ARTILLRY INTELLIGENCE BRIEFING

ENTERPRISE XR: IMPACTING THE BOTTOM LINE

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Table of Contents

Executive Summary

The past year has been volatile for AR and VR (a.k.a. XR). After an exuberant 2016, the sector's temperature cooled when consumer hardware penetration – a key leading indicator of industry health – fell short of expectations. So attention shifted to areas of nearer-term scale: mobile and enterprise.

For enterprise (mobile is covered in a separate report)[i], its nearer-term opportunity is due to a greater addressable market. There are more receptive buyers in enterprise environments, due to measurable time and efficiency gains in AR-assisted job roles. This creates a clear ROI narrative.

To quantify, companies like Intel and Coca-Cola demonstrate 15-45 percent efficiency gains today. This includes time saved in assembly, sorting and maintenance functions. Given that enterprise process management generally strives for single-digit efficiency gains, this XR impact is notable.

And unlike consumer markets, where mobile devices are the near-term play, head-worn XR devices are already penetrating the enterprise. This is due to one big variable: style. Current AR glasses don't pass consumer markets' stylistic requirements, but that's not an issue in the enterprise.

For all of these reasons and more, *ARtillry Intelligence* projects enterprise XR to grow from $554 million in 2016 to $39 billion by 2021, with an inflection point in 2019. Revenue in early years will be hardware- dominant as an installed base paves the way for recurring software revenue in later years.

Most of that revenue will be from AR versus VR. Though VR's place in the enterprise will be valuable and transformative, AR's market opportunity is larger. This is due to its breadth of applicability across enterprise functions, and pass-through vision that enables more usage time per working day.

But despite all of these positive dynamics and fertile ground for enterprise XR's growth, there will be challenges. As with any organizational technology adoption, there is red tape, inertia, sales cycles and the complications of system integration. As the saying goes, anything worthwhile isn't easy.

So how will this all play out? What are enterprise XR's benefits and proof points? What are enterprises saying and doing to indicate areas of opportunity? Who's exhibiting best practices? And what are the biggest lessons and takeaways? This report sets out to answer these burning questions.

Image Source: Vuzix

Key Takeaways

- XR has been heralded as the next major technological transformation. This will materialize, but later than expected.
  - Similar to the early-2000's e-commerce bubble, XR excitement and market sizing isn't overblown… it's just early.

- Soft consumer hardware sales have shifted attention to near-term scale and opportunity, including mobile and enterprise.

- *ARtillry Intelligence* projects enterprise XR to grow from $554 million in 2016 to $39 billion by 2021.
  - Enterprise AR will grow from $314 million in 2016 to $35.2 billion in 2021, including a 2019 inflection point.
  - Enterprise VR will grow from $240 million in 2016 to $3.8 billion in 2021.

- AR's share results from breadth of applicability for enterprise functions, and pass-through vision that enables versatility.
  - AR will also be widely applicable across verticals including CPG, automotive and aerospace.
  - Enterprises have less stylistic and budgetary restraints than consumers, given today's bulky and costly smart glasses.

- Enterprise XR includes live AR remote assistance (assembly, maintenance), pre-authored AR guidance (sorting, maintenance), and immersive VR collaboration (training, design), among other formats.

- Adoption drivers include strong ROI and operational efficiencies (time and error reduction) in functions like manufacturing.
  - Intel, Coca-Cola and others detailed in this report demonstrate 15-45 percent efficiency gains today.
  - Additional cost savings result from remote support and collaboration, which lessen travel and machine downtime.

- Beyond micro-economics, enterprise AR has potential to transform workforce management
  - AR's guided instructions or live remote assistance makes more people qualified for more jobs.
  - This unlocks enterprise efficiencies and employees' in-house mobility, task variety and morale.
  - AR can enable experienced and valued veterans to work remotely, rather than retire or burn out from field work.

- Enterprise XR benefits are counterbalanced by several challenges, most of them due to organizational inertia.
  - Like many technologies, XR will face resistance at organizational and departmental levels.
  - The first and only point of entry is often "innovation centers," where XR is often well received but then languishes.

- Tactics for overcoming hurdles include building on already-adopted systems (e.g. Android), and grassroots support.
  - Greater chance of deployment can result from advocacy within the business units proposed to use XR. Bottom-to-top organizational buy-in can create powerful demand signals that lead to real XR deployments.
  - Value propositions should go beyond bottom-line impact and be spun to address individual (and sometimes selfish) pain points of decision makers and influencers throughout the organization.

- Despite challenges, there's good news.
  - After initial adoption, subsequent XR implementations are easier to achieve, as comfort levels are gained.
  - There is evidence that sales cycles are reducing in length.
  - Cultural familiarity with XR will inch forward and lessen enterprise resistance – a common process in tech revolutions.
  - We'll see step functions as companies make investments that fuel advancement, which in turn drives more investment.

- Challenges will persist into 2018 but momentum and acclimation are leading towards a 2019 tipping point.
  - Enterprise XR will follow a similar adoption pattern seen in smartphone enterprise integration over the last decade.

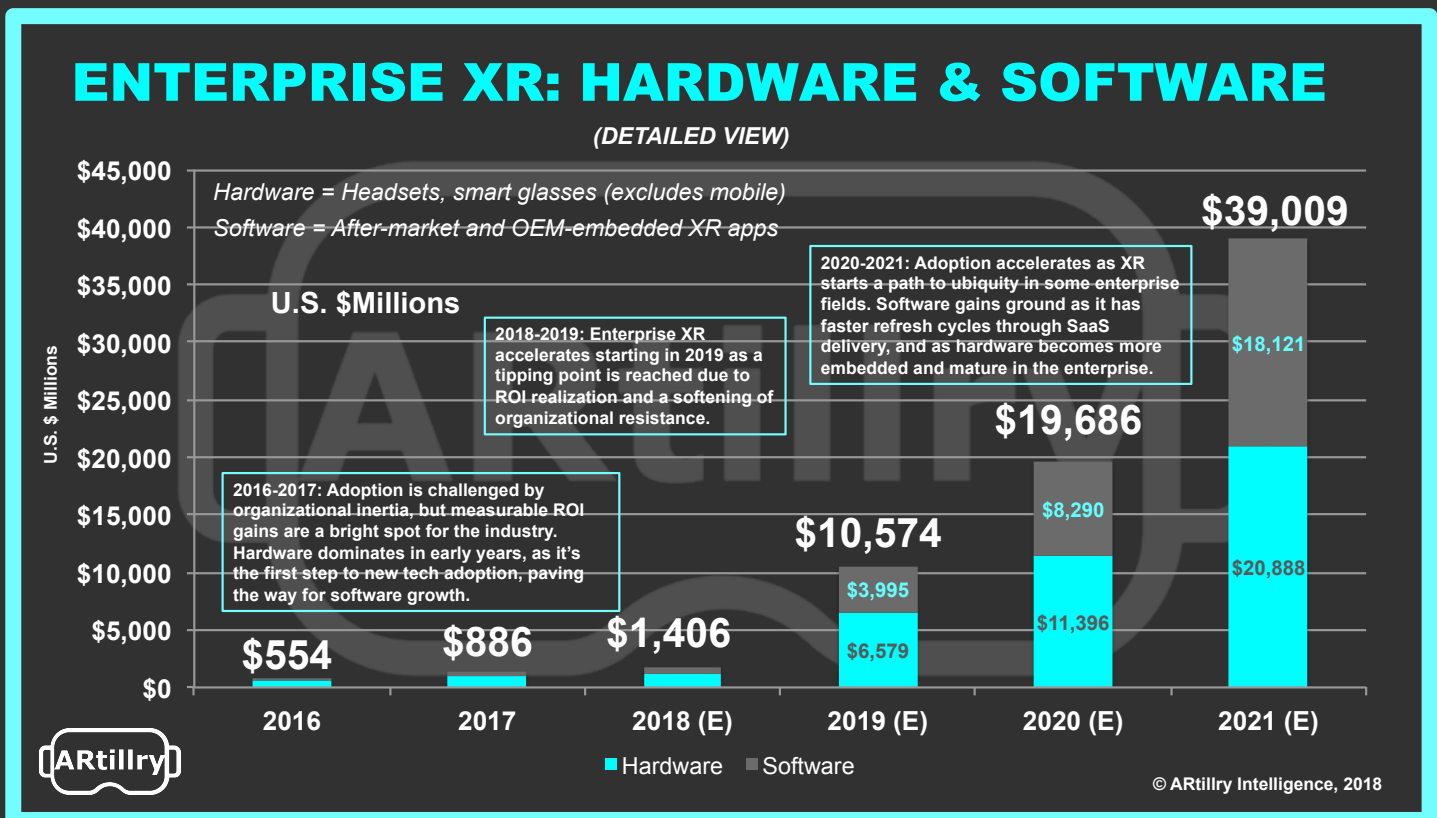*Key takeaways are also highlighted throughout the main body of this report.*

Introduction: The Road to $39 Billion

AR and VR (collectively known as XR) have been heralded as the next major technological transformation – on the order of the PC, consumer Internet and mobile revolutions. *ARtillry Intelligence* believes these claims are mostly true, but have been mistimed.

