VR/AR Association White Paper

Virtual & Augmented Reality for Business

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Thank you to *Atheer*[1] for the support in making this white paper possible.

[1] www.atheerair.com

Introduction

Virtual & Augmented Reality are immersive technologies that provide new and powerful ways for people to generate, use and interact with digital information. These technologies take traditional media beyond conventional screens and use photographic images, video or computer generated graphics (sometimes provided as an 360-degree view within your field of vision) as a new communication and interaction medium that can be used across your company from marketing and sales to field services, training and data visualization.

Companies like Walmart, Farmers Insurance and Boeing have already begun deploying this technology across their organizations for training. Specific examples of how other brands are using VR/AR right now are detailed below.

Whether you are a brand marketer, director of operations, run a line of business or head of HR, there are many ways you can deploy this technology to generate substantial revenue, increase productivity or improve safety.

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This white paper is broken into the following parts so you can skip to what is of interest to you:

WHAT IS VIRTUAL & AUGMENTED REALITY?

1

Virtual Reality (VR) is an immersive multimedia or computer-simulated environment that mimics physical presence in the real world or imagined worlds. VR also lets the user interact with that world. Virtual reality artificially creates sensory experiences, which can include sight, hearing, touch, and smell.

"Virtual Reality is really a new communication platform. By feeling truly present, you can share unbounded spaces and experiences with the people in your life."
- Mark Zuckerberg, CEO Facebook

Augmented Reality (AR) provides a live view of the physical 'real world' where digital elements are overlaid or "augmented" by computer-generated graphics, live, sound, haptics or GPS data. It can also provide a variety of news ways to interact with digital information within a user's field of view - including voice control, head motion, hand gestures and touch (on smart glasses, a smartphone or tablet). Many Augmented Reality smart glasses additionally provide on-board front-facing cameras that allow users to share what they see with with others in "see what I see" video conference calls.

Mixed/Mediated Reality (MR) is the same as AR with the difference being that MR has a connection to the real world (i.e. graphics that relate to the physical world). Wilipedia offers a great definition that provides a little more detail: "Mixed reality (MR), sometimes referred to as hybrid reality, is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. Mixed reality takes place not only in the physical world or the virtual world, but is a mix of reality and virtual reality, encompassing both augmented reality and augmented virtuality via immersive technology. "

For the sake of simplicity, AR/MR will be collectively referred to here as AR.

Think of VR/AR like a slider of immersion. On one end of the spectrum, you have the real world, and on the other end, you have full immersion (VR). In the middle, you find AR/MR. VR puts you into another completely different environment; AR augments the environment you are in.

Imagine holding up your phone and seeing the entire world around you from tables and chairs to floors, ceilings and even people turning into a Minecraft world, in real time. Now take that one step further (about five years from now) when we are all wearing glasses that ultimately take over our field of view. With the "Ferrari AR" app, every car you see is a Ferrari.

"We think VR/AR could play a major role in humanity's future. Our near-term roadmap has VR succeeding telephones, TVs, and the Internet as the next major advance in human communications."
- CITI GPS report

From radio and television to the internet and mobile, the evolution of communication technology is speeding up to transform the way we interact with people, brands and the world around us. Virtual and augmented reality represents the next leap forward, fully immersing us in the information and experiences that currently live on TV and mobile screens - while also bringing ways of interacting with new, vital business information from the factory floor to the service bay and aircraft hanger.

MARKET PREDICTIONS FOR VR/AR

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The total market size for VR/AR is estimated to reach $108B to 215B by 2021. The predictions vary wildly, but regardless of which you believe, this nascent technology is going to be a huge industry.

The International Data Corporation (IDC) Worldwide Quarterly Augmented and Virtual Reality Headset Tracker, for example, predicts that worldwide proliferation of virtual reality (VR) and augmented reality (AR) headsets is expected to continue over the next five years as shipments reach 59.2 million in 2021, up from 9.6 million in 2017.

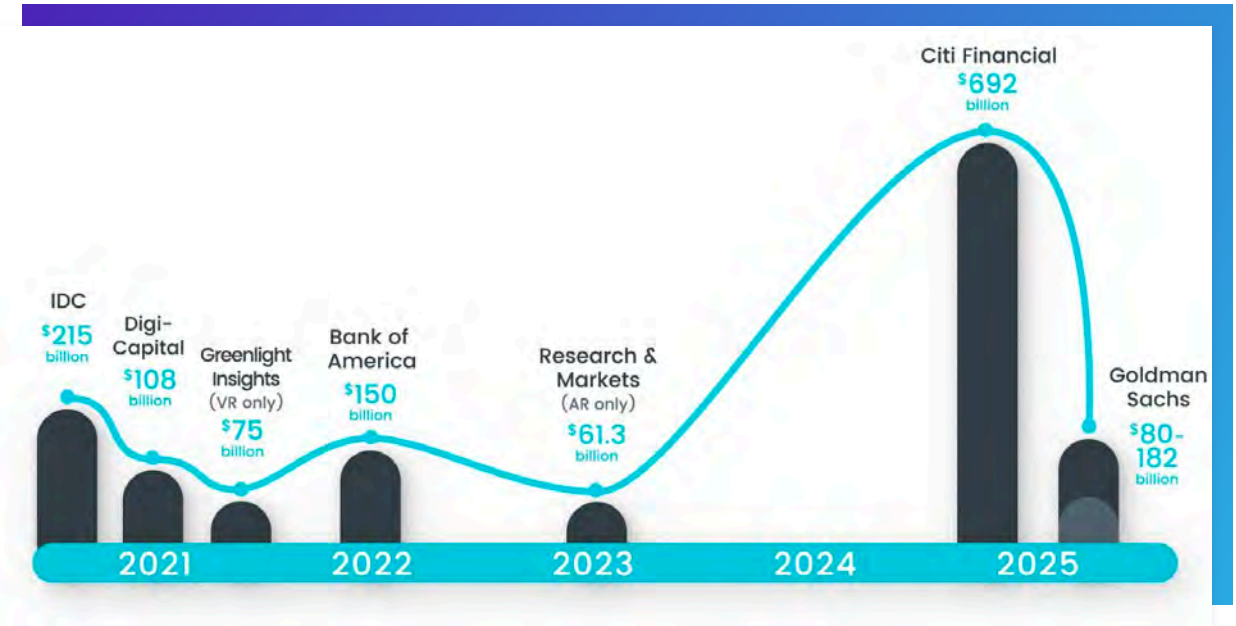
With the recent introduction of Apple's AR framework (ARKit) built into iOS 11, over 300 million devices will be AR-ready with full Simultaneous Location And Mapping (SLAM). This means that using the camera on your mobile device; you will be able to detect and map the world around you. Your phone will now know where the floors, walls, and tables are and be able to place virtual objects in the real world that will remain there.

Imagine leaving a note hanging in mid-air at a construction site to flag an inconsistency against the blueprints or using AR to give you step by step instructions on how to fix a complex manufacturing machine.

Google will introduce their version of mobile phone-based, position AR (ARCore) early in 2018 unlocking advanced AR potential in another 1.3 billion smartphones.

Over the next five years, mobile phones will lead this technology. It is predicted that over the next 3-5 years, we will see mass consumer adoption of this technology (>100M headsets), until then smartphones and expensive enterprise AR headsets will dominate the market

Revenue forecasts for Virtual and Augmented Reality vary dramatically, but all sources point to this technology revolutionizing the way we communicate.



MARKET PREDICTIONS FOR VR/AR

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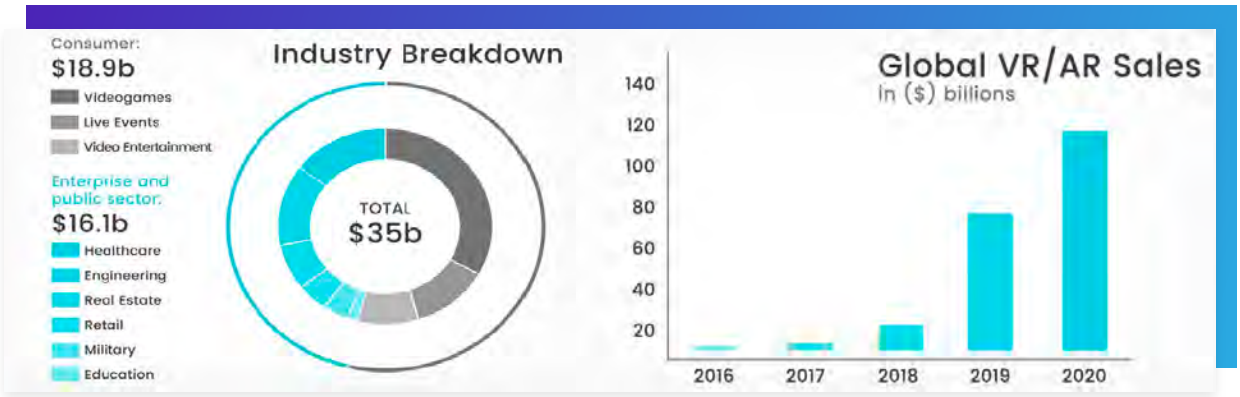

