference can also be caused by mirrors or direct sunlight.



Room scale experience

Works best in a dedicated room with up to 5m x 5m of floor space (min 1.5m x 2m). No trip hazards.

Two movement sensors should be mounted at opposite corners of the room, on the wall or on telescopic camera tripods. The Oculus Rift sometimes requires a third sensor.

Interact using VR controllers and additional devices (such as HTC's tracker).

Consider HMD cables. Trailing floor cables can be a trip hazard and contravene health and safety. Use metal frames or ceiling mounts to route cables above head height. The HTC Vive Business Edition includes a 5m extension. Eliminate cables altogether with new generation wireless HMDs.

Consider power for all devices and data cables. USB extension cables for movement sensors.