Similar in some ways – though not as drastic – to the early-2000's e-commerce bubble, excitement and market sizing for XR isn't overblown… it just may be a bit early. Evidence can be seen in slower than expected consumer VR hardware sales, a key leading indicator for the sector's near-term health.

As these signals started to materialize in 2017[ii], attention shifted to areas of nearer-term scale and opportunity. That includes places that have a larger addressable market or more receptive buyers. The former is true for mobile AR, while the latter is evident in enterprise XR integrations.

Sticking with enterprise (mobile AR was covered in a separate report)[iii], there's sizable revenue potential. *ARtillry Intelligence* projects enterprise XR to grow from $554 million in 2016 to $39 billion by 2021.[iv] Revenue will inflect in 2019 as enterprise resistance begins to recede (examined later).

ENTERPRISE XR: HARDWARE & SOFTWARE

(DETAILED VIEW)

Hardware = Headsets, smart glasses (excludes mobile)
Software = After-market and OEM-embedded XR apps

U.S. $Millions

2016-2017: Adoption is challenged by organizational inertia, but measurable ROI gains are a bright spot for the industry. Hardware dominates in early years, as it's the first step to new tech adoption, paving the way for software growth.

2018-2019: Enterprise XR accelerates starting in 2019 as a tipping point is reached due to ROI realization and a softening of organizational resistance.

2020-2021: Adoption accelerates as XR starts a path to ubiquity in some enterprise fields. Software gains ground as it has faster refresh cycles through SaaS delivery, and as hardware becomes more embedded and mature in the enterprise.

	2016	2017	2018 (E)	2019 (E)	2020 (E)	2021 (E)
Total	$554	$886	$1,406	$10,574	$19,686	$39,009
Software				$3,995	$8,290	$18,121
Hardware				$6,579	$11,396	$20,888

■ Hardware ■ Software

© ARtillry Intelligence, 2018

Updated market sizing, January 2018

By comparison, consumer AR glasses have a longer adoption horizon. Though likely boosted by Apple's rumored smart glasses in 2020, they aren't yet streamlined enough for consumers. But enterprises have less stylistic needs, as adoption criteria are more about bottom-line impact and ROI.

On that measure, enterprise XR boasts strong operational efficiencies like time and error reduction in manufacturing, sorting and maintenance. XR will also be widely applicable across enterprise verticals including everything from consumer-packaged goods (CPG) to automotive and aerospace.

Image Source: Google

What is Enterprise XR?

Before we dive deeper into market sizing, industry dynamics and challenges, what is enterprise XR? It includes assisted job functions as referenced, but what does it look like specifically? We'll answer that question through a few real-life examples, starting with a company you may recognize.

Coca-Cola: A Living Example

Coca-cola is already demonstrating AR's proof of ROI. It uses AR to fix broken equipment and for "changeovers" to assembly lines. That's when lines are quickly retooled for different products (e.g. bottle sizes or flavors). In both cases it's about reducing downtime and increasing the bottom line.

"Whatever you do has to impact the bottom line," said Coca-Cola Director of Product Management Michael Terrell at the recent AWE Europe conference. "When a machine goes down, it's the heartbeat of our operation. So if it's down, we're not producing product. Downtime is our enemy."

To reduce downtime, the company implemented a combination of Google Glass Enterprise Edition and Upskill's Skylight AR software. One key function is remote assistance for machine maintenance. When a bottle filler recently broke for example, remote AR-assistance enabled quick recovery.

"One of our techs grabbed the glasses and dialed in a vendor from a few thousand miles away," said Terrell. "It allowed him to troubleshoot and we got that equipment up and running within an hour. Prior to having this technology, cases like that could end up costing me a whole shift."

Besides downtime, Terrell underscores hard costs such as travel expenses for flying in a vendor or remote expert. This can add up to several thousands of dollars per incident. Given the frequency of these unexpected events – not to mention scheduled changeovers – the efficiency gains add up fast.

"When we're changing over, we're not producing product." said Terrell. "From a knowledge transfer standpoint, right there at a touch of the glasses [are] step-by-step directions on changeovers or step-by-step directions on trouble shooting. So this has really been a game changer for us."

ROI: Time is Money

The ROI demonstrated by Coca-cola includes real bottom-line impact. But of course that has to be quantified in a standard unit of measurement. For most organizations, that unit of measurement is dollars. But the path to measuring dollars is often tied to another quantifiable metric: time.

"There are a couple variables that we typically track, and one is time," said Upskill CSO Jay Kim (Coca-Cola's AR vendor) at AWE Europe. "It's simple to measure and the benefit is obvious for time saved in your business process, and what that means as a first-order variable to determine ROI."

Drilling down to more concrete terms, Kim claims that Upskill sees an average 30 percent reduction in project time. And this is a meaningful figure, considering Upskill's client base that includes GE, Boeing, and Coca-Cola. Compared to other technologies, this is a huge efficiency boost.

"30 percent is a game changing number," he says. "People in lean manufacturing and continuous improvement will spend millions and millions of dollars chasing a 5 percent improvement… So imagine what you're able to do when you can go and do things 30 percent faster."

In addition to time efficiency, another key metric is resolving "exceptions." These are unforeseen incidents that can slow down production or manufacturing output, such as equipment breakdowns. This was shown above by Coca-Cola's unexpected mishaps with bottling equipment.

"Each of the trips that they have to go and pay one of their vendors' technicians to come and repair a piece of bottling equipment is going to cost a minimum of $10,000" said Kim. "So there, the savings are lumpy but each savings makes it a solution that easily pays for itself."

Google likewise reports that its Glass Enterprise Edition reduces manufacturing time by 25 percent and inspection time by 30 percent. It also reduced medical doctors' administrative work from 33 percent of their day, to ten percent. And DHL gained a 15 percent boost in supply chain efficiency.

Elsewhere, we see similar time-efficiency gains that align with these figures. Intel recently reported 15 to 45 percent reductions in project time around its warehouse and fabrication facilities. Though it's a wide range – representing a variety of job roles – it's similarly supportive of AR's real impact.

"We're running a pilot in our distribution center and putting [AR] on workers who are doing picking and packing for our parts," said Intel's Chris Croteau at an ARiA event.[v] "The first day we had a 15 percent improvement in productivity…The peak that we measured was about 45 percent."

Image Source: Google

Workforce Management

Empowering on-site workers with deeper knowledge not only has micro-economic impact, but also broader implications for workforce management. Because AR-assisted job roles can reduce the need for extensive training, the technology can make more people qualified for more jobs.

Scope AR for example (profiled below), lets workers perform assembly or maintenance while guided by graphics or live remote support. This can eliminate the need for highly-skilled professionals to complete tasks, therefore allaying time-consuming and costly training for specific job roles.

"I have this thesis that we can help people take on new jobs, even ones they have no training for," Presence Capital partner (and Scope AR investor) Amitt Mahajan told ARtillry. "The idea that you don't need knowledge to perform in a given role is pretty powerful."

Coca-cola sees similar effects. The amount of time it takes for a given worker to be qualified for a skilled job role is currently a cost and logistical hurdle in its operations. AR assistance decreases that, making individual workers qualified and deployable to more positions across the organization.

"With sophisticated equipment, before we allow one of our technicians to touch that equipment, he or she has to go through at least four weeks of training," said Terrell. "So what I'm seeing now with this technology is that we're reducing that time by as much as 50 percent."

PTC sees the same phenomenon among its clients. Its ThingWorx AR software assists enterprise functions like training, assembly, manufacturing and maintenance. The company works with 28,000 enterprises, 1000 of which are working with AR, according to PTC's Mike Campbell at an ARiA event.

"Any one of us in the room could repair this machine and get it back up and running," Campbell said during a demo. "And the company is happy because they didn't have to roll a truck out to take care of it, and they've doubled the number of customers that each service technician can take care of."