IDC

133%

Estimated compound annual growth rate over the next 5 years

**Research & Markets*

$108 Billion

Estimated value of VR+AR Industry by 2020

**Digicapital*

$1.3 Trillion

Estimated value of VR/AR By 2035

**Citi Financial*

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Goldman Sachs (January 2016)
$182B by 2025

Citi Financial (October 2016)
$569B by 2025 (including vCommerce)

DigiCapital (January 2016)
$120B by 2020

IDC Report (August 2016)
$162B by 2020

Market Size Estimates: Drilling Down on Enterprise

Going one level deeper, VRARA research partner ARtillry Intelligence has revenue estimates for the enterprise sub-sector that's the focus of this report. Specifically, it projects enterprise XR (the catch-all term for VR/AR) hardware and software revenues to grow from $554 million in 2016 to $39 billion in 2021 (see chart below). Goldman Sachs estimates AR for enterprise to be a $180 billion market by 2025

http://www.goldmansachs.com/our-thinking/pages/technology-driving-innovation-folder/virtual-and-augmented-reality/report.pdf

Steep growth results from Enterprise XR's starting point at a small revenue base. It also results from XR's potential applicability across enterprise verticals. AR especially has a form factor that supports all-day use and clear ROI in functions like manufacturing (explored in later sections). Enterprise XR revenues will inflect in 2019, due to a tipping point for enterprise adoption. As often happens in tech revolutions, demand slowly builds while organizational resistance slowly recedes. We saw this most recently with enterprise smartphone deployment.

As is often the case with new technologies, there is resistance within large organizations that have established processes. This resistance can be a powerful factor but not as powerful as tech advancement in the long run -- especially tech that demonstrates strong ROI, as XR does.

Enterprise XR growth will also result from the sector's composition of hardware and software. Near-term revenue will be hardware-dominant as it's usually the first step in enterprise tech adoption. But that will create an installed base for software which will gain share of enterprise XR in outer years.

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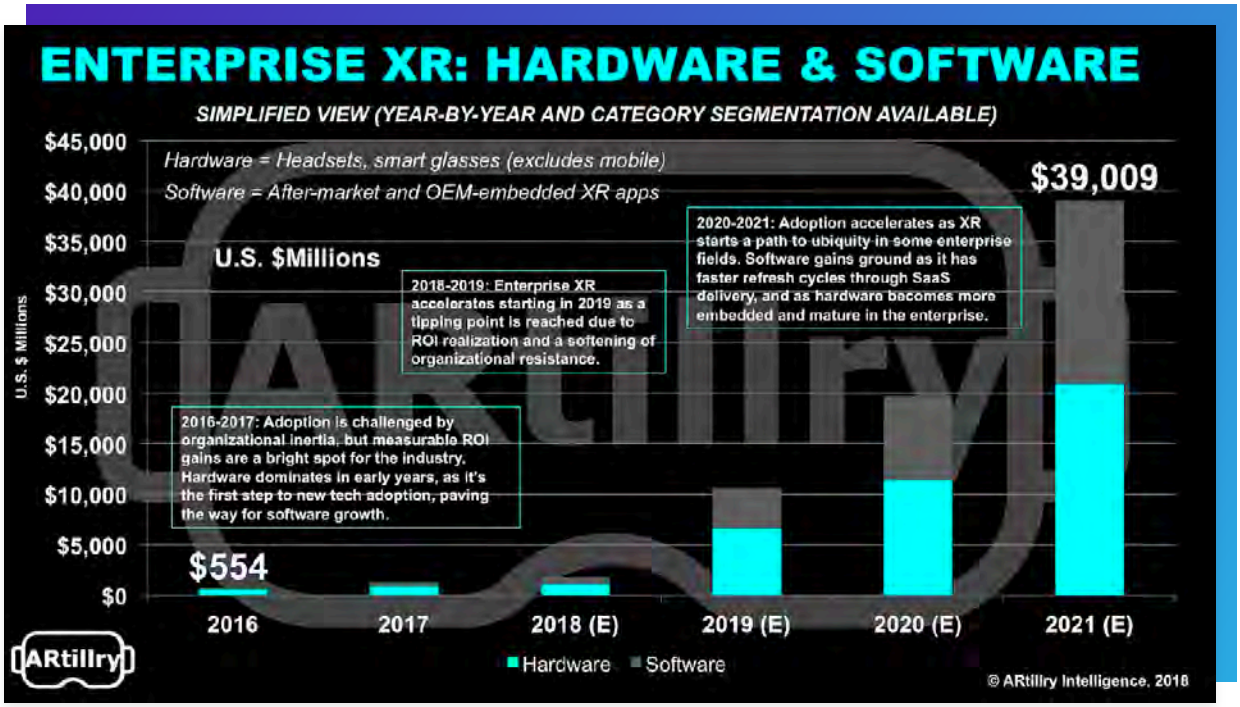
IDC supported this conclusion in a recent IDC report. "We have long believed that AR headsets will play a fundamental role in changing the way many companies do business in the near future and we are increasingly seeing the commercial use cases for VR unfold," said Ryan Reith, program vice president with IDC's Worldwide Quarterly Mobile Device Trackers in IDC's recent Augmented and Virtual Reality Headset Tracker report. "AR will introduce technology to a large portion of the work force that was never able to benefit from technological advances because of the need to use their hands to complete their job functionality. AR will change all that. And within VR, the commercial use cases that are emerging the fastest are within education, design/content creation, and retail, and we have strong reason to believe this is just the tip of the iceberg."

As we've seen in historic comparisons and benchmarks like enterprise Saas, software can have highly scalable and recurring revenue, thus bringing greater revenue potential to the sector. More detail can be seen in ARtillry Intelligence 's full report, Enterprise AR: Impacting the Bottom Line.

http://www.thevrara.com/artillry-research-reports



Source: ARtillry Intelligence (more quantitative detail included in full report: *http://www.thevrara.com/artillry-research-reports*)

4 The use cases for immersive technologies (VR/AR) are endless, but where they shine (aside from Entertainment and Gaming) are in Visualization. Now Sales & Marketing, Remote Assistance, Training, and Education can be seen.

"Enterprise clients are telling us that they need new ways of presenting and interacting with their massive amounts of data, to make communicating and acting on it more efficient and effective. VR and AR are the ideal technologies for solving these types of problems."

- Kevin Oke, VP Business Development, LlamaZOO Interactive

Virtual Reality is perfect for training where it is impractical to use real-life scenarios (Hazmat, Fire, Emergency). This allows users to train in a fully immersive environment without having to recreate the space or equipment. Walmart is training employees on customer service; UPS is training drivers, mining companies are training employees on mine safety, crane manufacturers are using VR to train people on safe operation before they ever step into the cab.

Digitizing your training with VR also unlocks complete session recordings & training data. Completion rates, behavioral patterns, and even compliance metrics may be surfaced using analysis tools built for virtual reality.

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Here are some use cases for Virtual & Augmented Reality you can deploy in your company now.

1. Data visualization and analysis

2. Pre-construction visualization (real estate, architecture, mining)

a. Sense of Size - The actual dimensions of a given object or space.

b. Sense of Scale - How large something is in comparison to the user, or other objects.

c. Sense of Distance - The actual distance covered.

d. Sense of Proximity - How near or far something is to a user or another object.

e. Sense of Presence - The feeling of "being there."

f. Sense of Materiality - The color, texture, and material type of a given object, and how it is affected by changes in lighting.

g. Sense of Ambience - What the character and atmosphere of a space is like when all of the previous factors are taken into consideration. This can include lighting and acoustics in a space.

3. Employee Onboarding

4. Training

a. On the job training

b. Hands-free instructions and training

c. Soft skills training

d. High-risk scenarios

e. Environmental immersion training

f. Technical skills training

g. Soft skills training

h. Emergency skills training

i. One to many training

j. Healthcare & Surgical training

k. Empathy training

5. Try before you buy

6. Remote collaboration & guidance (see what I see service)

7. Holographic Presence, Communications & Teleconferencing

8. Virtual screens (e.g. BigScreen, virtual white board...)

9. vCommerce

10. Product design and collaboration

5

Here are some use cases for Virtual & Augmented Reality you can deploy in your company now.

