



THE STATE OF AUGMENTED REALITY

**HOW CURRENT INDUSTRY
SUCCESS STORIES CAN INFORM
FUTURE USE CASES**

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INTRODUCTION

The hype surrounding augmented reality (AR) and virtual reality (VR) is enormous. In 2012, venture capital investment into AR and VR amounted to \$86 million across just 23 deals. In 2017, that figure exploded to nearly \$2.8 billion spread across 276 unique financings¹. In addition to the significant amounts of venture capital dollars that have poured into startups, well-established firms, such as Apple, Google, Facebook, and Microsoft, have all committed significant resources to developing AR and VR applications, hoping to realize the promise of this technology and unlock significant economic gains.



Apple CEO Tim Cook was quoted saying that augmented reality is a “big idea” that stands to have tremendous impact on the scale of the smartphone². Still, skeptics have highlighted that there is currently a lack of a clear path to profit, or that it would take many, many years to unlock the full potential of AR.

Despite such hesitations, our research indicates that this skepticism is largely unfounded. It is now clear that augmented reality has arrived.

The goal of this white paper is to lay out which players have already seen success in the augmented reality space, and where the greatest opportunities lie. This white paper will outline proven augmented reality applications and market size, and then consider the technology’s effectiveness in impacting consumer behavior.

Companies across a diverse set of industries that include manufacturing, cosmetics, and entertainment have already successfully leveraged augmented reality for measurable economic value and impact. Throughout this paper, we will highlight use cases across industries and functions that, when considered alongside rapid technological progress and innovation that will hasten adoption,, indicate a bright future for the medium.

Certainly, not all AR applications are created equal. Companies that develop and deploy AR with strong, clear utility for the end user will reap the most economic benefit. And, while examples that prove AR’s value as a pure entertainment platform exist, it is utility, not novelty, that should inform whether a brand considers developing an augmented reality solution or campaign.

KEY FINDINGS

- 1** Investment and spending in AR is massive from both established companies and venture capital firms.
 - 1 VC investment in 2017 totalled \$2.8 billion across 276 unique financings.
 - 53 AR focused deals or acquisitions in 2017.
 - Spending on the AR/VR sector is expected to increase from \$11 billion in 2017 to \$215 billion in 2021. AR investment specifically is expected to top \$60 billion in 2020.
- 2** AR implementation across the enterprise sector is delivering measurable ROI.
 - Strong use cases across different enterprise sectors such as healthcare, construction, manufacturing and warehouse logistics.
 - Spending on AR for enterprise is significant: \$362 million on on-site assembly and safety AR technology and \$309 million in process manufacturing and training in 2017.
 - AR hardware and wearables are most commonly used in enterprise settings.
- 3** AR is now being applied to business-to-consumer settings and is providing tangible ROI.
 - Brands that can provide a utility value see the most success.
 - -Use cases can be bucketed across four different use cases: Inspiration, Fabrication, -Navigation, and Education.
 - Some sectors AR is impacting are: fashion, retail, urban technology (see also: "smart cities"), cosmetics, automotive, tourism and travel, and entertainment.
- 4** Technology advances will enable more AR creation and will help increase adoption and accessibility.
 - Google, Facebook, Snapchat, and Apple have all invested significant resources into building and expanding the AR ecosystem.
 - New technology (including that which has been developed by the above companies) will enable brands to build and deploy AR experiences with increased efficiency and effectiveness.

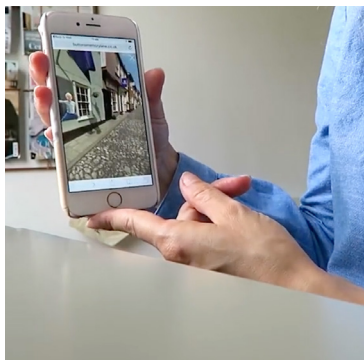
- The future of AR technology will advance towards reducing friction for customers (to overcome application download hurdles, clunky interfaces, etc.) and AR hardware is expected to become more ubiquitous with affordability.

5 Pure Play vs. Utility

- AR experiences fall into one of three categories: express utility, a strong brand that helps functionality mimic express utility, and novelty experiences.
- Necessity will always trump novelty for consumer applications of AR.
- There is still benefit for companies, in brand awareness and relevance, that are not able to position an AR experience as necessary.
- Advertisers from any sector, and any level of express utility, ignore AR at their own peril: Ad revenue in AR expected to grow from \$68 million to \$13 billion by 2022.
- Measuring metrics and feedback still murky. Whether brands using AR lean on traditional marketing metrics such as time spent and conversion rates or other KPIs will depend on the experience and desired outcome.

6 Future Outlook

- AR's momentum is real and will continue to add value to companies and expand into new areas of opportunity.
- AR and VR require the development of new technology infrastructure, but the advent of 5G technology should provide the necessary bandwidth to allow customers to experience AR and VR with low latency.
- Entertainment applications, beyond special use cases, will continue to lag behind in effectiveness vs. AR applications that provide utility to the customer. However, entertainment can approximate express utility through brand strength.





BACKGROUND AND CURRENT MARKET

AR is used today in both two- and three-dimensional digital visualization, with computer-generated data superimposed onto real-world physical environments, thus enhancing and augmenting the viewer's current perception of reality. AR adds digital elements to a live view, often through the viewfinder on a smartphone or tablet, or in a headset. The most common example of AR experiences are Snapchat's filters and the Pokémon go phenomenon in 2016.

VR facilitates a complete immersion experience into a non-existent reality that shuts out the current, real-world physical environment. VR generally creates a new, immersive experience for the viewer through headset devices such as the HTC Vive, Oculus Rift, or Google Cardboard. The idea is for users to be transported into near real-world or imagined environments, including those in which they could fight samurais on the Great Wall of China, or ride on the backs of dragons.

For a sense of the existing and future market for this technology, total spending on AR/VR products and services is expected to soar from \$11 billion in 2017 to nearly \$215 billion in 2021³. This exponential growth is in part due to recent investments and innovations led by tech giants such as Apple, Google, and Facebook over the past two years.

Over the next four years, the AR industry is forecasted for rapid expansion, as global revenues for the AR/VR market are projected to increase by at least 100 percent, according to the Worldwide Semiannual Augmented and Virtual Reality Spending Guide from the International Data Corporation.

The consumer, retail, and manufacturing segments are already, and will continue to be, early leaders in AR investment and adoption⁴. It is no surprise then that, in 2017, the largest AR industry use cases, by total

spending, were retail showcasing (\$442 million), on-site assembly and safety (\$362 million), and process manufacturing training (\$309 million).