Augmenting Morale

Beyond the benefits to a given organization, some of these workforce management effects that are unlocked by AR can have benefits on workers themselves. Though that alone isn't necessarily a selling point for enterprise adoption, there are ripple effects and benefits from improving morale.

For example, because AR makes individuals eligible for more job roles as examined above, it can enable greater in-house mobility. This can support programs for quality of work life and job variety. It can also mitigate the complacency that results from stagnation or repetitive, stationary tasks.

Moreover, AR remote-assistance can create positions of value that are done remotely. This opens up the possibility for "subject matter experts" (SMEs) to work at home or other convenient locations. It can therefore improve retention and allay early retirement for valued and knowledgeable veterans.

"We have an aging population of experienced people, and a rising population of inexperienced people," said Intel's Croteau. "It's great to talk about bottom-line advantages but what [enterprises] really worry about is those people with 30 or 40 years experience retiring."

Image Source: Scope AR

Flip the Model

Intel is applying this principle as a proof of concept in its own microchip fabrication. Due to the high dollar value and fragility of materials in this process, it traditionally deploys two workers to every station to ensure checks and quality control. But AR has begun to streamline that setup.

"We're automating that process and having that person wear AR glasses with a camera," said Croteau. "And we're having a [SME] elsewhere in a console that can now work with multiple of these workers…we don't have to have them both standing in front of the tool."

But this will really have an impact in more physically draining fields like energy and construction. In those fields, the best and most experienced workers are doing the hardest jobs, such as climbing poles and fixing turbines. And the viability of that work decreases quickly with age.

"What if we flipped that?" asks Croteau. "What if by being the best worker, you get to stay back at the central office with a hot cup of coffee and a cushy chair and you get to manage everybody else in the field?… an awards system that actually benefits you and actually prolongs your workforce time."

Flavors of Enterprise XR

Now that we've qualified the enterprise XR opportunity and quantified its ROI, it's time to examine a bit more detail on the types of XR that are developing in today's enterprises. Because there are too many formats to cover in a succinct way, we'll focus on three representative examples.

The remote assistance shown earlier by Coca-cola is just one form of enterprise XR. It's built on live "see what I see" support for on-site workers. Other AR formats include pre-authored directions, which are similar to remote assistance but not live. And for VR, we'll examine immersive collaboration.

Image Source: Google

AR: Remote Assistance

As shown by Coca-Cola, a 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 a VR headset for even deeper "see what I see" support.

In addition to Upskill (used by Coca-Cola), developers of remote AR assistance include Scope AR. Its Remote AR product is used by utilities, telcos and heavy equipment industries among others. The company works with Caterpillar for example to provide support for heavy-equipment end users.

ScopeAR CEO Scott Montgomery framed it to ARtillry as 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," he told ARtillry. "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."
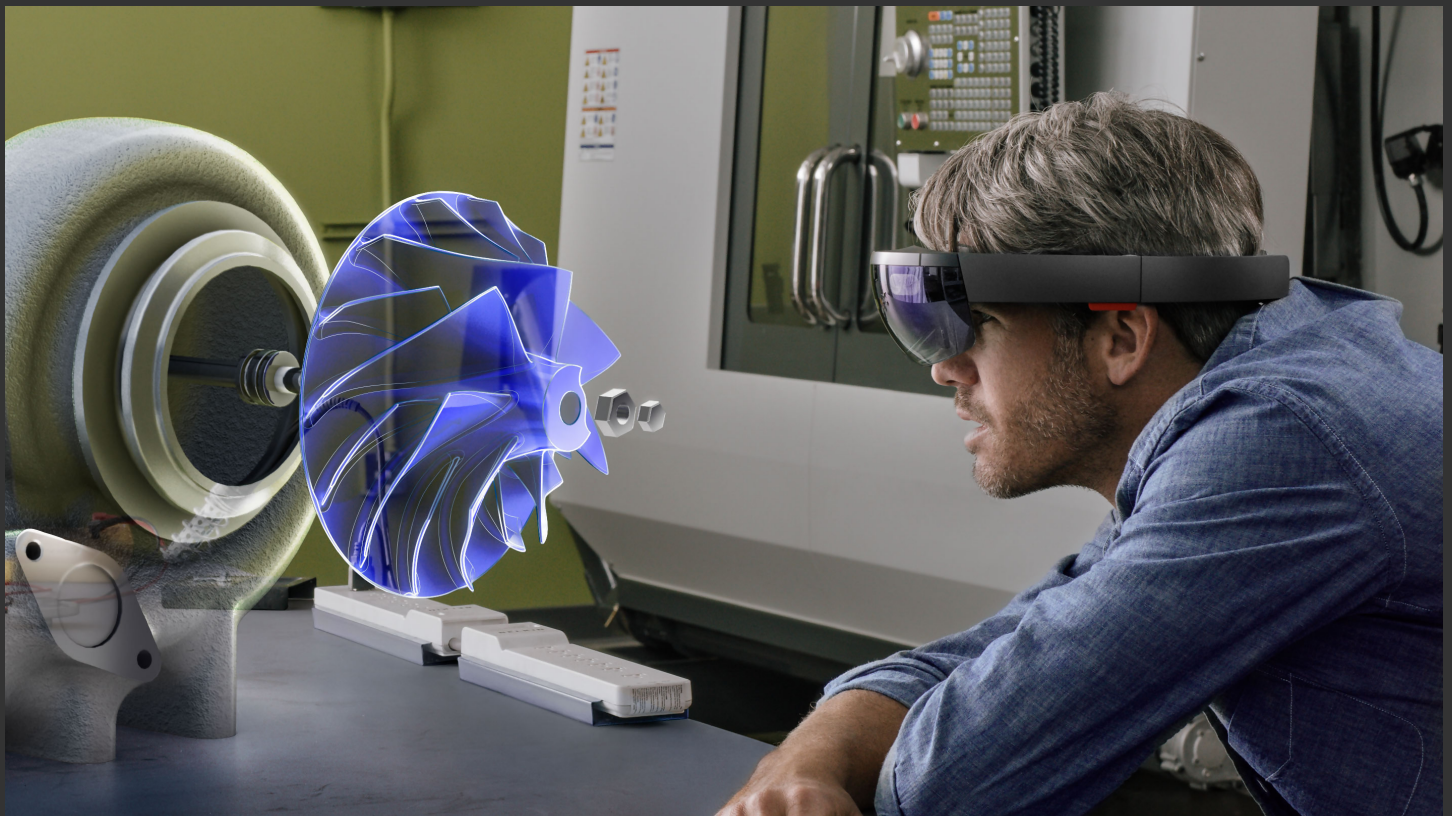
Image Source: Microsoft

AR: Authored Instructions

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.

In addition to efficiencies for AR providers, there can be added convenience for enterprise users. For one, they can summon AR instructions any time, or in any time zone. Put another way, if remote assistance is like live TV, pre-authored instructions are like on-demand programming.

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.

Video Companion: ThingWorx AR Authoring Process
(click URL to open)

https://youtu.be/CHi5Ddzpc8M?t=5m47s
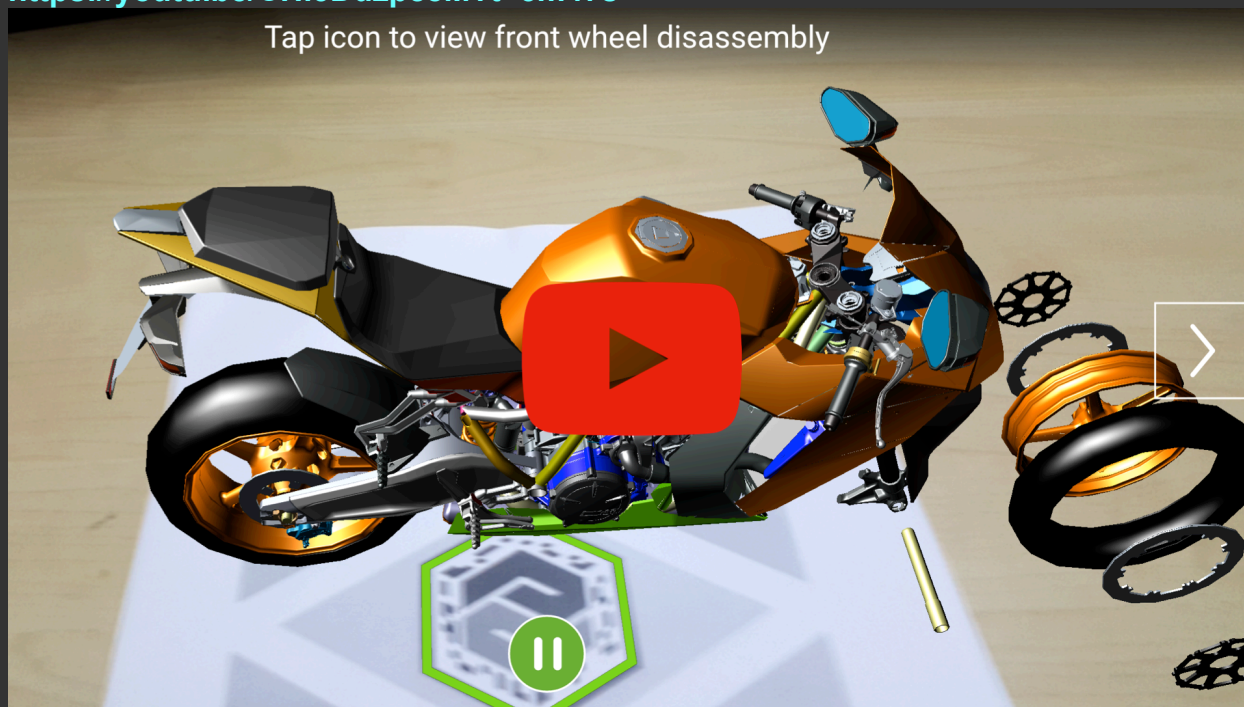
VR: Remote Collaboration