11. Visualizing sensor data and action needed (IoT)
12. Pick & Pack warehouse guidance
13. Prototype visualization
14. Product visualization in real world
15. Virtual tours & AR maps
16. HR Recruiting and basic training
17. Marketing
18. Scavenger hunt marketing activations
19. Distraction therapy (medical, dental, surgical, nursing home)
20. Immersion practice (public speaking, presentations)

6 To illustrate the list above, we'll go deeper on three representative examples: remote assistance (AR), pre-authored directions (AR) and immersive collaboration (VR). These have been contributed from ARtillry Intelligence's report, *Enterprise XR, Impacting the Bottom Line* (http://www.thevrara.com/artillry-research-reports)

Example 1: Remote Assistance (AR)

One valuable XR modality is live support from remote subject matter experts (SMEs) who can see exactly what an on-site worker sees. That visual channel is the basis for a live feedback loop for guided support. And the modality can be graphical annotations or voice assistance.

On the receiving end (on-site worker), the hardware is usually a head-worn AR device with a camera but can also be hand held such as an iPad. On the other end (SME), the hardware can be a touch screen device for drawing live annotations, or even a VR headset.

Developers of remote AR assistance software include Atheer, Upskill, ThirdEye, NextReality and Scope AR. The latter's Remote AR product is used by utilities, telcos and heavy equipment industries among others. For example, It works with Caterpillar to provide support for heavy-equipment end users. ThirdEye's remote help platform with the X1 Smart Glasses is used by the Department of Defense for example to help remote soldiers in the field connect to an expert sitting in a command center 7 be hands-free while receiving AR help.

Meanwhile, Porsche Cars North America, Inc. (PCNA) recently announced what it is calling "Tech Live Look," an Augmented Reality (AR) technology designed to improve technical services at Porsche dealerships in the United States and Canada. "Tech Live Look" uses Atheer's AiR Enterprise software – and it has gained the attention of the business press as well as automotive and augmented reality media.

Dan Gessner, writing in the New York Daily News wrote that "instead of a dealership employee being forced to contact the team about troubleshooting issues by way of phone and email, Tech Live Look allows both parties to view the car simultaneously together in real time".

Microsoft Hololens has one of the most well-known Remote Assistance Case Studies - 24 000 technicians are able to visualize and identify problems with elevators ahead of a job, and have remote, hands-free access to technical and expert information when on site – all resulting in significant savings in time and stress. Microsoft Gold Partners as NextReality are implementing this use case across different markets, like Energy, Manufacture or the Sea Economy.

Remote AR's value proposition is similar to call-conferencing providers' longtime proposition: remote interaction is cheaper than travel. That's always been the case with teleconferencing, but AR's visual component now makes it applicable to more situations.

"We're seeing use cases across virtually every heavy industry," Scope AR CEO Scott Montgomery told ARtillry in a recent article. "Automotive, utilities, telcos, energy, mining, oil & gas... you name it. It's a very horizontal technology. It's wherever there are remote workers, or there's no one on site that can solve a problem."

6 Example 2: Authored Instructions (AR)

AR authored instructions are similar in some ways to remote assistance. Rather than live support, pre-authored instructional graphics and animated sequences overlay physical-world equipment. The benefits include reduced cost through a "one-to-many" approach, and time-shifted access.

ScopeAR's WorkLink for example, helps enterprises author and distribute AR-guided support sequences. PTC's ThingWorx likewise has an authoring environment that reduces friction by working with a range of 3D graphical formats already used in enterprise environments (think: CAD files).

"ThingWorx Studio is something that we've built for content creators that want to create AR experiences without writing any code," said PTC's Mike Campbell at an ARiA event, "easily reusing 3D assets they have, incorporating animations and data from other enterprise systems."

Specifically, Thingworx Studio creates step-by-step graphically-guided instructions around 3D models. That workflow is then associated with a small decal known as a ThingMark. When attached to a physical-world item and viewed with an AR device, it launches the AR-guided instructions.

Atheer's AiR Enterprise provides the ability to not only author, deliver and provide instant updates to step-by-step "taskflow" instructional content within smart glasses, but also to yield vital business information about how effective that instructional content is.

The latter comes from taskflow reporting - which is an important feature to look for in any AR application. Taskflows help guide employees through often complex work, while taskflow reporting gives content authors a way to understand how effective those taskflows are. AR systems that provide taskflow reporting allow users to:

- Get realtime information about which taskflows each user has undertaken – There's no point in putting a lot of time and energy in developing in-depth, detailed taskflows if your workforce is not going to adopt them. Being able to see which of your employees is using a particular taskflow can be a big help in understanding why it may not be working. It could be because users are unaware of the availability of the workflow, that there are problems with the workflow itself – or that particular users are finding it hard to adapt to new ways of working and perhaps need more training and encouragement.

- See how far each user gets in executing on those taskflows – This is vital in both getting a more detailed understanding of how successfully a given taskflow is being adopted by your workforce. It can also be used to provide insight about whether you need to refine or improve a particular step in the workflow. If, for example, you find that most users are halting work on a 10-step taskflow at Step 4, you'll have clear data that tells you there are problems with either the instructions you have provided or in some aspect of the work itself within that step. You'll then be able to talk to the users, figure out the issues they are having and then refine the workflow so that it can be used more effectively.

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• Identify how long it takes each user to execute on a given task – In designing a taskflow for a particular task, you will probably have a target timeframe in mind for how long it takes to accomplish each task. Using taskflow reporting, you can see exactly when each step in the taskflow was started – and any times when users had to pause and resume any part of a taskflow. For taskflow designers, this is powerful as it again helps them understand whether the taskflow is actually helping employees to be more effective.

So having an AR application that provides good taskflow reporting allows you to assess the effectiveness of your taskflows and drive changes to those workflows based on the actionable business insights you are getting about them.

Example 3: VR: Remote Collaboration

The above examples are AR-oriented, but VR certainly has a place in the enterprise. This applies where greater immersion is required, such as training and design. For the latter, VR can enable far-flung professionals to collaborate remotely and in deeper ways than existing formats.

One example of this collaboration is Santa Barbara-based WorldViz. Its flagship Vizible VR software enables interaction with far-flung colleagues, clients or sales targets. Reps for large products like airplane engines can remotely demonstrate their wares through off-the-shelf VR headsets.

"The fact that we could offer to a company like Boeing the software that works with hardware they already have and gives them ability to walk around a one-to-one scale aircraft model, that was a real door opener"

-- WorldViz CEO Andy Beall told ARtillry in a recent article.

Like PTC's ThingWorx, Vizible includes an authoring tool. It lets users build visual components within collaborative environments with all the ease of a Unity or other game engine. This lets enterprises not only give VR presentations but build them, including visual assets or 3D models they already have.

This one-two punch represents a strategy to become the Power Point and Go-To-Meeting of VR, as Beall puts it. As already mentioned by Coca-Cola and ScopeAR, enterprise XR can\ realize the longstanding and unfulfilled promise of teleconferencing, but in a more immersive and effective way.

7

Companies should begin looking into VR/AR technology before they need it. Companies like IKEA and Lowes have already been working with this technology for several years, which is why they are first to market with new products that drive sales. Much like the beginning of the internet, early adopters will be ahead of the game, and complacent companies may find themselves left behind.

Companies that are on the fence about immersive technology should begin with a reasonable investment into discovery and proof of concepts. Get an early feel for the technology, the potential, and the feedback from their employees, along with an understanding of what it's like working with an AR/VR vendor.

8 STEPS TO BUILD YOUR VR/AR EXPERIENCE

8

1. Identify an industry expert partner (potentially from the VR/AR Association , which has approx 4000 companies registered)

2. Identify one project that has a measurable ROI (remote expert enablement, training, online marketing)

3. Establish a baseline for that measurable ROI also that you'll be able to come out of the project saying something like: *before we started using VR/AR¨a task used to take x hours to complete now it only takes y minutes.*

4. Start with one small mobile phone based AR experiment

5. Roll out a proof of concept (POC)

6. Study analytics (and how your ROI baseline has improved as a result of the AR/VR solution)

7. Use the data from your analytics to make a business case to proceed with a broader implementation. At this point, you may also need to provide answers to questions about security, maintenance, device management and integration with your enterprise IT infrastructure - so do the research you need to prepare for those questions from your company's IT departure.

8. Improve, repeat and scale

Because VR and AR are meant to better align with our senses; when a solution is properly designed it is the perfect medium to empower the employee. Make sure you choose a knowledgeable, experienced VR/AR partner to help with the 3D asset and SOP documentation.

8 Retail

IKEA Place

Ikea Place is a revolutionary new AR application that allows customers to visualize how furniture will look in their house in the exact size dimensions. This was one of the first Apple ARKit applications and remains one of the top 5 downloaded ARKit apps. Ikea isn't new to virtual and augmented reality having produced a VR Pancake Kitchen experience where you can cook pancakes in a beautiful Ikea kitchen. They also made the app available for download on the popular VR game distribution site, Steam. Another company doing VR and AR furniture placement is Marxent Labs, based in Florida.

Modiface

Modiface has created a solution that allows people to try on makeup in real time using augmented reality. This technology is currently being used by MAC, Smashbox, Estee Lauder and more. Similar to the way Snapchat works, Modiface enables overlays with very high precision.