By the end of 2021, the largest industry use cases will shift to industrial maintenance (\$5.2 billion) and public infrastructure (\$3.6 billion)⁵, followed by retail showcasing (\$3.2 billion). While momentum is currently concentrated in commercial business-to-business (B2B) applications, it is expected to move from B2B to business-to-consumer (B2C) settings.

Enabling these applications are strong venture capital investments in AR technology. Throughout 2017, AR technology providers have benefitted from VC funding ranging from \$10 million to over \$500 million. For instance, while dashboard-mounted display maker WayRay received \$18 million in Series B funding round led by Alibaba for its AR navigation technology for automobiles⁶, Apple dipped into its Advanced Manufacturing Fund to invest \$390 million into Finisar, makers of components that power the iPhone X's TrueDepth camera⁷. The latter's technology is expected to find its way into AR-focused features.

Magic Leap, the dominant player in head-mounted virtual retinal displays, closed a Series D round of \$502 million in November 2017 bringing the company's total valuation to \$6 billion⁸. VC investments in 2017 were not restricted to augmented reality experiences primarily based on sight. Ultrahaptics made a business of augmenting the sense of touch, and secured Series B funding of \$23 million⁹.

Given the magnitude of recent investments into AR and VR companies, and the potential for these technologies to disrupt untouched industries, it is not unrealistic to expect a heightened pace of acquisitions resulting in exits. In November 2017, for instance, Apple bought Vrvana, the Canadian developer of an augmented reality headset, for a reported \$30 million¹⁰. Over the summer of 2017, Google picked up Owlchemy Labs, a venture-backed VR game developer. Despite these tech giants having made substantial acquisitions, the sheer volume of acquisitions is disappointing so far – between 2012 and 2017, only 53 known acquisitions were recorded on Crunchbase. Of those 53 deals, 14 deals had disclosed prices totaling to \$2.4 billion¹¹.



TECHNOLOGY TRENDS

Video allows advertisers to develop deeper relationships with consumers through immersive and engaging branded experiences. When we asked users about their perception of brands through varying formats, we discovered that branded video outperforms standard formats, leaving the greatest lasting impact on the consumer.

Of the 2,400 consumers surveyed, those who experienced branded video formats were more impressed than those who experienced standard ads. This lead to:

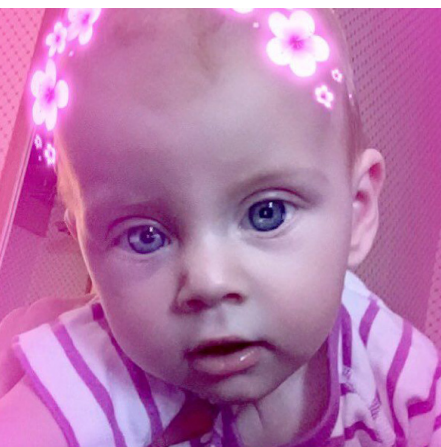
Mobile AR

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In the last 6-9 months, major technology companies such as Apple and Google have launched major developer-facing AR projects, a strong indicator of AR's growing momentum. In a race to dominate this new computing platform, these two tech titans are vying to launch software tools to own the platform of choice for content creators and consumers.

Apple released the ARKit with iOS11 in mid-2017. The ARKit is a developer tool that lets developers build AR experiences for iOS mobile devices (iPad and iPhone). It gives creators of AR apps access to advanced face-tracking, motion capture, and plane detection capabilities¹². With the iOS11 rollout, this technology is already available on 65% of the iPhones and iPads currently in use¹³, totaling hundreds of millions of devices. Developers and AR creators now have both the tools and the audience to develop advanced AR apps for any creative use case they can think of. This will bring better quality AR experiences to more lay users, potentially generating a 'killer app' in the near future.

Google launched a developer preview for ARCore last year, and publicly launched an upgraded version in Feb 2018. Similar to Apple's ARKit, the ARCore is a software development platform for building AR apps in Android. The platform delivers motion tracking, plane detection, and light estimation capabilities to content creators, enabling them to create advanced AR applications for a variety of use cases. These apps will be available on the Google Play Store to over 100 million Android devices, comprised of a limited set of device models (Pixel range, Samsung Galaxy S8 and S7 ranges, OnePlus 5, etc.)¹⁴



For many consumers, Snapchat's Lenses were the first augmented reality experiences they encountered. These Lenses allow users to add special effects to their photographs (for e.g. adding dog ears to a selfie). In December 2017, Snap Inc. opened its Lens Studio to developers to create their own AR Lenses. Up until that point, Lenses were only created by Snapchat's internal creative agency, and could be bought by brands at a high price, for use in ad campaigns. Now, any indie developer or small businesses can create their own Lenses for fun or advertising purposes. Snapchat hopes that this move will unleash a flood of creativity and nurture an ecosystem of AR creators. With one-third of their 178 million user base already engaging with Lenses for an average 3 minutes a day, it creates even more opportunities for users to interact with new AR experiences¹⁵.



Last last year, Facebook opened up its AR Camera Effects platform and AR Studio tool to the developer community. These tools allow developers and brands to create their own AR effects ('World Effects') for the Facebook and Messenger cameras (though not yet for Instagram). Facebook has already worked with more than 2000 brands and publishers to make AR experiences using the Camera Effects platform¹⁶, and hopes that opening it up to external developers will encourage more AR content creation, and 'make AR more a part of everyday life'.

The software development platforms discussed above can be loosely classified as follows. The Apple ARKit and Google ARCore platforms allow developers to create AR applications for iPhones and Android phones. Facebook and Snapchat's platforms allow developers to create AR effects for limited use cases (photo effects) inside those apps.



Apple and Google's platforms benefit from increased access to the mobile operating system (iOS/Android) and phone sensor hardware, such as the gyro and accelerometer. The quality of AR experiences built on these platforms will become more robust¹⁷, and may attract serious developers looking to create more involved and detailed AR experiences. These experiences will be delivered through applications distributed on the Apple App Store and Google Play Store. We expect to see the quantity and quality of AR apps to increase dramatically.

On the other hand, Snapchat and Facebook's platforms rely largely on camera data and computer vision algorithms. While the quality of these experiences isn't as robust, the development tools are easier to use, potentially attracting amateur

developers and brands looking to experiment with AR. Furthermore, these platforms allow for easy scalable distribution of content on Facebook and Snapchat (including through paid advertisements), increasing the appeal for brands and marketers.