Most examples so far have been 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 Intelligence* during a recent briefing.

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.

But VR collaboration isn't a silver bullet. It will have value to certain industry verticals and job roles, but doesn't apply to everything, as noted earlier. It will shine best where there's visual nuance to a product's collaboration, maintenance or sales. This includes fields like aerospace and automotive.

"VR in a social setting isn't going to be what lawyers need to do a deposition," Beall told ARtillry. "That's really well handled by Cisco high-end tele-presence systems and it's all verbal and intellectual information. Vizible works best where the material and the conversation are inherently spatial."
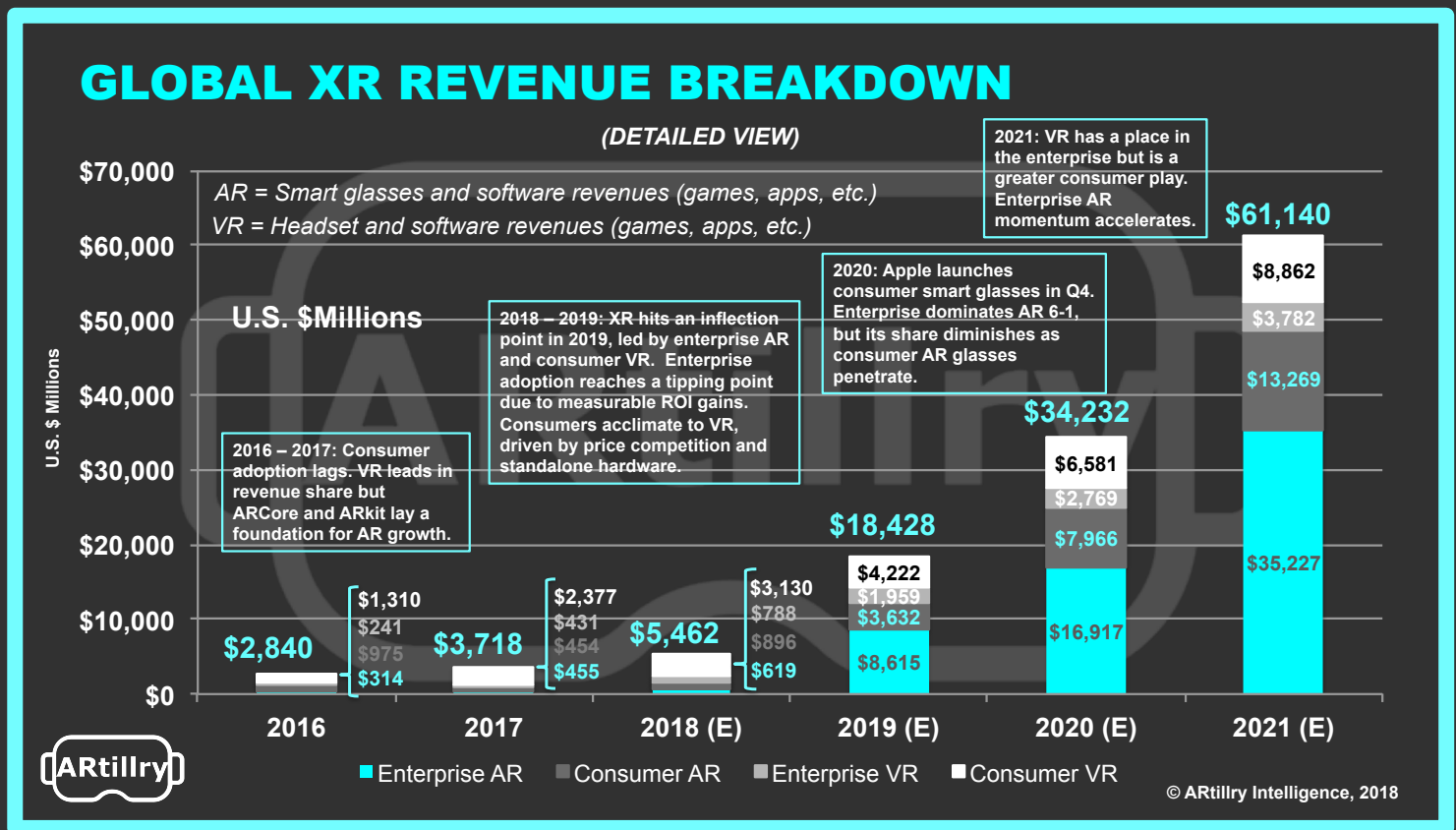

Image Source: WorldViz

Quantifying Enterprise XR

Based on enterprise XR dynamics examined so far, what's its market size? First, it's important to note that enterprise is one component of the XR universe, the remainder consisting of consumer markets. This report of course zeroes in on enterprise, which accounts for a dominant revenue share.

Specifically, enterprise accounts for 24 percent of XR revenues, growing to 64 percent by 2021. That share growth is due to many factors, including AR's ROI narrative and bottom-line impact. Consumer markets dominate nearer-term revenue due to VR gaming and revenue outliers like Pokémon Go.

Enterprise XR revenues will also 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 (see next section). We saw this most recently with enterprise smartphone deployment.

Going one level deeper, enterprise XR is further subdivided by AR and VR. But as indicated by the examples above, AR dominates. Though VR will be valuable, AR has greater breadth of applicability across enterprise functions, and pass-through vision that enables more visibility and versatility.

GLOBAL XR REVENUE BREAKDOWN

(DETAILED VIEW)

AR = Smart glasses and software revenues (games, apps, etc.)
VR = Headset and software revenues (games, apps, etc.)

U.S. $Millions

2021: VR has a place in the enterprise but is a greater consumer play. Enterprise AR momentum accelerates.

2018 – 2019: XR hits an inflection point in 2019, led by enterprise AR and consumer VR. Enterprise adoption reaches a tipping point due to measurable ROI gains. Consumers acclimate to VR, driven by price competition and standalone hardware.

2020: Apple launches consumer smart glasses in Q4. Enterprise dominates AR 6-1, but its share diminishes as consumer AR glasses penetrate.

2016 – 2017: Consumer adoption lags. VR leads in revenue share but ARCore and ARkit lay a foundation for AR growth.