StriVR

StriVR is taking their experience in training college and pro sports teams using virtual reality to enterprise. As their first client, Walmart is using virtual reality for training its employees in a variety of tasks. The program is so successful, they are expanding it.

MetaVRse

What started out as a VR consulting firm, has now become the destination for Hyper-realistic 3D models of your products for use in Web, AR, and VR. Their Web3D Player gives brands the ability to convert their 2D products into 3D hyper-realistic models that can be viewed in 360° and soon to offer AR capabilities to view products anywhere in the real world.

InContext Solutions

Providing retailers with the ability to test their store layouts in virtual reality, they can make course corrections sooner; and with much less cost than building a physical store. Heatmaps created using eye tracking give incredibly accurate analysis. Their cloud-based virtual reality simulations are being used by Walgreens, Walmart, CVS and more.

NextReality's Inplace

Allows live-sized holograms to present clothes, jewelry, watches and more, in a virtual catwalk available anywhere, anytime. Luxury retail, like Farfetch, are reaping the benefits from these solutions.

One last note on VR/AR for retail; Williams Sonoma purchased an AR company, Onward, for $112M. They produce high-quality 3D products similar to Ikea Place.

8 Airlines

Skylights

This San Francisco based startup is providing premium movie watching in VR for long flights. By immersing people in VR during their flights with theatre size screens, suddenly the flight from NY to LA will seem like a trip to the corner store.

Airbus

Global airline giant, Airbus is using mixed reality (Hololens) to train engineers and cabin crew on the intricacies of their new A350 XWB line of planes.

Eon Reality

Training employees on dangerous emergency procedures is costly and impractical. Using VR to allow employees to train in scenarios on a more frequent basis will allow for a much more prepared workforce. Eon Reality has been working on industrial training for a long time focusing in the energy, pharma, medical, public service, aerospace and airports sectors.

8 Real Estate

Matterport

Gone are the old school, real estate tours, consisting of a few photos. Now buyers can step into a property and walk around in stunning 4K 3D virtual reality. Matterport has introduced a fully integrated system of camera and software that makes it easy to create stunning 3D models of properties to see in VR.

Brands like Sotheby's have already begun using VR to show foreign investors properties without having to fly in.

Transported

Silicon Valley-based startup, Transported, is using regular 360° cameras to create virtual tours similar to those like Matterport (not in 3D/stereoscopic), without the need for special hardware.

YouVisit

Similar to other virtual tour systems, YouVisit is a leader in the space. Starting with college campus tours, they have now expanded into hotels, destinations and corporate tours.

HomeAR

Using your Tablet or smartglasses, you can walk inside of a house that isn't built yet, check the view of your windows and change decor and wall colors, all due to the wonderful power of ARKit, ARcore and Microsoft Hololens.

8 Automotive

Porsche Cars North America

Porsche Cars North America, Inc. announced the introduction of "Tech Live Look," an Augmented Reality technology designed to improve technical services at Porsche dealerships in the United States. "Tech Live Look" uses the AiR Enterprise™ software platform from Atheer, Inc., a leading provider of AR solutions, in conjunction with lightweight smart glasses. These high-tech spectacles feature the latest in projection technology and come equipped with a high-resolution, auto focus camera that shows even fine details such as threading on screws. The glasses include a powerful LED to illuminate dark spaces in the engine compartment or under the car.

Ford

Ford's immersive Vehicle Environment (FiVE) Lab is doing some incredible work using visualization of vehicles in the design process. Ford executives must view every vehicle in VR before they are approved to be made. VR is saving time and money on costly iterations.

Finger Food Studios

Vancouver-based Finger Food Studios is focused on using the Microsoft Hololens to allow engineers to visualize wind flow for a new truck for Paccar Group. This working proof of concept is already leading to shorter design turn around times, thus saving millions per year.

Zerolight VR

Working with the top vehicles in the world, Zerolight has become the standard for photorealistic automotive virtual reality. With clients like Pagani, Audi, Toyota, and Nissan, it's no wonder Zerolight has become the go-to company for the high-end automobile industry.

Bosch AR Repair

The Bosch company has introduced an AR repair system where you hold your phone or tablet over a car engine, and it walks you through the repair process. These types of service applications will become much more prevalent over the next few years.

Relay Cars

This VR sales tool allows car manufacturers to choose their environment and uniquely showcase their vehicles without having to pay for development of an application.

8 Automotive

AT&T "It can wait"

This VR public service announcement is directed at teens and the vital message that texting and driving is very dangerous. "It can wait" has been seen by thousands of students in an effort to make our roads safer.

Bonus: If you love car repair, but hate the dirty hands, here is a game that allows you to assemble a car right down to the nuts and bolts. This is a great example of how VR can be used for education.(the name of the game?)

8 Banking & Financial

Fidelity Investments

Imagine flying through a city in virtual reality, and every building is one of your investments growing up from the ground. Fidelity recently began experimenting with this exact premise. While still early days, it is a great first step and shows the world that Fidelity is forward-thinking enough to lead the way. The company is also experimenting with VR for sales empathy training.

Citi Financial

Taking a different approach to data visualization, the team at CitiGroup has come up with a conceptualization of what investment data might look light in mixed reality with Microsoft's Hololens. While still a concept, you can bet they will keep going until they get it right.

SAP

The enterprise software giant, SAP began showing off some proof of concepts recently for VR/AR data visualization and also virtual tours of banking institutions of the future.

BNP Paribas

VR was used to train workers into business continuity procedures, namely on how to relocate and start working at their safe office, in case of catastrophes like earthquakes, hurricanes or tsunami.

8 Health & Medical

HealthiAR

This comprehensive information site covers all things VR/AR medical related.

Invivo

Toronto-based, medical VR company, Invivo is helping pharmaceutical companies, hospitals and physicians provide lessons in virtual and augmented reality. With clients like Lilly and Novartis, this company is leveraging its 20 years experience in the medical field to bring quality VR/AR products to the market.

Bioflight VR

VR training for physicians and surgeons in a variety of scenarios is what Bioflight VR has done very well. From pediatric trauma to smoking cessation, this VR training is setting the bar high.

Virtual Reality Medical Centre / VR Phobia

VRMC is using VR to treat patients for everything from PTSD to phobias of spiders. Using immersion therapy, this San Diego based company is pushing the limits of what's possible.

Augmetix

Using AR and Google Glass to give physicians a hands-free way to record, store and recall patient information; Augmetix solves a number of patient-centric challenges in the medical field.

Kapanu

A Swiss company, Kapanu is using AR in a unique way to show patients what their teeth will look like after cosmetic surgery. By using advanced scanning techniques, they are able to recreate the new teeth in place of the old in real time. This technique is similar to the face tracking that Snapchat uses to put bunny ears on your head, only a little more useful. NOTE: Kapanu was just acquired by leading dental manufacturer, Ivoclar Vivadent.

8 Virtual Reality Architectural Renderings

Richmond, VA based software company Shockoe has found success building interactive virtual reality renderings for architecture firm Fultz & Singh. The traditional method of communicating Architectural designs to a client involves a significant amount of assumptions on the part of the architect, namely, that the client can visualize all of the aspects of how a three-dimensional space will feel using a two-dimensional rendering. However, actual space has certain factors that are difficult or impossible to communicate with two-dimensional renderings.

The process involves significant time spent with both the client and the architect negotiating their assumptions about what a change might look or feel like. There is a significant amount of guesswork for all parties, as they must attempt to "imagine" a space rather than "enter" a space. The architect must then make changes based these imagined perceptions. As a result, it can often take many weeks of back-and-forth communication between architect and client in order to arrive at a final design.

Virtual Reality is the ideal solution for addressing these issues because it allows for an accurate representation of actual space as referenced above. The client can now enter an area, and see the architect change the environment in real-time, often allowing a decision to be made after only one or two viewings. The return on investment is significant, as the time between presentation of work and client buy-in is greatly diminished.

"The positive impact of this technology cannot be understated. It is literally changing the way we do business and how we ommunicate with our clients. What used to take weeks now takes hours, thanks to the sense of presence that virtual reality affords."

- Amrit Singh, Partner - Fultz & Singh Architects

8 Industrial (Mining, Oil & Gas, Manufacturing)

MineLife VR

MineLife VR by LlamaZOO Interactive is a Virtual Reality software platform that presents a truly three-dimensional digital twin of a mine plan from exploration to closure, at scale, using actual planning and geospatial data. The software synthesizes traditionally dispersed, complex geospatial and mine planning data. As a unified data source, MineLife VR enables mining companies' internal and external stakeholders to immerse themselves in the mine plan, and interact with it through its entire lifecycle, from any angle, whether thousands of feet up in the air or down on the ground.