At a broader level, this rush to create developer tools and platforms signifies a public commitment to augmented reality as a new computing platform. It also democratizes AR experiences by giving third-party developers the tools to create AR apps and photo-effects, and a massive audience to distribute them to. These companies hope to enable creation of diverse use-cases and experiences, drawing more consumers to AR.

Headset AR

The near-ubiquity of smartphones means that AR will soon be accessible to hundreds of millions of consumers. In the near term, we expect mobile AR to have gained the most traction with mass audiences. However, as more use cases develop, and headset technology improves, we expect to see an increasing demand for high quality experiences delivered through standalone headsets. Some experts like Ori Inbar, the founder of New York-based augmented reality venture capital firm SuperVentures, believe that once AR becomes ubiquitous and mainstream (see AR Cloud below), headset-like devices will become commonplace.

Headsets offer significantly better quality MR (“mixed-reality”) experiences, but adoption at scale will take longer thanks to the high cost and complexity of these devices. Currently, headset-based MR is more easily applied to enterprise use-cases (such as warehouse automation.) or for devoted, niche segments such as gaming. But mass customer use cases are around the corner. Apple’s rumored AR glasses don’t have an official release date yet, but market watchers estimate that they’ll hit stores in 2020¹⁸. Microsoft, on the other hand, has a publicly announced product, currently at the developer kit stage. The Microsoft HoloLens uses the Windows Mixed Reality platform to blend the real world with overlaid images. A standalone headset, it uses motion sensors, advanced cameras and a waveguide system to project images onto the user’s eyes¹⁹.

Several other MR headsets are in development or production, including gear from Magic Leap, DAQRI, and META. Magic Leap announced partnerships with the NBA and Turner to produce MR sports content for its upcoming headset, a “creator edition,” which is set to ship in 2018²⁰.



OTHER TRENDS - A TECHNOLOGY DEEP DIVE

1

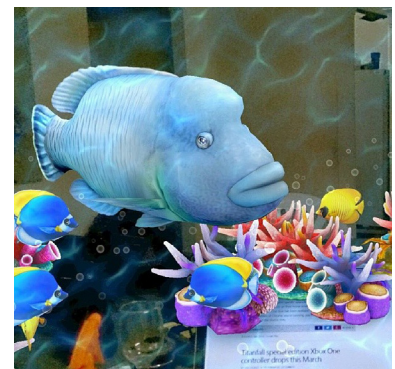
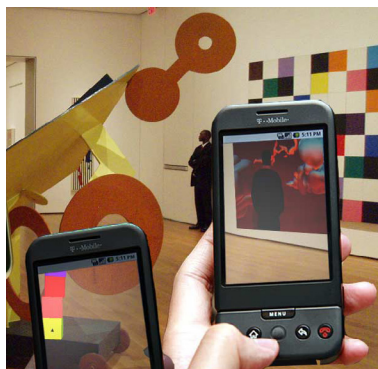
Markers and QR Codes

Some AR applications require 'markers' to initiate, or trigger an experience. An AR marker is effectively a digital cue that signals to an AR enabled device to trigger an AR experience. These markers provide a fixed point of reference for tracking, positioning, and orientation, acting as an interface between the physical world and the augmented reality content. Any image can be used as a marker, including QR codes. Other than the technical utility, consumer applications sometimes use brand images and logos as markers, to make the brand a focal point of the experience. For example, Elle Magazine used the cover image of its November 2016 'Women in Hollywood' issue as a marker. When a reader with the ElleNow iPhone app viewed the cover through their phone camera, the marker was triggered and an AR video started playing, featuring interviews with several women in Hollywood, this extended the storytelling through a new, interactive multimedia dimension²¹.

2

Markerless Tracking

Markerless AR is a relatively sophisticated technology that uses the phone camera and sensors to recognize and use planes in the physical environment as targets for AR objects²². This is significant because a device, such as smartphone, would no longer need to rely on a marker or QR code to trigger an AR experience. Instead, Simultaneous Localization and Mapping (i.e., SLAM²³) algorithms use the phone accelerometer and gyro along with the camera image data, to map out horizontal planes in the environment and track AR objects on them. Some applications (including Pokémon Go²⁴) also use GPS data along with other sensors to trigger AR content. Markerless AR experiences can be delivered and viewed in almost any real-world context, expanding the potential use cases for AR. Google's ARCore and Apple's ARKit provide developers with markerless tracking technology²⁵.



3

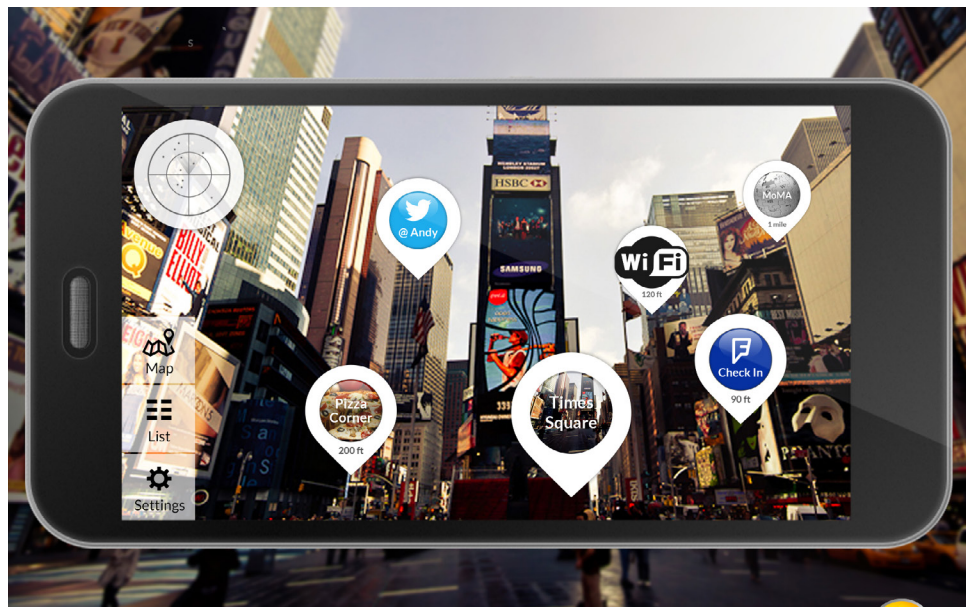
Web AR

Most mobile AR experiences are deployed through smartphone applications. This forces consumers to perform the non-trivial task of downloading and installing an app - a significant barrier to distribution. Web-based AR systems that allow AR content to be viewed and shared through mobile and desktop web browsers address this problem²⁶. Instead of downloading a new app, users simply click on a link to open a page in their mobile web browser, activate their device camera and view the AR content. Google is at the forefront of the effort, having recently released experimental prototypes for developers, that leverage the ARCore and ARKit platforms²⁷. Mozilla has also recently released an experimental WebXR kit for ARKit developers²⁸.