Year	Total	Enterprise AR	Enterprise VR	Consumer AR	Consumer VR
2016	$2,840	$314	$975	$241	$1,310
2017	$3,718	$455	$454	$431	$2,377
2018 (E)	$5,462	$619	$896	$788	$3,130
2019 (E)	$18,428	$8,615	$3,632	$1,959	$4,222
2020 (E)	$34,232	$16,917	$7,966	$2,769	$6,581
2021 (E)	$61,140	$35,227	$13,269	$3,782	$8,862

Legend: ■ Enterprise AR ■ Consumer AR ■ Enterprise VR ■ Consumer VR

U.S. $ Millions (axis: $0, $10,000, $20,000, $30,000, $40,000, $50,000, $60,000, $70,000)
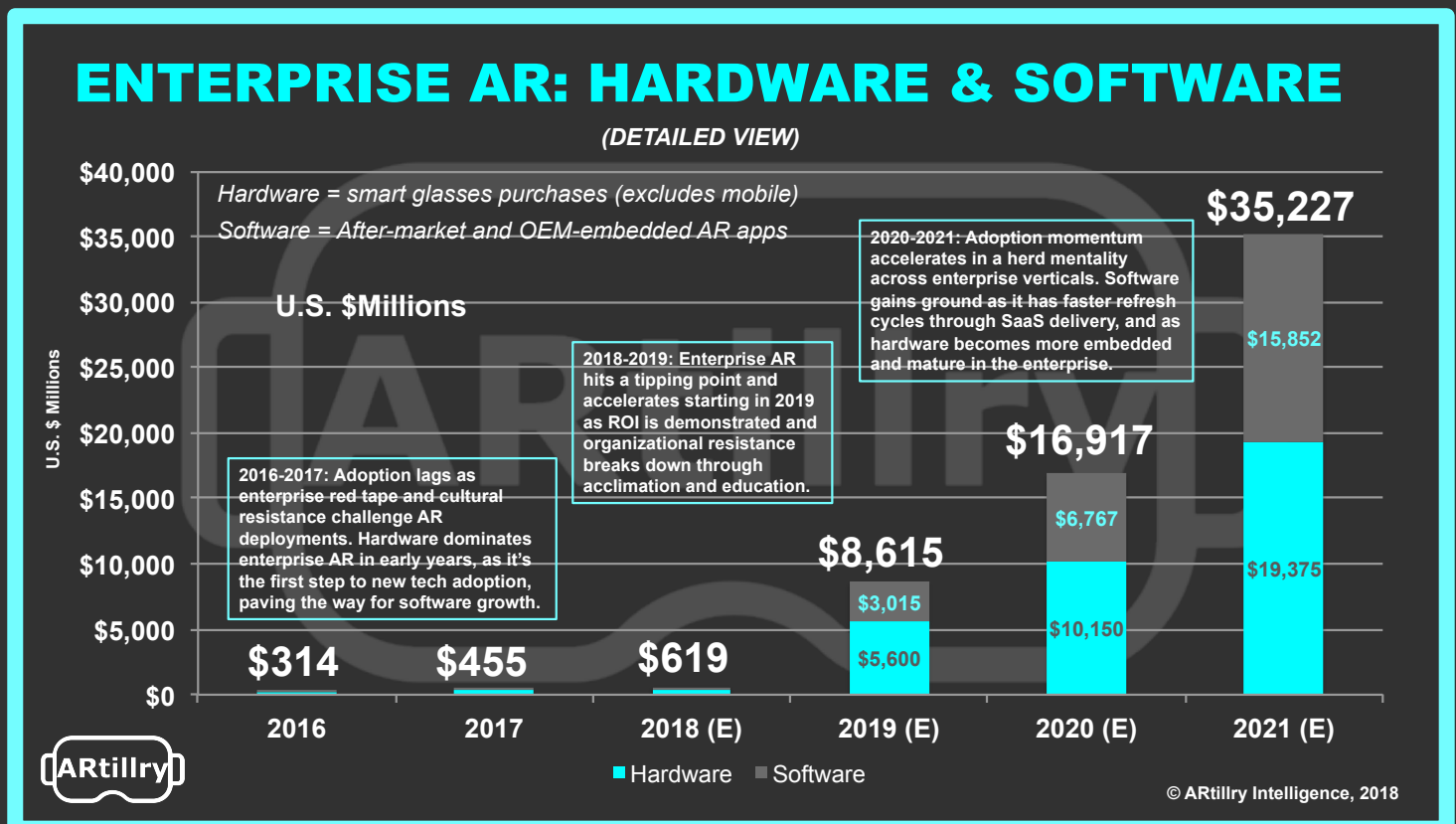
© ARtillry Intelligence, 2018

Revenue Drill Down: AR

Starting with AR, its enterprise deployment will derive revenues that grow from $314 million in 2016 to $35 billion in 2021. It's the fastest growing XR revenue segment and the largest sub-sector in 2021. These figures are indicated in *ARtillry Intelligence*'s updated market forecast (January 2018).

Why such steep growth? First, from a market sizing and forecasting perspective, there are often high growth rates associated with sectors that start from such a small base. Enterprise AR's current revenue levels are early stage, and will see high growth rates if they're to reach their potential.

An inflection point will come in 2019 as examined above, due to a tipping point for enterprise adoption. Revenue in outer years will be driven at least partly by software economics. As we've seen in historical comparisons such as enterprise Saas, it can have highly scalable and recurring revenue.

Hardware will dominate revenue in early years, as an installed base is established (as is often the first step for new tech adoption). That hardware base will pave the way for enterprise software implementations, which will slowly gain share of overall enterprise AR revenues in outer years.

ENTERPRISE AR: HARDWARE & SOFTWARE
(DETAILED VIEW)

Hardware = smart glasses purchases (excludes mobile)
Software = After-market and OEM-embedded AR apps

U.S. $Millions

2016-2017: Adoption lags as enterprise red tape and cultural resistance challenge AR deployments. Hardware dominates enterprise AR in early years, as it's the first step to new tech adoption, paving the way for software growth.

2018-2019: Enterprise AR hits a tipping point and accelerates starting in 2019 as ROI is demonstrated and organizational resistance breaks down through acclimation and education.

2020-2021: Adoption momentum accelerates in a herd mentality across enterprise verticals. Software gains ground as it has faster refresh cycles through SaaS delivery, and as hardware becomes more embedded and mature in the enterprise.

Year	Total	Hardware	Software
2016	$314		
2017	$455		
2018 (E)	$619		
2019 (E)	$8,615	$5,600	$3,015
2020 (E)	$16,917	$10,150	$6,767
2021 (E)	$35,227	$19,375	$15,852