This disruptive application of AR/VR technology has been adopted and recognized by some of the largest mining companies in the world, including Teck Resources, and more recently Goldcorp, who selected MineLife VR as 1 of 4 global finalists for #DisruptMining 2018 - a prestigious competition designed to encourage new technologies that solve some of the biggest challenges in mining, with a $1M investment or contract being awarded to the winner.

Operational Command & Control 3D

OCC 3D (*https://www.llamazoo.com/spatial-business-intelligence/*) by LlamaZOO Interactive provides 3D digital twin visualization of l ive 4 site operations,providing centralized real-time tracking of equipment and vehicle positioning, health, and productivity, as well as planned vs. actual progress. The platform was developed for the mining industry, but the value it provides is applicable across oil & gas, manufacturing, and other industries.

OCC 3D turns companies' existing data into a highly visual, remotely accessible, and real-time visualization. Digital twins are ideal for overseeing and optimizing machine, equipment, personnel, and site-wide operations, enabling companies to avoid unplanned maintenance by remotely monitoring machine and equipment health and data; gain centralized data oversight by integrating any number of data sets into one centralized interface, all accessible in real-time; increase output and efficiency by monitoring operations through a data visualization dashboard that enables just-in-time decision making; and unlock the possibility for mid-shift adjustments.

8 VR Simulations & Data Analysis

Complex and expensive machinery or parts can be simulated in virtual reality with complete functionality. The VR developer will leverage the client's CAD files to ensure 100% accuracy and the highest level of visual clarity.

The advantages of creating such a simulation in virtual reality include increased accessibility, improved safety, and reduced costs. These solutions can be deployed to any brand of VR headset, and are accessible on-demand.

Accessible training: Reduce the time, costs, and risks associated with training by providing real-world simulations proven to increase retention and engagement.

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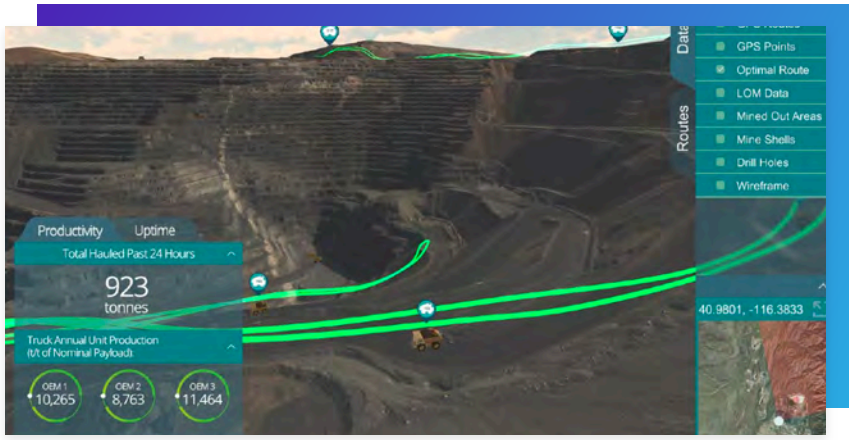


Upskill

The use of augmented reality in manufacturing is beginning to take off, and Upskill combines the AR capabilities of newly funded Upskill and beverage giant, Coca-Cola to increase productivity in the workplace. The trial was so successful; they are rolling this technology out to other parts of their enterprise.

PTC

30-year-old industrial software company, PTC recently introduced their augmented reality platform called Thingworx that allows users to create custom AR overlays using marker stickers applied to the product being worked on. From work instructions to service manuals to sales and marketing materials, PTC is leading the AR revolution in industry. See their recent comprehensive article from Harvard Business Review (*https://hbr.org/2017/11/a-managers-guide-to-augmented-reality*).

8 VR Simulations & Data Analysis

Serious Labs

The Canadian company Serious Labs, recently raised over $5M to continue developing VR/AR training solutions for enterprise applications; like VR crane training and others that combine the physical with digital.

Kineviz

Kineviz builds visual analytic tools targeting complex, high dimensional data problems. Their GraphXR software enables researchers and subject matter experts to quickly and painlessly derive insight from big data and large graphs. Kineviz has delivered 10x-plus efficiency gains to their clients with a combination of PhD-level data expertise and artistic design. Their visualizations connect with all popular data stacks and leverage GPU acceleration, machine learning, and open web standards.

Dali-VR

The world is exploding with digital data, with an increasing complexity in terms of volume and variety. Companies are now looking for intelligent ways to analyze and explore data in more intuitive and creative ways. VR could be game-changer to turn things around, opening new opportunities to interpret and manipulate digital data. But, the customization of virtual environments for specific types of data is still costly, time consuming and requires high level of expertise.

To overcome this challenge, Dali-VR combines VR and Big Data Analytics in a platform where anyone can intuitively create 3D environments for data visualization. Dali-VR is a two-sided marketplace that connects the worlds of business and engineering. On one hand, developers, designers and engineers can use Dali-VR development platform and online marketplace to build and sell customized VR tools as apps. For the end users, Dali-VR is a low code and modular platform that allows the creation of customized VR environments by anyone, without 3D programming skills.

Dali-VR's primary use case was retail banking, an intuitive and immersive visualization of several financial reports. With this, the client was empowered to analyze the progress that has been made with respect to the financial condition, results of operations, capital position and business of the multinational company – comparing the homologous year with previous ones. In addition, it was possible to aggregate different types of information in one environment and to interact with the data to extract the most relevant insights.

8 Restaurant & Food

Kabaq

NY based AR Food company, Kabaq is leading the way for restaurants to place high-resolution models of their food directly in front of you so you see exactly what you can expect. Recently, they were a featured ARKit demo with the ability to drop food directly on any surface for a 360° 3D view.

Bartender Simulator

This fun and exciting game from Polish studio, VR Factory puts you directly in the action as you learn all the flare and fun of being a world-class bartender.

Klip VR

Partnering with restaurant chain, Honey Grow, Klip Collective has launched one of the first VR training systems for the restaurant industry. From how to greet customers to manage food stock, this comprehensive training program is being rolled out across the country.

19 Crimes

Australian winemaker, 19 Crimes recently introduced an amazing AR app that brings the story of 19 Crimes wine to life on the bottle. This unique and engaging app is available for download, now you have another reason to drink a bottle of wine.

8 Travel & Tourism

Discovery TRVLR

Discovery Channel is heavily invested in VR producing tons of unique and exciting content including mini travel documentaries, all available for free. You can zip down Armenia's longest zipline or descend into a holy dungeon, all from the safety of your VR headset.

Google Earth VR

Using the power of Google Maps 3D data, this free magical VR experience allows users to travel anywhere in the world and stand in the middle of the action. Most people take this opportunity to travel to their first house and look around. Brands have not yet tapped into this wonderful experience, but that might be coming soon.

MetaVRse

North America's leading VR/AR Consulting firm has created a world-first travel AR experience they call the AR Teleportal, which allows travel companies to provide mobile-based AR experiences to potential travelers turning their living room into a portal into another world.

YouVisit

In addition to college, corporate and city tours, YouVisit is also leveraging their platform to bring the world of travel to your living room in VR. Brands and destinations are slowly adopting this platform as an easy way to give users a 360° look at the world from a desktop, mobile, and VR.

XPLR by Travelweek

This custom VR application has been used by Celebrity, Carnival and Holland Cruiselines to bring the ship to you through VR. Check out the free app to view your next travel destination today.

VisitAR by NextReality

An AR product developed to provide indoor and outdoor experiences - it animates paintings, creates X-ray holes in buildings, allows you to walk inside churches that don't exist anymore and allows you to be guided by holographic knights into castles and palaces.

8 Communications & HR

MeetingRoom

MeetingRoom is a VR communication tool that allows companies to bring people together from around the world to collaborate in the same space. With enterprise-level security and features, this program is poised to set the standard in office meetings in VR.

BigScreen VR

What started as a cool way to watch movies with friends in VR, has become a widely used productivity tool allowing people to collaborate on projects and see their computer screens as huge TVs inside VR.

9 Uses for VR/360° Video

Virtual Reality comes in many forms from live-captured 360-degree video to computer-generated (CG) worlds. The key for businesses is to find the method that will get your message across most effectively.

Below we outline the different types of VR you can and the budget ranges associated with each. (Note: The budget estimates are current as of December 1, 2017).

360° Video

VR/360 Video also known as 3DVR and Stereoscopic VR uses multiple cameras in a custom array that captures video from 360 degrees. YouTube and Facebook have already launched their 360 degree platforms opening up the possibilities of sharing VR/360 video to those who want to view this on their computers and mobile devices. Brands across numerous industries have already begun to see significant success using 360° video. Hong Kong Airlines' 360° ad was 35 times more effective than the same traditional 2D ad. The Lionsgate Blair Witch VR campaign elicited a 57% voluntary replay rate.