4

AR Cloud

The AR Cloud may potentially be the next great innovation in AR technology. A concept popularized by Ori Inbar, the AR Cloud concept is AR as a platform, a shared, three-dimensional map of the world that allows persistence of information in the real-world (think of a shared google map but with augmented reality functionality). Inbar believes that the AR Cloud will serve as a 3D soft copy of the world which can be accessed by multiple users from any location or device, thus allowing for truly shared AR experiences²⁹. People would "click on bricks," and information about any object or place would be accessed in an AR format in real-time, at the place itself. The AR Cloud is still some years away, but its proponents believe that it will allow AR apps to truly connect to the real-world, and use that context to create more valuable content³⁰.



CURRENT SUCCESS IN THE ENTERPRISE SECTOR

Given all of these new technological innovations and investments, the largest gains have occurred in B2B applications where routine job processes are made more efficient and brought to a higher quality of standard because of AR integration. Augmented reality has the capability to transcend gimmick and hype through utility. After its global success in gaming, consumers have shown that there is tremendous interest in AR applications and that its immersive appeal transcends borders. Through Snapchat and Pokémon Go, people are just learning how to view their phones as windows into another world. In order to transform AR from technology that piques people's curiosities for a few minutes a day to one that is a necessary part of their daily lives, enterprises must embed it into natural workflows.

With spending on augmented reality technology estimated to reach \$60 billion in 2020³¹, AR is predicted to impact universities, social enterprises, and every industry in the near future. While it has already changed how users play games and view their environments, it has also begun revolutionizing how companies such as General Electric, Facebook, and Amazon are interacting with their employees and competitors.

AR is facilitating the process of executing tasks and absorbing data by overlaying images and information right onto actual objects. While B2C applications have been focused on creating more entertaining and addictive user experiences, B2B applications of AR have directly contributed to dramatically improved quality and productivity in various fields. As AR continues to increase performance for enterprises throughout the entire value chain, companies that fail to adopt an AR plan will fall behind.

In the enterprise landscape, AR has been carving new paths in manufacturing, medicine, and product design. Nomadeec is a telemedicine application for the Microsoft HoloLens that is also compatible with smartphones, tablets, and smart glasses. It allows EMTs and paramedics to flick through virtual modules of patient profiles, assessments, and video chats with medical professionals with a swipe of a finger. Since every second is critical in an emergency and any lost time could mean death for a patient, this application could save millions of lives. With the telemedicine industry estimated to reach \$113 billion by 2025³², Nomadeec is foreseeing a future where hands-free computing and heads-up displays can enable efficient and frictionless recovery.

In the case of Newport News Shipbuilding, a company that constructs U.S. Navy aircraft carriers, AR is being utilized in the final leg of its manufacturing process. By actually seeing final carrier designs superimposed in front of massive ships, engineers have been able to quickly mark extraneous steel structures that are not part of the completed carrier, reducing their inspection process from 36 hours to 90 minutes, which translates to a time reduction of 96 percent. On average, time savings of 25 percent or more are being reported general for manufacturing processes that leverage AR³³. As mobile devices and wearables advance rapidly, it would be prudent for companies to explore ways in which they can integrate AR into their daily operations.

In addition to allowing users to visualize external images overlaid on real objects, AR provides the opportunity to view internal characteristics of products on its exterior. At Bosch Rexroth, which supplies manufacturing power units and controls, this X-ray vision allows them to show their customers the mechanics of the internal pump of their CytoPac hydraulic power unit. This see-through capability also extends to people. A medical device company called AccuVein uses AR to superimpose images of people's veins directly onto their skin. This has tripled the success rate of needle sticks on the first attempt, while decreasing calls for assistance by 45 percent³⁴.

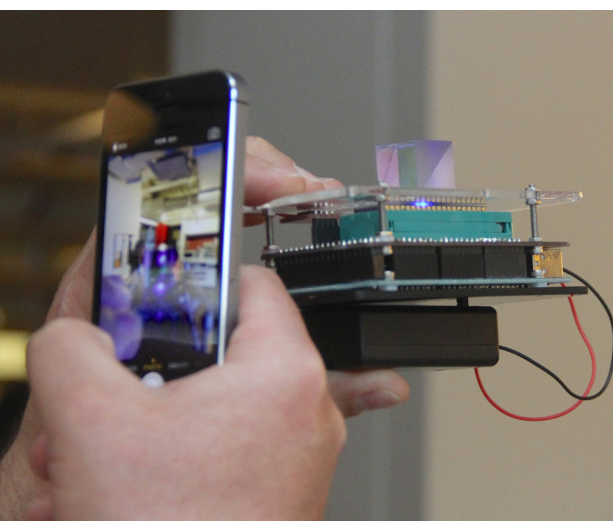
Similarly, an app called Janus Health AR allows dentists to share live renderings of their patients' new teeth. Seeing your new smile superimposed over your face would certainly make the visit much more enjoyable. While this visual can calm nervous patients, AR can guide dentists and orthodontists to evaluate their patients more effectively and produce better results³⁵.



Augmented reality has also facilitated training by increasing efficiency and clarifying procedures. Nebulous instructions and poor coaching are incredibly costly for any company, and they can lead to irregular outcomes. Using 3D holograms, AR training applications can provide employees with the interactive benefits of in-person training and the location-independent flexibility of instructional videos. This technology can be a clear, visual guide that provides real-time feedback for processes ranging from product assembly to machine operation.



After implementing AR training, Boeing has seen a stunning improvement in productivity and quality. The technology was the perfect tool to walk trainees through assembling a wing section with 30 parts, through 50 steps. They were even able to finish assembly in 35 percent less time than trainees who were referring to normal 2-D drawings, and the number of trainees with little to no experience who could execute the process correctly in their first try spiked by 90 percent³⁶. Further, an additional study conducted in 2015 by Boeing proved that there's a tangible cost savings to implemented AR in complex factory floor environments³⁷.



AR training is especially applicable to organizations with high levels of risk. The U.S. Department of Homeland Security implemented AR in its training to teach personnel how to respond to disasters. Since real-world training in explosions would be dangerous, this safer alternative decreases costs. Similarly, BP uses AR training to simulate intense drilling conditions. With this technology, they can guide teams through specific procedures and enable them to practice emergency responses to crises without any risk.