■ Hardware ■ Software

© ARtillry Intelligence, 2018

Updated market sizing, January 2018

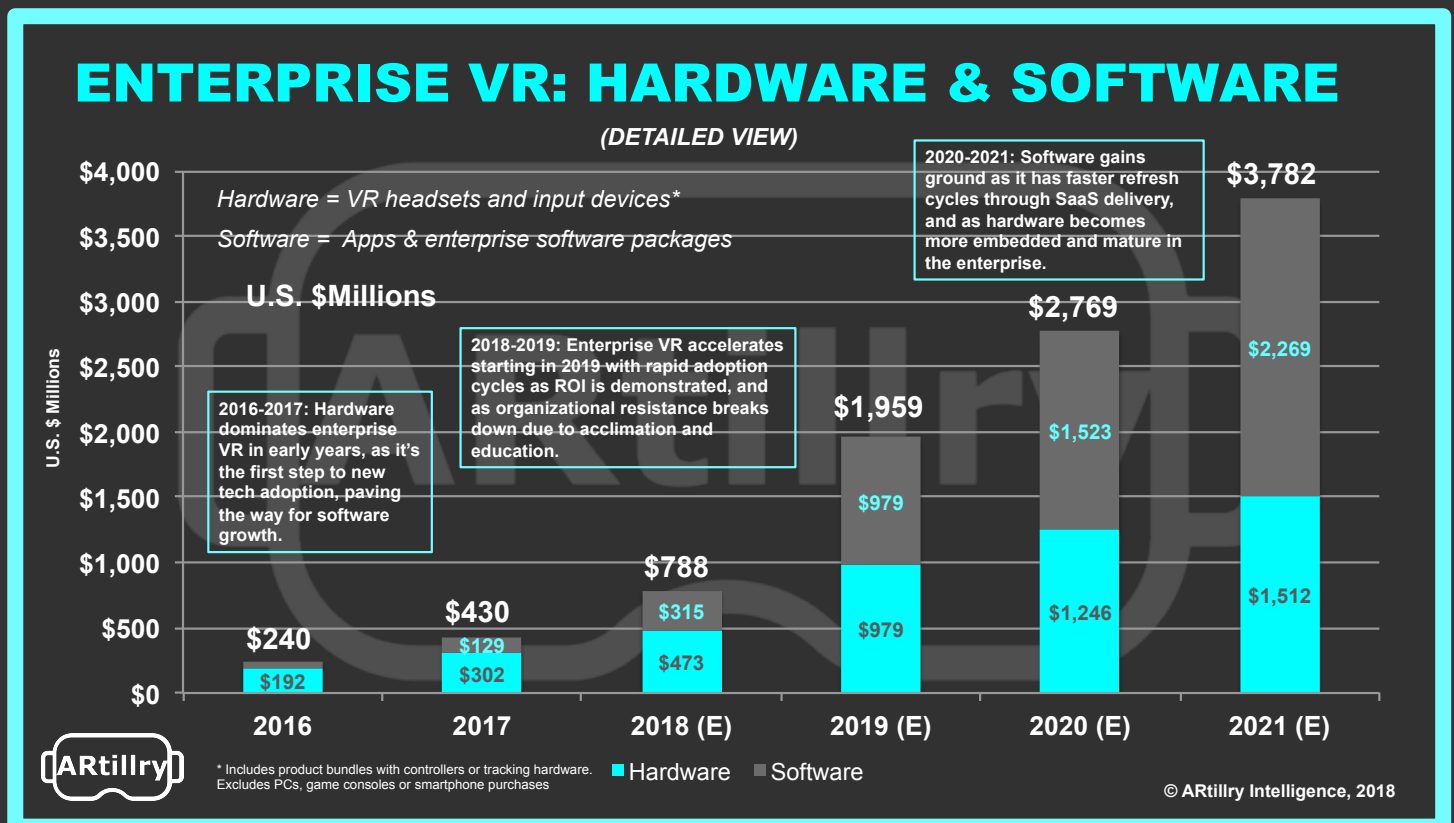# Revenue Drill Down: VR

Moving on to revenues from enterprise VR deployments, they'll grow from $240 million in 2016 to $3.8 billion in 2021. Though strong in their own right (46 percent compound annual growth rate), these revenues are less substantial than their AR counterpart. But the opportunities are still notable.

VR will be stronger as a consumer play, as shown in the overall XR revenue chart above. That stems from VR's inherent isolation, which inhibits some job functions and share of time per working day. It will be transformative, but within a narrower range of job functions such as collaboration and training.

"In the B2B setting, an interesting area is corporate training," Comcast Ventures' Michael Yang told ARtillry. "For anyone who has worked at large corporations, you have mandatory training for legal or compliance reasons. VR or even AR [can] solve that or make the training less brutal, frankly."

Much like enterprise AR, near-term revenues will be hardware-dominant as it's the first step to tech adoption. That installed base will pave the way for software, which will take over in outer years. Software will also be driven by refresh rates that outpace hardware replacement cycles.

ENTERPRISE VR: HARDWARE & SOFTWARE

(DETAILED VIEW)

Hardware = VR headsets and input devices*

Software = Apps & enterprise software packages

U.S. $Millions

2020-2021: Software gains ground as it has faster refresh cycles through SaaS delivery, and as hardware becomes more embedded and mature in the enterprise.

2016-2017: Hardware dominates enterprise VR in early years, as it's the first step to new tech adoption, paving the way for software growth.

2018-2019: Enterprise VR accelerates starting in 2019 with rapid adoption cycles as ROI is demonstrated, and as organizational resistance breaks down due to acclimation and education.

Year	Hardware	Software	Total
2016	$192	$48	$240
2017	$302	$129	$430
2018 (E)	$473	$315	$788
2019 (E)	$979	$979	$1,959
2020 (E)	$1,246	$1,523	$2,769
2021 (E)	$1,512	$2,269	$3,782

Y-axis (U.S. $ Millions): $0, $500, $1,000, $1,500, $2,000, $2,500, $3,000, $3,500, $4,000

* Includes product bundles with controllers or tracking hardware. Excludes PCs, game consoles or smartphone purchases

■ Hardware ■ Software

© ARtillry Intelligence, 2018

Updated market sizing, January 2018

Augmented Reality Check: Enterprise Challenges

Throughout the commentary and market sizing so far, it's clear that there are myriad opportunities in enterprise XR. But we would be irresponsible to not acknowledge the challenges that counterbalance those opportunities. Having a sense of realistic hurdles can prepare market entrants.

The challenges are multi-dimensional but share a common trait: organizational inertia. Like many emerging technologies before it, XR will face resistance. And that happens on an organizational level but also through inter-departmental friction, as change agents champion it while others resist.
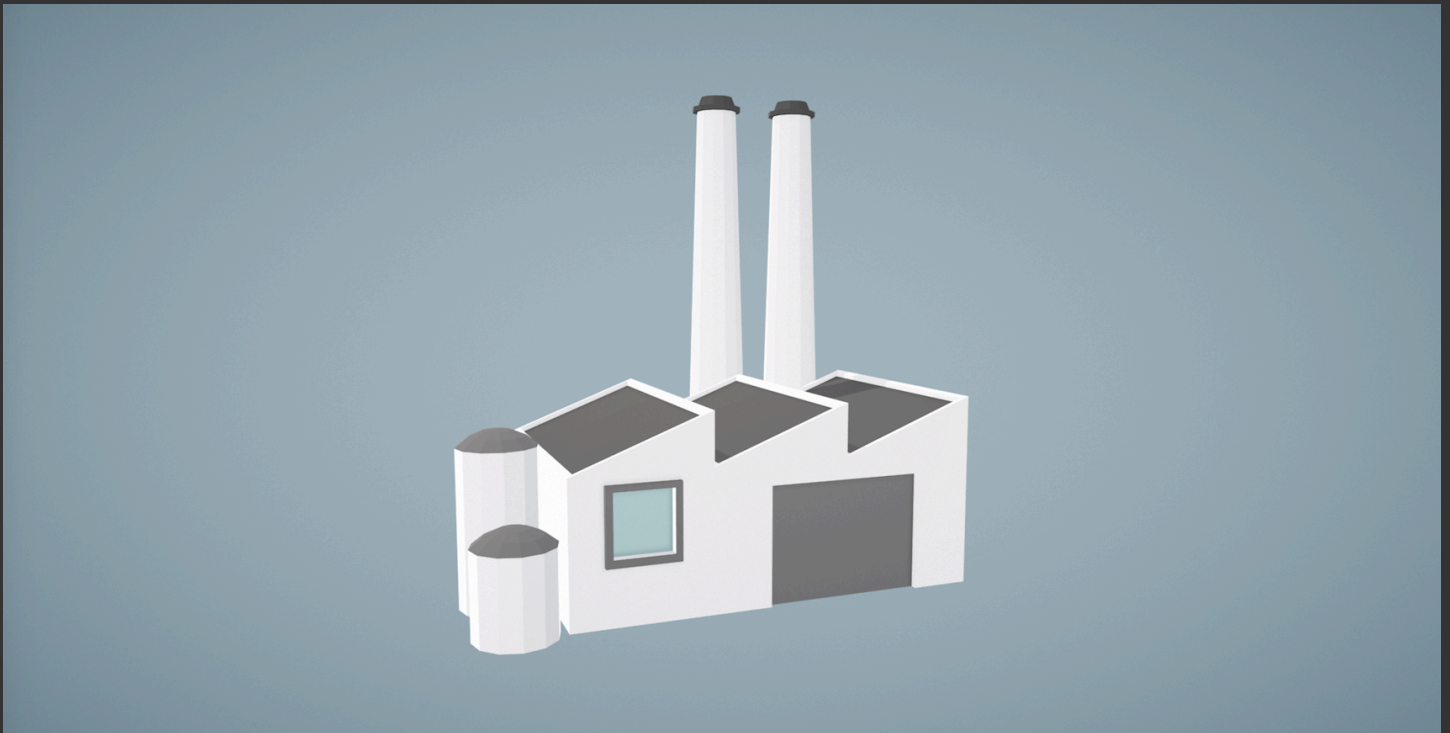
Image Source: Google Poly

Organizational Inertia

At the heart of organizational behavior is a principle that large enterprises have a natural resistance to new technology. This interestingly resembles living organisms (sharing the Latin root, organ, meaning tool or instrument), which have an automatic resistance to disease or foreign substance.

"When you have a new technology, the antibodies come out to stop it," said former Lockheed Martin CIO David Smith at an ARiA event. "That's true for your body, except when it's not a disease but something that takes similar resources: a baby. So the trick is to explain it's not cancer, it's a baby."

Realware CEO Andy Lowery has a similar take. Due to natural resistance in organizations, Realware's product design purposefully sidesteps known friction points. Its monocular headworn AR device operates on Android, and simply places a tablet interface in front of one's eye.

"Enterprises like things that are conservative, understood and tested." he said at the same event. "So by designing a wearable device that's an Android tablet that frees your hands, we take a lot of that mystification out of the equation and [you] don't need to worry about IT and security protocols."

Other ways to tackle this natural resistance are to do it one step at a time. This can involve gaining buy-in of internal budget influencers in a slow process of pilot programs. Though it can take time, this process can help ease organizations -- and the conservatism that rules them -- in a gradual process.

