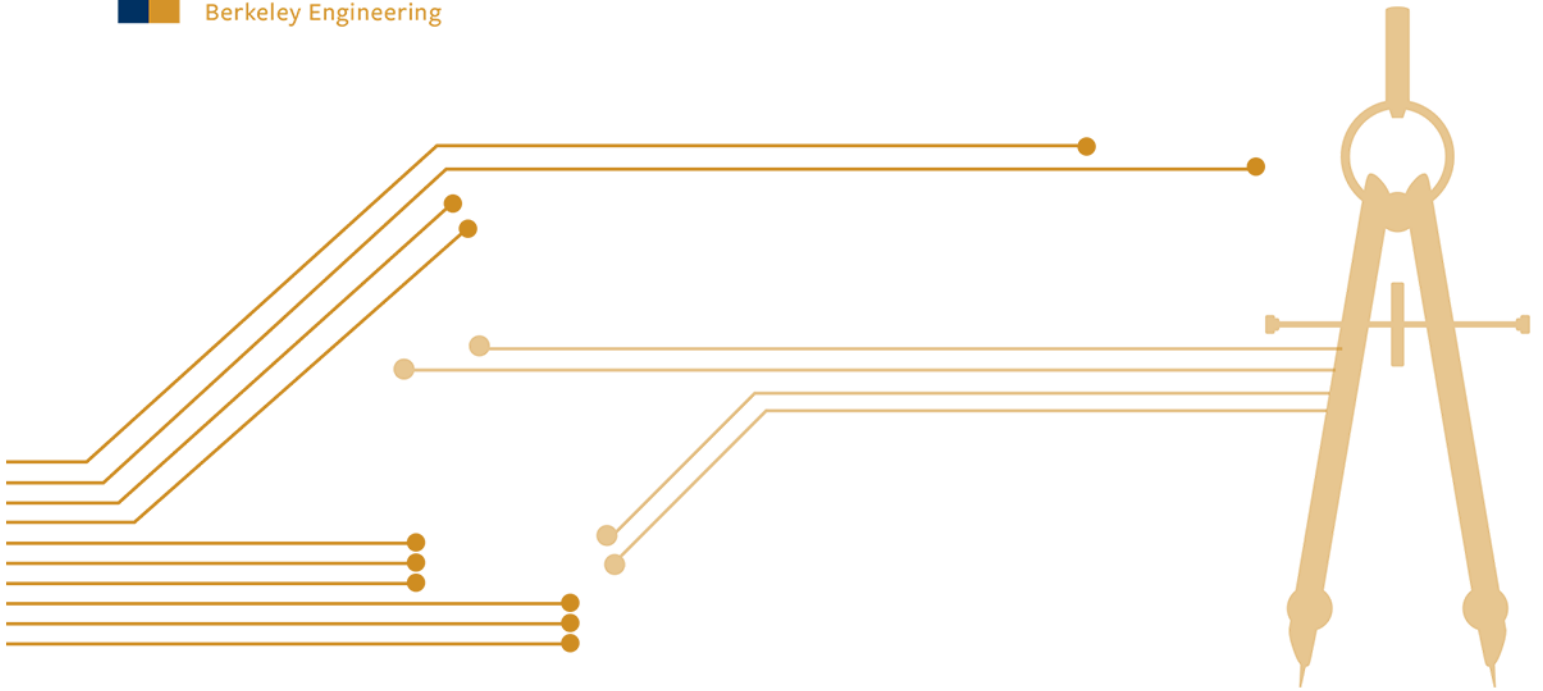




Pantas and Ting

Sutardja Center
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Berkeley Engineering



Next Generation Shopping Experience

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Introduction

The internet was a catalyst that changed the way people shopped. It enabled new players in the retail space to take a foothold and eventually dominate. We are seeing another set of critical technology enablers like virtual reality and augmented reality that we believe will change the way people shop.

For the scope of this paper, we will mostly focus on virtual reality.

Retail History

Since shopping is a big subject, we are scoping it very tightly, starting in the 1960s because we find interesting and relevant trends happening since then. And in the activity chain of shopping we are focusing on retailer's characteristics and strategies that affects customer's purchase selection and decision.

Big Discount Shops

In 1960s and 70s the United States saw a mushrooming of a series of "discount" shops like Walmart, Target and K-Mart. Their business strategy displaced small independent shops by offering shopping convenience.

Big Discount shops are retail stores that occupies an enormous amount of physical space and offers a variety of products to its customers. These shops achieve economies of scale by focusing on large sales volumes. Because volume is high, the profit margin for each product can be lowered, which results in very competitively priced goods¹. They promoted one-stop-shopping experience where customers can stop just once at their store and buy everything they need or want². They also provided good store access so that people can locate and reach their stores easily.