AR applications also allow companies to bridge distances between their employees. Lee Company, which services building systems, have been leveraging AR to guide their on-site technicians remotely. By connecting technicians with experts, they dramatically improved worker performance and decreased labor and travel costs of more than \$500 per technician per month by minimizing the number of repeat visits. For every dollar Lee Company invested into AR, they calculated a return of \$20³⁸.

Even though many AR applications are available in enterprise hardware, companies must also consider the fact that AR is only in its earliest stages. For one thing, voice commands and gaze-tracking are advancing rapidly in smartphones, and these technologies are set to complement existing AR applications. GE has been wise to test voice commands in AR to help their factory workers conduct complicated wiring processes in wind turbines. This led to a 34 percent increase in productivity.

Enterprises must also consider that more hands-free wearables, such as headsets and glasses, are entering the global market.

Similar devices are currently being piloted at thousands of companies to help factory workers visualize various instructions superimposed onto machinery and in their environments. This would be a better alternative to neglected instruction manuals, and it could lead to more efficient work with fewer costly mistakes. Looking ahead, it is easy to imagine a factory worker using these wearables to command a virtual control panel or see different performance metrics appear while strolling through an assembly line.

In January 2018, San Antonio-based H-E-B Grocery Co. actually executed a comparable pilot program with smart glasses manufacturer Vuzix Corp. By wearing augmented reality glasses, H-E-B employees were able to perform tasks without a separate computer or training materials. By seeing real-time information and cues directly ahead of them, H-E-B workers were able to repair machines and scan packages quickly and accurately. In this workplace, AR imbued a superpower that equipped employees with X-ray vision. At H-E-B, it enabled users to see digital renderings of the machine schematics. When deployed on a larger scale, in factories, warehouses, and retail stores, computer-generated holographic images can substantially reduce hours, errors, and costs³⁹.

AR technology has been successful specifically in enterprise because it facilitates cheaper and safer simulations, creates consistent, step-by-step training, and enables quicker superimposition of maps and complex schematics; basically, in the case of enterprise adoption, AR provides massive utility value for its end user. While mass consumption for AR has been slow primarily due to technical difficulties and an education barrier, non-consumer facing applications have been successful because they have been proven to be cost-efficient. These applications are also scalable, and they gain traction quickly because they are easy to promote within organizations and companies. B2B applications are also easier for AR developers to target because the scope of their task is narrower, and it's easier for them to address specific business problems. On the other hand, producing mass-market blockbuster AR applications is more amorphous and requires frequent trial-and-error. As the realistic nature of AR experiences improves with the advancement of optics and screens, understanding AR's current success in B2B applications can guide us in recognizing how developers can chart the path for widespread B2C adoption. By focusing on creating compelling and useful applications that allow employees to engage with it daily in "meatspace," AR developers can make the technology truly ubiquitous.

BUSINESS-TO-CONSUMER USE CASES

Augmented reality is rapidly changing not only enterprise industries such as manufacturing and robotics, but also consumer-facing firms and businesses as well. As in enterprise, the most successful use cases in AR are those that offer customers an experience with clear, strong utility. Retail firms such as IKEA can provide customers with the ability to transpose a piece of furniture from a showroom into their living room, while cosmetic brands like L'Oreal allow customers to try on makeup and beauty products by simply using a smartphone's mobile camera. Brands that can leverage AR to provide a utility value for their customers are the ones that will pioneer the most rapid and pervasive adaptation of AR technology in consumer-focused industries.

AR use cases can be conceptualized by defining four different areas of utility: Environment Visualization, Education, Navigation and Inspiration.

..... **Environment Visualization**

Users leverage AR to render physical spaces with particular specifications before committing resources to actual construction. An event planner can conceptualize what a convention room would look like with different stage and seating arrangements while a set designer can digitally construct an array of scenes before committing a significant amount of capital to execution.

..... **Navigation**

Cars are increasingly being equipped with AR tools to help drivers and riders navigate to their destinations. This is a dramatic improvement over existing navigation options, which risk diverting drivers' attention from the road. Additionally, companies are beginning to deploy in-store navigation systems to make in-store shopping more efficient and experiential, while tourism bureaus in certain cities are leveraging AR to help travelers wayfind around new and unfamiliar geographies.

..... **Education**

AR can be used in numerous ways to improve educational experiences and enhance the effectiveness of teaching. In museums, AR provides new ways for visitors to view and interact with exhibits. AR is also enabling users to learn skills, such as cooking, and expand their knowledge across an infinite number of subjects, from anatomy to astronomy, all from the comfort of their home with a smartphone.

..... **Inspiration**

Utilizing AR to provide inspiration to consumers has the widest applicability. AR allows customers at beauty salons to imagine new hair colors and styles. Architects can use AR to manipulate digital overlays to create countless renderings, while fashion designers can use AR apps to visually display different styles on a mannequin.

1

Environment Visualization

One major benefit to augmented reality compared to virtual reality is in its ability to enhance the existing environment, rather than fabricating a new one entirely. It allows consumers to envision a different rendering of their current space.



This is particularly important when consumers are considering expensive purchases or working with empty space, such as during periods of interior decoration, renovation, or design. According to a September 2017 study from UK-based market research firm DigitalBridge, one-third of consumers surveyed indicated they would be more likely to make an immediate purchase of an expensive item—a renovated kitchen or bathroom, furniture—if they were able to access an AR visualization of it first, which could reduce the conversion time for that kind of sales by as much as six months.

Companies such as IKEA, Pottery Barn, Zillow, and Wayfair have already developed and launched proprietary mobile applications in which consumers hold their phones over their living rooms and kitchens to see an overlaid visualization of a piece of furniture in that room. In Pottery Barn's 3D Room View, for example, consumers can see various configurations, colors, and sizes of everything from desk lamps to media consoles and sofas in their own homes.

Chris Papaleo, who spearheads emerging technology initiatives at Hearst, imagines a world where readers of Home Beautiful or Elle Decor can toggle through different renderings of their interior space in various styles. One swipe and a consumer sees a room decorated in mid-century modern. Another swipe and the consumer sees a safari motif.

This would also be invaluable for important events, ranging from conferences to galas to weddings. Instead of closing one eye and holding up a photograph of a previously-used centerpiece, or closing both to imagine something brand new, a consumer could see it fully imagined before investing thousands, if not millions, of dollars.