"One bite at a time… that's how you eat an elephant," said Newport News Shipbuilding's Patrick Ryan at an ARiA event. "You spend a few weeks [on] a pilot project, then give it to a shipbuilder who saves 35 percent of his time. And then we take that to the next level, and the next, to big scale rollouts."

Image Source: Google

Two Orders of Magnitude

Several ROI metrics we've assembled for this report have a consistent range of efficiency gains, which fall between 15 and 45 percent. Though that's certainly attractive and sometimes "game changing" according to Upskill's Jay Kim, it paradoxically isn't enough in some cases.

Dan Bricklin, inventor of VisiCalc believes that for organizations to adopt new technologies, they have to be two orders of magnitude better than what's currently being used. He explained this theory at an MIT event last year, built from the lessons he learned from disrupting analog spreadsheets.

"You have to be two orders of magnitude -- that's 100 times better -- than what came before," he said. "Doing a good-sized spreadsheet by hand took hours, but if you did it with an electronic spreadsheet, you can build something in minutes. That's night and day difference, not just a little better.

This 100x delta is already being validated as a compelling ROI case for enterprise XR adoption. Specifically Newport News Shipbuilding's Patrick Ryan was able to demonstrate similar efficiency gains for the inspection function of his operation, which is usually done with paper documents.

"We inspected a number of compartments on a ship and planned to take 36 hours with a big stack of drawings," he said. "We did it with AR in 90 minutes. That's a 95 percent cost takeout – the biggest we've ever seen. And that's what breaks down barriers and you get that 100-1 success story."

Another rule of thumb Bricklin applies to new technologies being sold to enterprises: It has to recoup its cost almost immediately. He witnessed this firsthand with the spreadsheet's initial ability to replace $5000 per-month financial forecasting technology with a single Apple II running VisiCalc.

"In order to matter, the decision to use the new technology has to be obvious, a no brainer. It's got to be something like two weeks payback," he said. "That immediate justification for purchasing expensive hardware you didn't have, along with the software, became known as being a killer app."

Though this requirement for such large-scale payoffs is daunting, it's not impossible to achieve, according to Lockheed former CTO, David Smith. And the good news is that once adoption happens, subsequent implementations of the same or related technologies are easier to push through.

"That 100x return is going to be an essential thing, which is why killer apps are so important," he said. "They essentially open the hole in the organization that allows all the other cool stuff to happen."

Organizations are People

When devising ways to get past organizational hurdles, it's important to customize value propositions to specific needs. And with that thinking, it's important to remember that organizations are made up of people. Their technology adoption likewise happens through people -- albeit several people.

Put another way, new technology shouldn't be sold only as solving a business problem – such as the ROI metrics cited throughout this report – but individual pain points. The dirty little secret is that budget holders often approve technologies that benefit them individually on a day-to-day basis.

When this advocacy happens on a greater scale, it can lead to cultural adoption. And given the power of culture, it can overcome lots of the adoption resistance and organizational inertia introduced above. This includes departments ranging from the assembly line to the C-suite, sometimes in that order.

"Technology up until now has been addressing white collar problems." said Atheer's Rika Nakazawa at June's AWE conference. "And now this is something that's very illuminating that blue collar factory workers are feeling like they're able to take advantage of the technology."

This goes back to Patrick Ryan's elephant metaphor. When addressing pain points of individual stakeholders throughout an organization, advocacy can reach critical mass. Though it can take a while, this grass-roots approach throughout the org chart can be a powerful adoption driver.

"Grass roots efforts turn into a general manager becoming an advocate because he now sees it," said Ryan. "Then the master ship builder says 'I want this,' in addition to the 18 year old that just started, and you get that top to bottom organizational adoption. That's how you go from pilot to deployment."

Image Source: Scope AR

Over-reliance on Innovation Centers

Though it can be effective to gain advocacy through grassroots support, the prevalent enterprise inroad seems to be corporate innovation centers. That's because they're most receptive to new technologies. However, over-reliance on such entry points has led to unsuccessful XR deployments.

"As we look at the enterprise, we're not integrating into the operational sides of the businesses that can really benefit," said Intel's Chris Croteau at the aforementioned ARiA event. "We're selling to the geeks inside with titles called 'advanced path finding' or 'technology leadership'."

The problem with this approach is that receptivity in these innovation centers can be misperceived as organizational adoption, which doesn't pan out. The takeaway: Thought it's easier said than done, XR adoption faces better chances with the more difficult grass-roots approach that addresses end users.

"That tactical piece is important," said Upload's Enterprise Strategy Lead and EndeavorVR founder/CEO Amy Peck at June's AWE conference. "We all understand the technology, but how do we get something built? How do we get a purchase order confirmation?"

Video Companion: Enterprise XR's Bottom-Line Impact
(click URL to open)

https://youtu.be/4_gY7CsRRYo

Speak the Language

In addition to navigating organizations and gaining multiple internal champions, it's important to speak the right language. Comcast Ventures' Michael Yang believes that penetrating enterprise-buying cycles requires putting aside technical minutiae and telling a more focused ROI narrative.

"Whiz-bang visualization in itself doesn't derived value," Yang said at a recent SVVR event. "[Enterprises] want to know how a knowledge worker is going to use it and why their job is now freed up, and how there's bottom line result [for] the next time they have to report to Wall Street."

To pull this off, Yang cautions that it's critical to understand tech-buying patterns of target enterprises. When it comes to corporate integrations, the most effective way to do that is to adapt to the customs and cadence of the enterprise software world, as well as intimately knowing a prospect's business.

"To really understand how to create a software solution for them, you have to understand their underlying business process," he said. "Talking amongst other VR people isn't going to move the agenda in terms of getting an enterprise-oriented app into corporate America."

This is about understanding business processes, especially in corporate integrations, and the types of software that has erstwhile supported them. It's about CRM and ERP and other enterprise software. Knowledge of those processes, in addition to technical chops with VR, will be a winning combo.

"Many folks we meet aren't thinking that way," said Yang. "It's because we haven't cross-fertilized the DNA. If you haven't spent time with enterprise software developers or systems integrators, you're not really understanding the business problem you're trying to apply VR to."

This applies to pricing as well. In this exercise of adapting to enterprise software patterns, there's an opportunity to benefit from its advantages. And one of enterprise software's biggest advantages is the recurring revenue, scalability and unit economics of SaaS packaging.

"If it's going to be an enterprise businesses that wants to be valued appropriately, it has to be a SaaS subscription-based software license model," said Yang. "Corporations are accustomed that. They're buying CRM, they're buying databases, they're buying stuff in that way."

The Good News

Despite the challenges, Yang says there's a bright side in that enterprises will increasingly need XR integrations as resistance diminishes. And they're not going to do it themselves, as it's not their competency. This will open up lots of opportunity to VR companies that can speak the right language.

"I would challenge VR folks to step right into that," he said. "[Enterprise software] is a multi-billion dollar global business and they don't know anything about VR. They're scared about VR and AR and frankly need your help, so that's where it can all come together."

And organizational inertia is breaking down to some degree, as familiarity with XR technology grows. For example, there's evidence that sales cycles are reducing in length and more projects are being launched. Challenges and resistance will continue into 2018, but the momentum is promising.

"An interesting trend we're seeing from the sales side is that our sales cycle, from the original outreach to the start of a pilot or the execution of a contract, is shrinking drastically," said UpSkill's Jay Kim at an ARiA event. "That I think is a good sign for the overall health of the industry."

This trend partially results from acclimation to XR, which eases adoption over time. It could also accelerate in a step function as companies take risks, according to AR pioneer Christine Perey.[vi] Those investments push the technology forward and in turn drive more adoption and investment.

This process is common in tech revolutions. Comfort levels build slowly in the enterprise, then reach a tipping point that's followed by mass adoption and market size inflection. We predict this to happen in 2019 (see charts above), and follow a similar adoption pattern as enterprise smartphone adoption.

Lastly, finishing where we started, Coca-Cola's Michael Terrell admits that implementing new technology isn't easy. It takes many moving parts to adopt it — both internally and externally (e.g. bottling partners). His advice: the best way to sell XR is with hard data about bottom line impact.