Currently, the cameras for VR are very expensive and are usually custom to each project or involve using off the shelf components such as GoPro's and custom video stitching software to make them work. Each camera captures a different angle, and the software aligns the images and "stitches" them together into one seamless 360-degree image. Think of an orange peel that you manage to get off in one piece, that is what VR content looks like while editing. The main challenge right now is the post-production cost which typically runs two to three times the cost of traditional video production.

"VR/360° Video puts the viewer front and centre for every experience"

- Alan Smithson, CEO MetaVRse

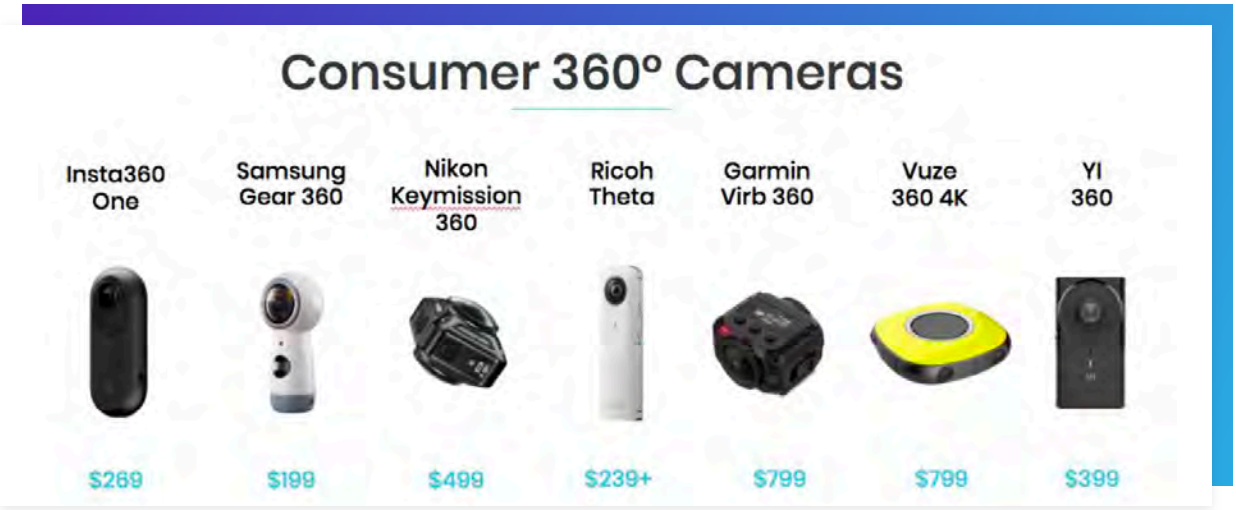
Uses for VR/360° Video
- Live events (concerts, sporting events)
- Storytelling
- Cinematic experiences
- Trade Shows
- Real Estate Tours
- Movie Trailers

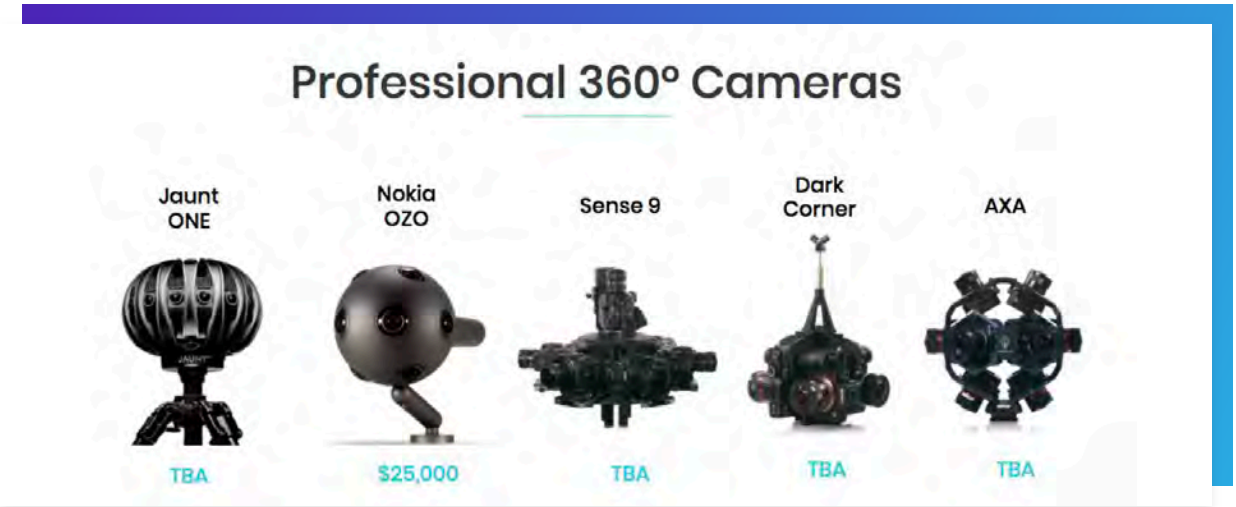
Challenges
- Shooting requires advanced planning
- Careful use of motion will reduce or eliminate motion sickness
- Post-production can take a lot longer due to the stitching and editing process
- Distribution is not 100% defined yet
- Costs are somewhat prohibitive to smaller brands

Costs
- $10,000 to $50,000 per minute of high quality, cinematic/stereoscopic VR content
- $500 to $5,000 per minute of lower web-based

See a List of 360° Camera Rigs6
https://delight-vr.com/blog/complete-list-of-vr-cameras-2017/

9 Uses for VR/360° Video





9 Computer Generated (CG) Virtual Reality

- Unity 3D
- Unreal Engine
- Improbable Engine
- WebVR

Immersive CG (or computer generated) VR content represents a completely graphics driven experience. Rather than using cameras to capture a live environment in 360 degrees, computer animators are employed to create a new virtual world. This is where the imagination of a marketer can start to run wild. Imagine showcasing your newest product from the view of an eagle soaring over the ocean or view from an ant looking up a cell phone as if it were as big as a billboard. Brands can now tell their stories using a medium that consumers will forever remember.

The complexity of CGVR varies from experience to experience and can be created out of 8-bit block images like Minecraft to incredibly real environments. The budgets associated with CGVR typically run double if not triple those of VR Video and take considerably more time to develop. Planning and patience is required to make something that is brand focus yet authentic. It is important for brands not to take a spray and pray approach to this new medium. If the public starts to view VR as simply a marketing tool, they will reject it and VR will go the way of the QR code.

One of the most compelling things about CGVR is the ability to create interactive elements within the experience. For example, using the Oculus Touch controllers, you can pick up objects while moving around the environment. Interaction within the VR experience is the ultimate and with the launch of Oculus Rift, HTC Vive, and Sony Playstation VR all coming in 2016, brands can be first to market with unique, engaging content that captures the imagination and mindshare of consumers.

Most VR experiences are being made using the two primary development programs; Unity and Unreal Engine. Unity advertises that over 70% of all VR is made on their engine. However, other stats suggest that 70% of the money made in VR is created using Unreal Engine. Unity has a much easier learning curve and is working on an editor that will allow you to make VR in VR thus saving time having to put the headset on and off as you create.

Unity 3D is used in basic applications to get things done quickly without too much effort. Unity is used for AR and VR alike and offers a fast way to create content. Unity is easier to learn, but more difficult to master. Unity Pro is $1500 or $75/month

Unreal Engine (UE) is used when top production quality is important. UE offers much higher poly counts and allows for photorealistic applications for training scenarios. The shaders and lighting effects seem to be higher quality in UE vs. Unity. Unreal Engine is free but gets 5% of royalties from any project made using the engine. It is also 100% free for Schools and Universities.

9 Computer Generated (CG) Virtual Reality

Both engines have assets available on Unity Asset Store and Unreal Engine Marketplace. Other game engines of note include web-based Improbable and free Cryengine.

Uses
- Game Launches
- Product Launches
- Trade Shows
- Product Visualizations
- Storytelling

Costs
- $50,000 to $1M+ depending on complexity

Challenges
- Custom CGVR is a large investment
- Projects take time to develop
- Interactive HMD's are not yet available to the public
- Distribution is not 100% defined yet
- Costs are very prohibitive to smaller brands

10 WebVR

WebVR offers several unique advantages over game engines but also presents additional challenges. WebVR requires no software download or plugin, is hardware agnostic, and allows developers to build from the ground up without a game engine getting in the way. Moreover, it can be built on top of existing web apps; allowing for hybrid solutions that leverage traditional computing as well as VR/AR. That said, WebVR standards are still in flux, so it's not as easy to jump into and start building as Unity3D. There's also no equivalent of the Unity Asset Store. Yet it does enable the ability to incorporate a vast range of web-native tools and plugins. Finally, there is no cost to build or deploy in WebVR other than your time.