Similarly, another potential application is for movie sets and production. Lord of the Rings director Peter Jackson and his partner Fran Walsh co-founded an augmented reality studio, Wingnut AR, that aids in the world-building process. This way, those working on a film can do everything from testing out different set arrangements in low-stakes environments to previewing a fantastical story on an ordinary countertop at an office cubicle before deploying resources to make it a multi-million-dollar motion picture production.

In these instances, augmented reality becomes the ultimate way of trying before buying, assuaging any concerns consumers may have about making major financial investments, enhancing their initial buying experience ex ante and also reducing the chances of dissatisfaction ex post.

2

Navigation

AR applications and tools are helping to transform the ways in which people navigate a variety of environments and situations.

A host of actors are building AR solutions that will allow drivers to follow directions without having to look down at a mobile phone. Startups, such as Navdy and WayRay, are accelerating the development and deployment of Heads-up Displays (HUDs).

HUDs are augmented reality enabled devices that transpose real time mapping data onto a device on a windshield console. These devices not only transpose mapping data and directions but can also act as a central communication device and allow drivers to take phone calls, play music, and get to their destination without diverting attention from the road. Both startups have attracted significant venture funding. Navdy, which launched in 2013 and began shipping its first products in 2016, has raised over \$40 million⁴⁰, while WayRay has raised over \$30 million, recently attracting \$18 million from Alibaba⁴¹. WayRay has even launched its own SDK Kit to allow other developers to build AR apps for automobiles⁴².

Startups aren't the only entities working towards developing new AR enabled navigation tools for cars. Incumbents such as Volkswagen, BMW, Ford, and General Motors have all dedicated resources to building out their own HUD capabilities⁴³ and equipping new cars with the technology.

Even more telling is the fact that major non-automotive companies, such as Panasonic, Alibaba and Apple are all attacking the market. Panasonic just displayed its newest HUD technology at the Consumer Electronics Show in January of 2018⁴⁴, while Alibaba's investment in WayRay was part of a broader strategy to deploy HUDs in cars manufactured by Banma, a joint venture between Alibaba and Chinese carmaker SAIC⁴⁵. Finally, Apple has built applications on its iPhone specifically to enable it to act like a HUD.

This activity signals a huge potential for growth: Future Market Insights predicts a compounded annual growth rate of 23.2 percent for the HUD market and IHS, a



business insights firm, predicted HUD sales to top 9.1 million units by 2020⁴⁶.

In addition to transportation, AR implementation in retail stores is proving to be a testing ground to leverage AR for both navigation and advertising purposes. Lowe's Home Improvement recently launched Lowe's Vision, an AR navigation app that leverages Google Tango⁴⁷. This application allows customers to find certain products and add them to a digital shopping cart while in the store. Aisle411, a venture backed startup based in St. Louis, has partnered with several big retailers such as Walgreens and Toys "R" Us, to provide an in-store navigation experience. Their AR-enabled technology allows customers to navigate large retail stores and identify different promotions and deals with their smartphones. Aisle411, eventually hopes to become a digital shopping assistant and one of the plethora of new technologies aimed at improving the instore shopping experience⁴⁸.

Augmented reality is finding several applications for travelers and tourists. Several large airports have invested in AR wayfinding solutions. Gatwick Airport in London teamed up with the startup PointrLabs to install 2,000 beacons to support a geolocation AR mobile application⁴⁹. As technology writer Alice Bonasio explains: beacons provide more accuracy than traditional GPS and can provide an end-to-end (from departures to boarding a flight) "blue dot" AR navigation experience for customers⁵⁰. While helping customers navigate terminals seems the most prominent function, retailers hope to profit as well by being able to pinpoint customer locations and provide real time deals and promotions⁵¹.

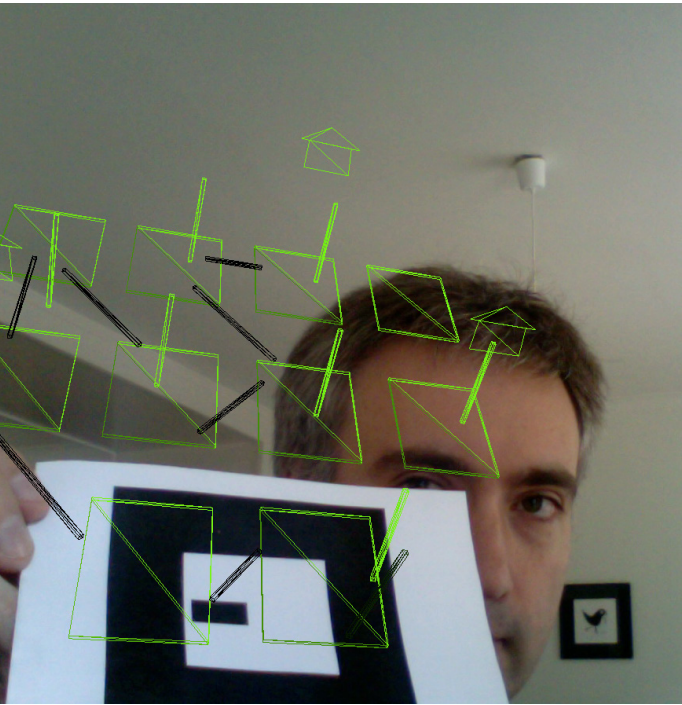
Augmented reality applications are emerging across the world to provide tourists with a better way to both navigate and discover new destinations. Blippar, one of the leading AR companies, recently launched AR City, an app that allows travelers to navigate 300 different cities⁵². The Greater Houston Convention Visitors Bureau in partnership with the Houston First Corp, a government organization that operates the city's convention and arts facilities, launched Visit Houston AR in November of 2017 aimed at helping tourists navigate and explore the city⁵³. Finally, even the 2018 Olympics provided an AR application to help tourists navigate Pyeongchang⁵⁴.

The many examples of augmented reality use cases for navigation indicate that AR is powerfully suited to change the way people navigate both indoor and outdoor environments. Auxiliary benefits, like advertising, shopping guides, information services, safety alerts, can be easily added to any navigation application, increasing the utility for the user and creating additional avenues of commerce.

3

Education

AR is providing new methods for educating several different audiences. From students to tourists to customers, AR enables educators and brands to build experiences that leverage AR to facilitate learning.



Education is an industry that will witness major changes through AR. Already, medical schools are using augmented reality hardware to visualize the human body⁵⁵. Allowing experimentation on a digital body will not only help students prepare for real patients but will reduce the number of costly cadavers needed for research purposes⁵⁶.