"I've been a change agent the majority of my career and driving change isn't easy," he said. "But we always have to go back to the data and let it prove or disprove what we're thinking. And in this case, the data is showing me that this technology is truly impacting my bottom line."
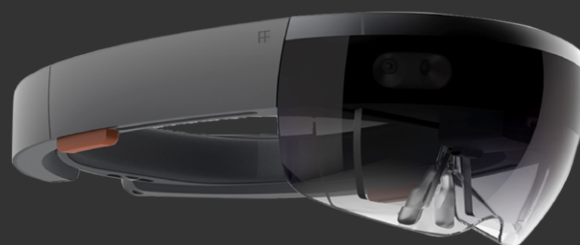
Key Takeaways (redux)

- XR has been heralded as the next major technological transformation. This will materialize, but later than expected.
  - Similar to the early-2000's e-commerce bubble, XR excitement and market sizing isn't overblown... it's just early.

- Soft consumer hardware sales have shifted attention to near-term scale and opportunity, including mobile and enterprise.

- *ARtillry Intelligence* projects enterprise XR to grow from $554 million in 2016 to $39 billion by 2021.
  - Enterprise AR will grow from $314 million in 2016 to $35.2 billion in 2021, including a 2019 inflection point.
  - Enterprise VR will grow from $240 million in 2016 to $3.8 billion in 2021.

- AR's share results from breadth of applicability for enterprise functions, and pass-through vision that enables versatility.
  - AR will also be widely applicable across verticals including CPG, automotive and aerospace.
  - Enterprises have less stylistic and budgetary restraints than consumers, given today's bulky and costly smart glasses.

- Enterprise XR includes live AR remote assistance (assembly, maintenance), pre-authored AR guidance (sorting, maintenance), and immersive VR collaboration (training, design), among other formats.

- Adoption drivers include strong ROI and operational efficiencies (time and error reduction) in functions like manufacturing.
  - Intel, Coca-Cola and others detailed in this report demonstrate 15-45 percent efficiency gains today.
  - Additional cost savings result from remote support and collaboration, which lessen travel and machine downtime.

- Beyond micro-economics, enterprise AR has potential to transform workforce management
  - AR's guided instructions or live remote assistance makes more people qualified for more jobs.
  - This unlocks enterprise efficiencies and employees' in-house mobility, task variety and morale.
  - AR can enable experienced and valued veterans to work remotely, rather than retire or burn out from field work.

- Enterprise XR benefits are counterbalanced by several challenges, most of them due to organizational inertia.
  - Like many technologies, XR will face resistance at organizational and departmental levels.
  - The first and only point of entry is often "innovation centers," where XR is often well received but then languishes.

- Tactics for overcoming hurdles include building on already-adopted systems (e.g. Android), and grassroots support.
  - Greater chance of deployment can result from advocacy within the business units proposed to use XR. Bottom-to-top organizational buy-in can create powerful demand signals that lead to real XR deployments.
  - Value propositions should go beyond bottom-line impact and be spun to address individual (and sometimes selfish) pain points of decision makers and influencers throughout the organization.

- Despite challenges, there's good news.
  - After initial adoption, subsequent XR implementations are easier to achieve, as comfort levels are gained.
  - There is evidence that sales cycles are reducing in length.
  - Cultural familiarity with XR will inch forward and lessen enterprise resistance – a common process in tech revolutions.
  - We'll see step functions as companies make investments that fuel advancement, which in turn drives more investment.

- Challenges will persist into 2018 but momentum and acclimation are leading towards a 2019 tipping point.
  - Enterprise XR will follow a similar adoption pattern seen in smartphone enterprise integration over the last decade.

Key takeaways are also highlighted throughout the main body of this report.

About ARtillry Intelligence

ARtillry is a publication and intelligence firm that examines augmented reality and virtual reality, collectively known as XR. Through writings, data and multimedia, it provides deep and analytical views into the industry's biggest players and opportunities. It's about insights, not cheerleading.

Run by career analyst and journalist Mike Boland, coverage is grounded in a disciplined and journalistic approach. It also maintains a business angle: Though fun and games permeate VR and AR (especially the former) long-term cultural, technological and financial implications are primary.

Learn more at **https://artillry.co/about**

About Intelligence Briefings

ARtillry Intelligence Briefings are monthly installments of VR/AR data and analysis. They synthesize original and third-party data to reveal opportunities and dynamics of VR and AR sectors. In addition to data, a layer of insights is applied to translate market events and raw figures into prescriptive advice.

More information, past reports and editorial calendar can be seen at:

https://artillry.co/artillry-intelligence/

About the Author

Mike Boland was one of Silicon Valley's first tech reporters of the Internet age, as a staff reporter for *Forbes* (print) starting in 2000. He has been an industry analyst covering mobile and social media since 2005, and is now Chief Analyst of *ARtillry Intelligence*, covering emerging tech.

Mike is a frequent speaker at industry conferences such as VRLA, ad:tech and LeadsCon. He has authored in-depth reports and market-sizing forecasts on the changing tech & media landscape. He contributes regularly to highly read online news sources such as *TechCrunch*, *Business Insider* and the *Huffington Post*.

A trusted source for tech journalists, his comments have appeared in A-list publications, including *The New Yorker*, *The Wall Street Journal* and *The New York Times*.

Further background, history and credentials can be found at:

http://www.mikebo.land/

Methodology

This report highlights *ARtillry Intelligence* viewpoints, gathered from its daily in-depth coverage of the XR sector. To support the narrative, data are cited throughout the report. These include *ARtillry Intelligence* original data, as well as that of third parties. Data sources are attributed in each case.

For market sizing and forecasting, *ARtillry Intelligence* follows disciplined best practices, developed and reinforced through its principles' 15 years in research and intelligence in the tech sector. This includes the past two years covering AR & VR as a main focus. Inclusions are listed below.

More about ARtillry's market-sizing credentials can be found here:
https://artillry.co/artillry-intelligence/forecasts/methodology/

WHAT'S COVERED IN FORECAST DATA

The market sizing figures in this report include enterprise AR and VR products. These are each subdivided by hardware and software.

VR hardware includes headsets and bundled input or tracking devices, but does *not* include gaming consoles, smartphones and PCs required to run some headsets. Similarly with AR, smart glasses are included in revenue projections, but mobile devices (such iPhone sales) are not.

INCLUDED

AR & VR Hardware (Headsets, smart glasses)
AR & VR Software (Enterprise productivity software, games, apps, in-app purchases)
Bundled Hardware (Input or tracking devices)

NOT INCLUDED*

PC or Gaming Consoles (e.g. Playstation4)
Smartphones (e.g. iPhone to run ARkit apps)
AR & VR Services: (e.g. Enterprise consulting)
VR Cameras (e.g. 360 degree camera hardware)
AR & VR Advertising (e.g. Immersive in-game ads)

*We will expand category inclusions in future forecasts

Focal Range

This report's intended focus is business strategies rather than technical ones. Though technical components are referenced throughout the report (mostly software examples), it is not meant to be a comprehensive survey of enterprise XR products, such as headsets and their comparative features.

As such, venerable enterprise XR hardware products weren't profiled in this report, which should not be viewed as a value judgment. These include but are not limited to Meta, ODG, Vuzix, Daqri and Magic Leap. The business strategies and concepts covered apply equally to these products.

Disclosure and Ethics Policy

ARtillry has no financial stake in the companies mentioned in this report, nor was it commissioned to produce it. With respect to market sizing, ARtillry remains independent of players and practitioners in the sectors it covers. It doesn't perform paid services or consulting for such companies, thus mitigating bias — real or perceived — in market sizing and industry revenue projections.

ARtillry's disclosure and ethics policy can be seen in full at:
https://artillry.co/about/disclosure-and-ethics-policy/

Contact

Questions and requests for deeper analysis can be submitted at:
https://artillry.co/contact/

Resources

Links to additional information on enterprise AR and organizations mentioned in this report

VR/AR Association, Enterprise Committee
http://www.thevrara.com/ar-enterprise

AR in Action (ARiA)
http://arinaction.org/

Augmented Reality Enterprise Association (AREA)
http://thearea.org/

Augmented World Expo
www.augmentedworldexpo.com

Augmented Reality Dot Org
http://www.augmentedreality.org/

References

[i] See ARtillry Intelligence Briefing: *ARCore & ARkit: The Acceleration of Mobile AR*
[ii] See ARtillry Intelligence Briefing: *2017 Lessons, 2018 Outlook*
[iii] See ARtillry Intelligence Briefing: *Mobile AR: App Lessons and Business Strategy*
[iv] See ARtillry Intelligence Briefing: XR Global Revenue Forecast, 2016-2021
[v] Augmented Reality in Action (ARiA): see above
[vi] Christine Perey: see AREA above