Effective execution of selection and access was primarily focused on running good operations and efficient supply chains. They used database technologies backed up by Electronic Data Interchange (EDI) and barcode scanning.

Club Stores

Starting from the late 1970s, a new type of stores called "Loyalty" stores such as Costco and Sam's Club started showing up. Club stores usually sell a wide variety of merchandise, in which customers may buy large, wholesale quantities of the store's

¹ http://www.investopedia.com/terms/b/big_box_retailer.asp

² https://en.wikipedia.org/wiki/Big-box_store

products, which makes these clubs attractive to both bargain hunters and small business owners³.

They relied on locking in customers through a small upfront fee and incentivizing them through rewards for all purchases. During this time, retail Customer Relation Management (CRM) technology also made its debut. Though rudimentary, this started a larger scale customer behavior analysis which helped enhance customer experience.

Category Killers

The 1980s saw some specialization within Big Discount Shops and were called “Category Killers”. Examples like Home Depot and Office Depot are focused on one or few categories of related merchandise and they offer a wide selection of merchandise in these categories at relatively low prices⁴. They also offer end-to-end solutions, which are products and services, in the specific business segment in which they compete. This value-add provided improved customer shopping experience on top of wide selection and easy access.

E-tail Stores

The phenomenal growth of internet reach in the 1990s, gave rise to “E-tail” stores with Amazon and eBay leading the charge. E-tail stores’ distinction is that they sold goods and services through the internet. They use technology as a competitive advantage that the disruption they brought is still felt today.

Most e-tailers are obsessed about offering the best possible experience to their customers, so much so that it is often referred to as Customer Obsession. This includes elements such as good customer support with timely response to queries and proactive resolutions to problems a customer have yet to complain about. They also enhanced personalized shopping experience by displaying customer-preferred brands and/or types of products when a customer returns to their websites or through special offers as specific holidays or a customer’s birthday are coming up.

To be price competitive, e-tailers use Dynamic Pricing. They dynamically set prices for their products and update them very frequently by employing big data analytics. The analysis blends the actual cost of the item, product demand and supply, probable time of purchase, customer’s buying history, et cetera to predict the best customer experience outcome balanced with decent gross margin.

E-tailers also provide convenience as shopping transactions can take place 24 hours in the day, 7 days a week. They are able to offer much wider selections than brick-and-mortar stores since they are not limited by physical floor space. By lower entry of

³ https://en.wikipedia.org/wiki/Warehouse_club

⁴ https://en.wikipedia.org/wiki/Category_killer

barriers to suppliers, e-tailers work with many more suppliers. This also leads to enhanced product selection experience for customers.

Most e-tailers execute customer obsession, dynamic pricing and shopping convenience with a focus on running very efficient operations and supply chains often employing best practices from Japanese operations paradigms like Kaizen & Andon Cords. They also employ data driven decision making techniques for both strategic and tactical decisions (operations, financial, investment, et cetera).

Another distinct feature of e-tail firms is that they are judged very differently from a brick-and-mortar stores in terms of financial performance. While brick-and-mortar stores derive their value from delivering consistent financial returns, e-tailers derive their value mostly from future growth expectations. Amazon, in particular is running a negative net working capital. Essentially, Amazon's suppliers finance its daily cost of operations.

Case study - Amazon's business strategy

Jeff Bezos' Amazon's business strategy (see **Exhibit 1**) summarizes the turning point seen in the retail space. Bezos strategized that for any retail business to thrive and grow, it needs a good amount of sellers since they bring out good selection of products. A good selection of products drive better customer experience. And with good customer experience, customer traffic grows. Better customer traffic will attract more sellers thus providing a self-sufficient eco-system. Low-cost business structures should be applied when scaling the business. And the savings from a low-cost business model should be passed on to customers as low priced goods thus reinforcing better customer experience. This business strategy was named the Movie Screen because just as one screen can show multiple movies, this business strategy can be used by multiple business around the world.

Brick-and-Mortar Stores' Woes

At the turn of the century, brick-and-mortar stores are struggling with low selection, non-personalized services and sub-optimal pricing. For those that could not compete with e-tailers, they closed down for good. For other retailers, they continue to reduce their number of stores open (see **Exhibit 3**) to cut cost and get back to sustained profitability. The loss of more than half of typical foot traffic (see **Exhibit 4**) has made brick-and-mortar-only retailers realize that they should no longer compete for physical access. Some realize the need to compete in e-commerce, the technology used by e-tailers, as well as embrace emerging technologies that they can use to compete in personalization services.

Selling Experience

As brick-and-mortar stores struggle being relevant and e-tailers continue to deal with the limitations of indirect customer interactions, both are realizing that it is no longer about the product. It is about connecting with customers and letting them know that their products are what will make their lives better. In essence, retailers are focusing on selling experience; on having customers use their products and experience the lifestyle it advocates.