Beyond medical application, AR is being piloted to enhance the educational experience of traditional K-12 schools. Pearson, a leading educational research company, has partnered with Microsoft to use HoloLens in the classroom⁵⁷. According to Joanna Webb, head of immersive learning design at Pearson, the company is 80 percent finished with an AR pilot program with Microsoft and has deployed augmented reality across a variety of subjects including history and geometry. This program allows artifacts to be brought out of the textbook and into the classroom and enables students to manipulate 3D maps and coordinate planes. While data that proves an increase in student performance isn't yet available because the application

of the technology is still new, Webb mentioned that augmented reality use cases in the fields of medicine and military training have improved comprehension and led to an increase in confidence with the subject matter. Webb believes that the short term application will be through mobile, which is cheaper, but as the price for AR hardware drops, glasses and wearables will be the preferred method for instruction in a classroom setting to minimize outside distraction.

Museums provide another fertile testing ground for augmented reality. The National Museum of Natural History in Washington, D.C. recently built an AR experience called "Skin and Bones," which allows a museum visitor to superimpose flesh and muscle on skeletons through a smartphone app. And while Audrey Chang, chief of business planning and partnerships at the museum, says that metrics are still being determined to judge the value of the pilot, the ability to advance learning through AR technology is a real additive. Adjacent examples of AR being used to enhance visitor experiences on U.S. cultural tours⁵⁸ (for example: ARt Glass, a company that creates AR experiences for cultural sites, will be used to enhance tours of George Washington's Mt. Vernon

home), and the brand new landmark recognition app launched by Blippar⁵⁹ that allows tourists to identify and learn more about historic landmarks, supports Chang's assertion.

Brands are also using augmented reality to educate their customers. Brands that have complex products with many moving parts are using augmented reality to help customers fix, assemble, and understand. Hyundai for example, has developed an augmented reality user's manual that provides car owners with 3D instructions to help identify and fix minor vehicle trouble⁶⁰. Kia and Mercedes have followed suit with similar AR user manuals which enable customers to better understand all the different components of a car. This utility factor for AR mirrors the use cases for many enterprise functions that leverage AR for maintenance and assembly purposes.

4

Inspiration

Augmented reality stands to change the discovery and inspiration process the same way that visual-based technology such as Instagram did a decade ago. Instead

of scrolling down a feed and seeing images in two dimensions, mobile augmented reality applications could transform a living room into the courtyard of a riad in Marrakech, or a commuting car into a gondola on a Venetian canal.



AR technology would prove particularly effective for sectors in which consumers are either hesitant to shift their brand loyalties (e.g., beauty) or pull the trigger on an expensive or unfamiliar experience (e.g., travel). An October 2016 study from Interactions, surveying Americans between the ages of 18 and 64, found that 25 percent surveyed would want to shop makeup by augmented reality; 35 percent would shop shoes using the technology; and as much as 55 percent would shop clothing using AR. Many consumers still rely on word-of-mouth recommendations from trusted networks or sampling to try something new in these categories (a 2017 survey of American women by Popsugar revealed 79 percent of surveyed women get travel inspiration from friends; a 2017 Statista survey of women 18 and older showed that 27 percent get beauty inspiration from friends and acquaintances).

Converse's Sampler mobile app already allows people to see what the shoes would look like on their feet, while Uniqlo's virtual dressing enables the same capabilities in an in-store setting. And, in the beauty industry, augmented reality integration in mobile apps has already become the norm for companies such as Estée Lauder, Elizabeth Arden, and Laura Mercier. Many of these platforms also have social media integration, which enhances the inspiration experience so that people can share new looks with friends and family, as well as receive fresh ideas from their networks.

But are consumers more likely to buy once they have played around on one of these apps? According to ModiFace CEO Parham Aarabi in an interview with Racked.com, there is an 80 percent increase in conversions for consumers who use the makeover technology.

Augmented reality could be the future of trying on clothes, a new hairstyle, or a fresh makeup palette. Rather than uploading a static photo to a platform, brands pay an augmented reality technology provider such as ModiFace between \$200,000 and \$500,000 per year, which is quickly becoming the dominant tool for companies like Sephora and L'Oréal. This technology enables users to sample various products both at home or in a live, in-store retail setting. As recently as July 2017, Amazon patented AR technology for trying on items sold in its ecommerce store at home. The hope is that Augmented Reality Presentation, the current name of Amazon's patent technology, will lower barriers to purchase certain goods (jewelry, clothing, and more) online, as well as reduce returns, a consistent logistical and financial drain on an ecommerce business⁶¹.

But brands that spend to maintain augmented reality apps each year hope that augmented reality will complement a brick-and-mortar retail experience—perhaps by providing inspiration in the form of an AR enabled in-store mirror, for example—and not replace it entirely. Bullish AR investment and development trends among retailers and brands producing visual-driven products would likely play catch-up if they do too little in augmented reality too late. As Steve Dennis, a Forbes contributor and expert on the retail sector states: "Physical retail isn't dead. Boring retail is⁶²." And, as Cathy Hackl and Samantha Wolfe indicate in their book *Marketing New Realities*, research indicates that as much as 40 percent of shoppers would be willing to pay more for a product that they have experienced through augmented reality.

Pure Play vs. Utility

We have found that AR experiences typically fall into three camps for brands trying to break in: one, an AR experience with express utility, or an experience with definitive value proposition to consumers; two, a brand so strong that consumers who are not

receiving a clear utility benefit from the AR experience engage with it because they love the brand itself; or three, a purely playful and fun experience for brands that are not able to neatly fit into one of the previous categories.

The way we have approached the “necessity” function mirrors what Hackl and Wolfe discuss, regarding a fundamental truth of marketing: “People buy the ‘why’ and not the ‘what.’” If consumers can see how an activity—buying clothing, navigating, researching travel destinations, completing job training—is enhanced by AR, they will be more inclined to use it. Consumer hurdles to adopting AR are most easily overcome if the AR experience is attached to some express utility.

For brands with less obvious AR-integrated utility—as an example, we’ll think of a playful cereal brand—the best entry point will come through the strength of the brand itself. Pokémon Go became an overnight sensation, commanding 752 million downloads and \$1.2 billion in revenue as of September 2017, not because consumers were keen to use an AR-enabled application, but because they loved the Pokémon franchise. The game tapped into a sense of affinity and nostalgia for Pokémon that would have driven consumers to engage with that brand in any way it was presented. Many professionals we spoke with anticipate that the upcoming Harry Potter game from Niantic, the same company that initially created Pokémon Go, will similarly appeal to a wide audience. The common thread between those games is the strength of the brand itself. Our research indicates that, after express utility, the consumers will be most likely to engage with AR experiences that are driven by beloved brands.