Uses
- Rapid Prototyping
- Low resolution games and experiences
- Barrier free (no downloads)

Costs
- $15,000 to $250k+ depending on complexity

Challenges
- WebVR is still unknown and fickle
- Bandwidth is a major challenge

WebAR

Over 1.5 Billion mobile devices will be AR-enabled in 2018, and with Apple's ARKit and Google's ARCore allowing for more advanced position and plane tracking, WebAR will give companies the ability to push out content without the friction of downloading another app. MetaVRse was one of the first companies to introduce WebAR in October 2017.

Uses
- Retail and eCommerce
- Low resolution games and experiences
- Barrier free (no downloads)

Costs
- $15,000 to $250k+ depending on complexity

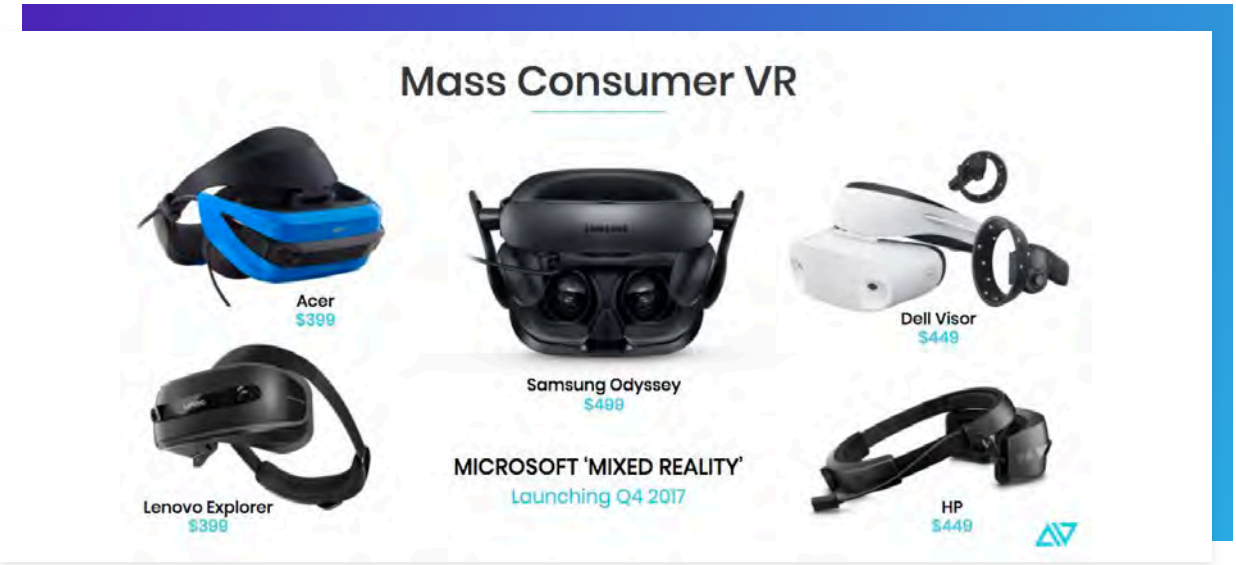
Challenges
- WebAR is still unknown and fickle
- It will soon become part of ARKit and ARCore's main business model

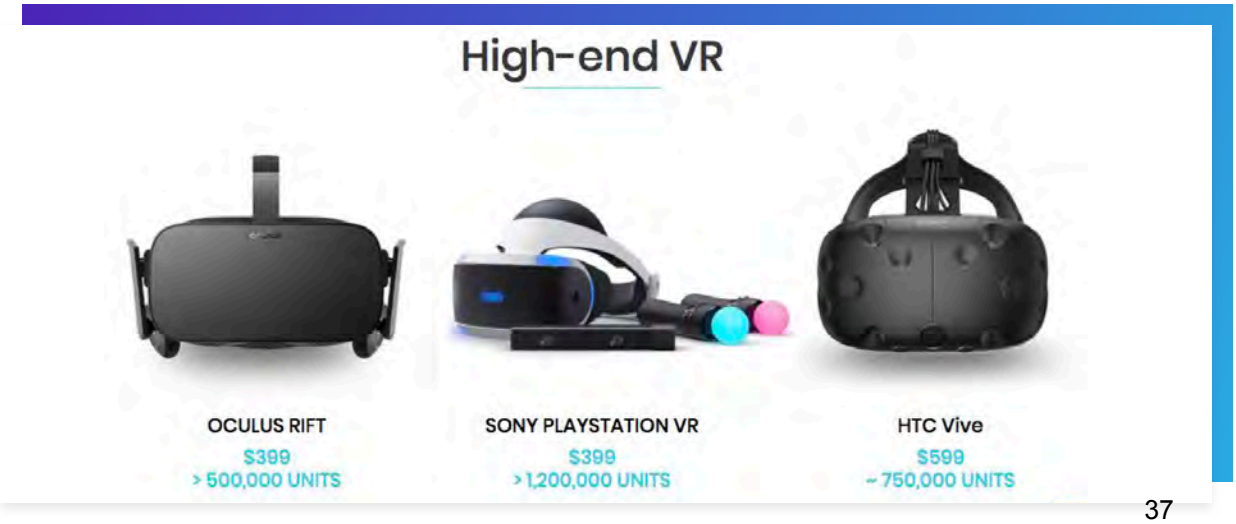
10 VR Head Mounted Displays

Almost every major technology company in the world is making a VR headset. From Oculus Rift to HTC Vive to Samsung Gear VR and Microsoft Holographic; these headsets are making it easier for companies to embrace and scale these technologies. In the near future, these headsets will be free from the tether and will bring true 'room scale' VR to the masses without the need for expensive computers and graphics cards.

NOTE: prices might have decreased of the headset from the time of this publication.

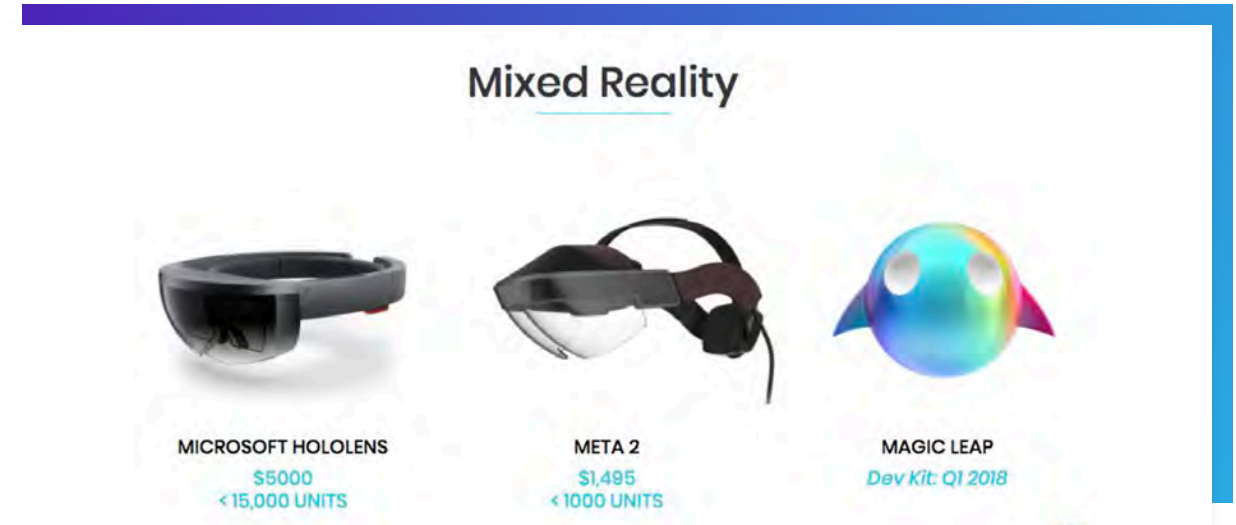
10 VR Head Mounted Displays





10 AR Head Mounted Displays

Augmented Reality headsets are being developed with more enterprise applications in mind. From remote assistance to on the job training, AR glasses are changing the way businesses communicate with employees. From lightweight Google Glass to the complete holographic computer built into the Microsoft Hololens, AR is coming first to enterprise.



10 AR Head Mounted Displays

In addition to these AR and MR glasses and headsets, a new wave of smart glasses is expected from manufacturers leveraging the new Augmented Reality (AR) reference design offered by international Sketch-to-Scale manufacturing giant Flex Ltd.

It was announced at CES 2018 and aims to reduce time to market for companies making AR devices for enterprise and consumer applications. Atheer provides the AR interaction module and enterprise software support for the Flex Augmented Reality Reference Design.

Flex Ltd. boasts $24 billion in annual revenues, a workforce of 200,000 employees and 50 million square feet of manufacturing and services space. It designs everything from augmented reality and virtual reality systems to smart watches, smart clothing, robots, connected home devices and home health monitoring systems. In short, when Flex releases a new reference design, it has the power, scale and capability to make a real difference.

The release of the Flex Augmented Reality Reference Design comes at a time when AR adoption in enterprises is entering a new phase. According to Ramon Llamas, Research Manager with IDC's Devices and Displays team, there is a real demand by customers for solutions that address hardware design, platform stability, enterprise application readiness and security.