In this ecosystem, while it is harder for the playful cereal brand mentioned above to gain traction in an AR experience than something with a highly interactive brand or express utility, it is still possible and beneficial. There are two main reasons why the playful cereal brand (or any other brand that does not neatly fit into the express utility or highly-interactive brand category) would—and should—consider an AR experience as part of its stack: brand awareness and brand relevance.

For a playful cereal brand, even having an AR experience as simple and fun as a mascot that dances on the box when a consumer holds a mobile phone up to it, or a coupon that can only be unlocked using specific AR integration, is worth it. The risk that a brand is not part of the conversation around technology, and all of the ways that consumers can use the devices in their pockets and purses, is high if nothing is done with AR at all. Being part of the conversation around the technology, and possibly deploying it even as a minor part of an advertising toolkit, could help with social media, marketing, and public relations campaigns. These brands would be part of the continuing conversations around emerging technologies.

Matthew Quint, Director for the Global Institute on Brand Leadership points out that, for a brand that wants to engage with AR in a playful way to drive brand awareness and stay relevant, it is worth thinking about the “spinoff effect.” That is, how many people would need to be using the AR brand experience for the spinoff effect to be cool? With that mindset, the pure fun AR experience can gain momentum, sometimes even snowballing into a viral campaign, if the reaction videos to people using that AR experience are equally as amusing as the experience itself. For the playful cereal brand looking to engage with AR as novelty, rather than necessity or utility, it should think of AR as a valuable tool in its toolkit for creative advertising. This is especially true, considering a study done by Tractica, relayed in Wolfe’s Marketing New Realities, anticipates that ad revenue in AR will grow from \$68 million to \$13 billion by 2022. Advertisers ignore AR at their own peril.

Not only that, but when Pokémon Go first came out, brands were mostly unequipped to ride the game’s popularity. It became a flash-in-the-pan sensation. For the next AR moment, whether Niantic’s upcoming Harry Potter game or another experience, brands should be ready to surf that tide.

If a brand reaches consumers through AR, there are still question marks in the industry around metrics and feedback that could and should be measured. Early AR adopters are incorporating existing marketing analytics approaches into the AR experiences, leaning on conversion rates, time spent, reach by way of influencer marketing, and more.

Even more challenging for AR is what key performance indicators (KPIs) should become standard when there is such a wide range of possible experiences and outcomes using the technology. A Snapchat filter of a puppy face cannot and should not be measured with the same KPIs as Pokémon Go or a text art history overlay on a Picasso masterwork at the MoMA. What brand advertisers should consider, however, is whether consumer-engagement would best be measured in relation to one-time usage, time spent, referrals, or multiple visit-usage.

Future Outlook

As audiences demand more engagement and connection with brands, marketers need new ways to break through the clutter of traditional advertising. AR is a powerful tool to accomplish these goals. In an interview with Hackl and Wolfe, the vice president of Blippar—a company focused on building augmented reality solutions for advertisers—mentioned that “AR campaigns have an average dwell time of 75 seconds—this is 2.5 times the average of radio or TV ads.” While enhanced storytelling is an easy win for many brands, finding ways to enhance utility for consumers will make AR an indispensable tool for enhancing and increasing

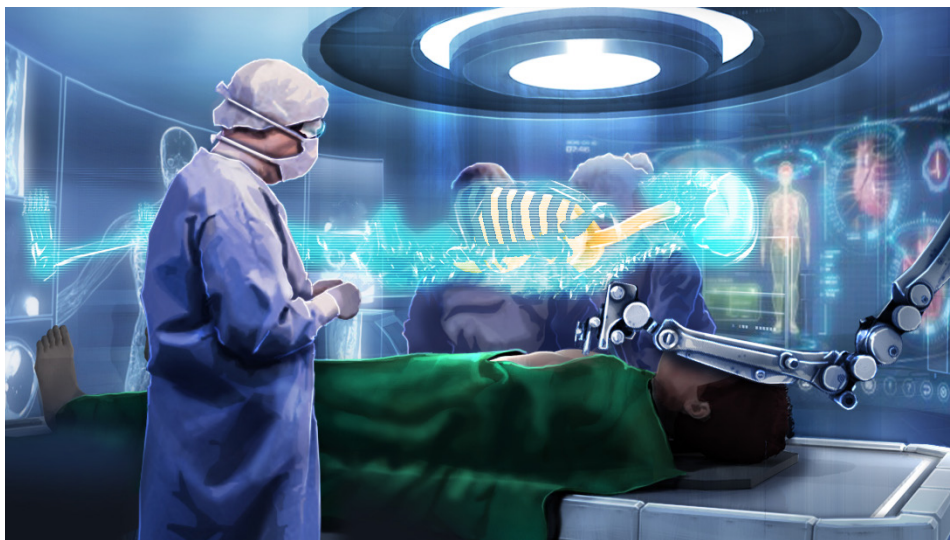
engagement with campaigns in the marketer's toolkit. We believe that further progress will take place in incremental steps.

First, further experimentation by content and technology players will lead to development of new types of experiences and content distribution methods. On the brand side, more consumer companies will invest in pilots, and the quantifiable results will build confidence and reduce the risk of future projects. These developers and brands will find varying degrees of success, until a few standardized platform infrastructures and monetization models emerge.

Once these platforms are commonplace, brands will compete to build the most contextually relevant and viscerally memorable experiences for users. Brands that have developed strong capabilities in AR storytelling will emerge as leaders in this space, while others will remain me-toos. To be a leader tomorrow, companies will have to invest in building capabilities today, and allow for sufficient time for them to mature.

Second, the seamless experience that customers will demand when consuming AR enabled experiences will require a significant increase in data bandwidth. According to a Qualcomm white paper, AR and VR are already pushing the boundaries of connectivity⁶³. The advent of 5G technology could provide the solution as it stands to increase broadband speed by up to 1000 times over existing 4G technology. AT&T and Verizon are expected to roll out 5G technology in 2018⁶⁴.

Enterprise applications of augmented reality have successfully impacted the bottom lines of several B2B and B2C companies. It is only a matter of time before AR applications become near ubiquitous and the companies willing to experiment will be the ones best positioned to ride the AR wave, when it takes off.



FOOTNOTES

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