"The entry of major manufacturers such as Flex into the AR market offers the potential to significantly accelerate augmented reality hardware development," he explained. "And it's not just the hardware that has to pass muster; it's the platforms that act as the connective tissue between user/device/back-end servers; the applications that must be developed and made available to users; the security that has to go through the entire system and reach every endpoint; and most critically, getting the buy-in from multiple parties within the enterprise (line-of-business users, C-level executives, finance, marketing, and especially IT)."

10 AR Head Mounted Displays

Mobile Augmented Reality

The advancement of AR technology is moving at a lightning pace, but no headsets can compare to the reach of mobile. With billions of devices in the world about to be AR-enabled through ARKit and ARCore, the bridge between the current and future is mobile AR.

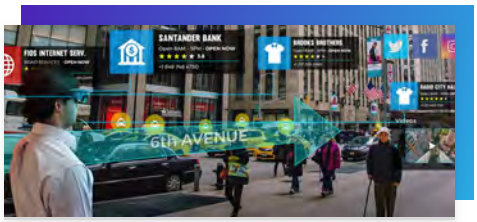
BlippAR

Starting life as a way to bring print to life, BlippAR has become more of a machine learning, computer vision company allowing users to point their phone at any object and have their AI algorithm tell you what it is. Expect to see a lot of this moving into the retail space.

ScopeAR

Allows enterprise clients to overlay instructions over the real world with the use of AR glasses and mobile devices. Their Worklink and RemoteAR systems allow real-time collaboration in the field.

ThirdEye's X1 AR Smart Glasses and AR Software platforms are used by Fortune 500 companies to enhance their operational efficiency. Live remote help, real time image recognition, geo-located digital data & streaming head-motion controlled multiple-screen sports/entertainment content are a few of the AR use cases.



Vuforia is a platform that allows developers to rapidly make and deploy marker-based augmented reality to bring to life printed materials or signage.

11 Challenges Facing VR/AR Adoption

"Price and content are absolutely critical for understanding whether our industry is going to get to maturity,"

- John Riccitiello, CEO Unity 3D

Price point

Currently, the prices of quality head-mounted displays (HMDs) runs around $400-600, plus you need a powerful computer with a kick a$$ graphics card ($2000) and of course you will want some games (5 @ $30 = $150) for a total of over $2550.

Mobile phone-based VR is much easier on the wallet, but is still very expensive when you consider the cost of the phone; Samsung S8 or Google Pixel ($800-1400) + Gear VR or Daydream VR headsets ($150) for a total of $950 to $1550.

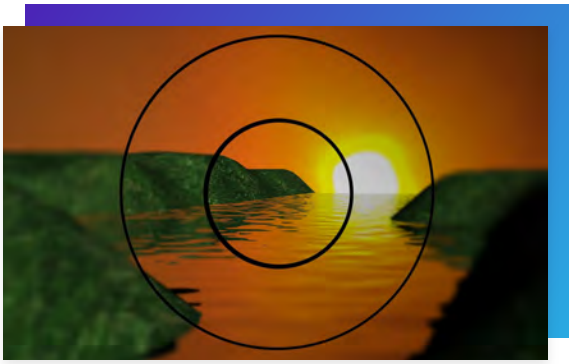
Luckily, Oculus just announced (Oct 2017) the Oculus Go, a complete stand-alone VR headset (no phone) with a controller and a $199 complete price point. VR is about to be accessible to the masses!

Computational power

As the demand for higher quality VR experience builds, the computational power to drive these experiences is also going up. Current headsets are 2160 x 1200 (Vive & Rift), but some companies have recently started introducing much higher resolution (8K) headsets to great praise. Use of eye tracking and foveated rendering will allow for much higher resolutions and more computing power.(see eye-tracking below)

Eye-tracking

Apple's recent acquisition of the leading eye-tracking company, SMI and Google's acquisition of their biggest competitor, Eyefluence; marks the beginning of foveated rendering. A technique used to conserve processing power by only rendering high resolution in the 5% of a person's vision. Think of your vision in concentric circles, the middle is clearest and moving out to the periphery; things get blurry. Go ahead, look through your peripheral vision.



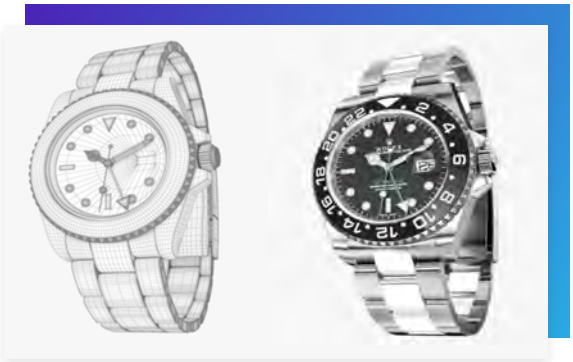
Example of foveated rendering

11 Challenges Facing VR/AR Adoption

3D Modelling costs

Imagine that everything around you, from books to cutlery, to computers will need to be rendered into 3D. Now you need to decide on which method, using programs such as Maya, Octane, 3DS Max, and Cinema 4D. And finally, you need to make sure your budget will meet your requirements for your project.

MetaVRse specializes in hyper-realistic 3D product models for use in Web3D, VR and AR. Sites like Turbosquid and Sketchfab showcase public 3D renderings made by the crowd.



Example of a hyper-realistic 3D model.

Field of view

One of the most common complaints about VR and AR headsets is the small field of view (FOV). The Gear VR has 101°, Oculus 120°, and Vive 130°. In contrast to this, the Microsoft Hololens has a 35% FOV. This problem is being worked on by every company, and future headsets will approach the human limit of 210°

Security

Pretty soon, we will be able to conduct meetings in virtual and augmented reality (hopefully easier than using the board telecom system). The idea would be to don your headset, and your persistent avatar would attend meetings and sound, look and act just like you. What if Sally from accounting just happened to walk by your desk, pick up your headset and join a meeting on your behalf? Security protocols for retinal and eye-tracking to unlock your headset will be a very lucrative business opportunity, but perhaps Apple will just make it standard on Apple Glasses.

Sensors & inside-out tracking

One of the first things people do in VR is look at their hands. The fact they cannot see them today is a definite challenge. The new Microsoft Mixed Reality headsets by OEM partners deliver just this only adding inside-out tracking (being able to track the headset and hands in 3D space without the need for any external tracking systems (like Vive, Rift and Playstation VR). This is solved through regular and depth-sensing cameras.

11 Challenges Facing VR/AR Adoption

Microsoft Hololens Sensor Suite

Lack of multi-model interaction

Just how effective your workforce is in using Augmented Reality will depend a great deal on the "interaction model" of your AR solution. Ideally, it should support multiple ways of interacting with users. The right interaction model can make all the difference between something that provides a great demonstration of potential and a solution that can be tested, piloted and rolled out in a real-world setting.

There are four common ways to interact with the augmented reality technology:

• **Gestures** – Most smart glasses used in AR have front-facing cameras that offer the ability for the glasses to "see" what a user sees – and be able to interpret the motion of a hand in front of them. Gestures are a great way to precisely interact and are perfect for dirty or loud environments. To be effective, an AR solution needs a precise and efficient hand tracking algorithm can enable the smart glasses to take advantage of an on-board RGB camera or depth sensor to recognize and respond to gestures. This will provide a true hands-free working experience.

• **Voice** – There are some situations when gestures are not ideal. These include situations where a user's hands may be occupied with tools. In that case, voice commands provide an important and safe alternative for interacting with smart glasses. Ideally, you want to be able to add voice commands to your smart glass system actions and allow your developers to define voice commands to extend their apps.

• **Head motion** – In situations where voice commands and gestures are not suitable, (such as noisy environments), head motion is a great alternative. If your AR solution provides multi-display and sphere view technologies, it will allow workers to access and scroll between content (including video feeds) and drill into images, maps, and 3D models with a simple motion of their heads.

• **Touch** – Good AR solutions should provide support for industry-standard touchscreen devices so that workers using popular phones and tablets can leverage some of AR features (including video conferencing, on-screen guidance and documentation such as shop manuals) when they are working in environments where they don't have to use work gloves or carry tools in their hands.

Conclusion

12

If you made it this far, congratulations, you now know more about VR/AR than 99.9% of the world. This medium is at around $7.4B in 2017 increasing to $21B in 2018 and growing steadily at an incredible rate of 133% per year. In the next 3 years, mobile AR will be the dominant platform for these 3D experiences. Web3D (seeing products in 3D on websites) will become standard, and in about 5 years, we will move from mobile phones to AR glasses that will give us superhuman abilities (squint and get 100x vision). Those companies who invest early in this technology will see massive gains over their competition.

For more information or to find the right partner for your VR/AR project, visit the VR/AR Association website https://www.thevrara.com