Virtual reality (VR) and its sister technology, augmented reality (AR) is a realization of this “experience concept” in technology. Applications using either technology stand to eliminate customer pain points, elevate customer service, and create a differentiated, personalized customer experience⁵.

Technology evolution and trends

E-commerce

E-commerce gave customers purchase power with virtually endless collection of products on their computers and purchase goods any time, every day. Retailers had to take care of building sophisticated website, payment infrastructure, inventory management, and shipping and return logistics.

Mobile

Then came the mobile world where customers using smartphones could do online shopping virtually on the go taking the ease of e-commerce to next level. Most of the retailers now have their own dedicated mobile application⁶. These applications allows the customers to do research, to do product comparisons and even to complete purchases. Purchases, payments became so seamless that buyers could go to specialty stores purchase products and pay using smartphones without even standing in line at checkout counters.

Omni-channel

Customers are no longer discriminating between mobile and desktop when it comes to shopping and whether that is in a brick-and-mortar store or on an e-tailer’s site. Omni-channel does not just drive e-commerce and mobile application but also get people to the store. Smartphones are the new personal shopping assistant for people once they are inside stores. Multi-channel retailers who operate both e-commerce and in-store channels are taking a note of these trends. They are coming up with innovative strategies in the way they think about omni-channel shoppers because they realize that a shopper who gets in-store after starting his experience online or from a mobile

⁵ <https://hbr.org/2016/09/virtual-and-augmented-reality-will-reshape-retail>

⁶ <http://www.emarketer.com/Article/Shoppers-Downloading-More-Mobile-Retail-Apps/1014041>

application is their most valuable kind of customer⁷. Basically if a shopper took the time to do research online and then gets into a store, there is a higher chance of sales conversion.

Virtual Reality

We live in a world today where a common smartphone has more processing power than a supercomputer of the late 1980s, early 1990s⁸. With more processing power available, embedded processes aided with hardware assisted accelerators/GPUs and paired with various motion tracking sensors, virtual reality technology revolution is now far reaching beyond video games. Retailers are now looking at new ways to give their customers immersive experiences and go beyond just seeing but holding, wearing and trying out in extraordinary scenarios which are all key steps in the purchase process.

Virtual Reality in Commerce

Retailers are experimenting now with virtual reality technology to understand the possibilities for future customer experiences. Through virtual reality, retailers are giving customers the opportunity to view products from all angles with 360 degree look and feel, enhancing the presentation and bringing real-life experiences to the shopping experience.

The in-store experience

eBay, in partnership with Myer, an Australian department store launched the first ever virtual reality department store where customers are treated to a personalized experience that brings the in-store experience to them, no matter where they are.

Visualization

Lowe's Holoroom and IKEA VR Experience focuses on helping their customers visualize home improvements and renovations before it happens. Through their application, users can experience a virtual rooms in real world size. With IKEA VR Experience, customers, with the use of a virtual reality headset, can use the application to explore differently-styled kitchen room settings where users change the color of cabinets and drawers with a click⁹. Lowe's Holoroom starts with an iPad app where customers can design a kitchen or bathroom, moving cabinets and choosing colors. Once completed, they can view the designed room with a virtual reality headset¹⁰.

Landrover had virtual cars in their showrooms where customers instead of actual cars were offered virtual 3D tours of the car using VR technology where they could look and

⁷ <https://www.thinkwithgoogle.com/articles/omni-channel-shoppers-an-emerging-retail-reality.html>

⁸ <http://pages.experts-exchange.com/processing-power-compared/>

⁹ <http://fortune.com/2016/04/06/ikea-vr-virtual-kitchen/>

¹⁰ <http://retail-innovation.com/lowes-in-store-augmented-reality-room-designer>

feel car virtually¹¹. Audi City offers the same visualization experience that they saw 70% increased sales with 65% of the customers not requiring a test drive.

Personalization

Lowe's in partnership with Google is launching Lowe's Vision, an app where it combines area learning, depth sensing and motion tracking to give devices the ability to see their environment in 3D¹². They enable their customers to visualize in their own homes how Lowe's products will fit without having to bust out a measuring tape. Adidas came up with cyberFit interactive fitting room where a body scanner "BodyKinectizer" based on Microsoft Kinect enables customers to determine the right size of a product and allows them to dress their virtual body¹³.

Seeing is believing

Thomas Cook, a travel company, is experimenting with virtual reality through YouTube app and Google cardboard with "try before you fly" marketing campaign¹⁴. They are enticing customers to try out the experience their would-be vacation for five minutes.

Conversion

With consumer's deep rooted desire to "try before we buy" and not just seeing but holding, wearing and trying out interactively are all key steps of virtual reality. Interactivity leads to immersion. And that immersion leads to conversion, a conversion of browsers to actual buyers.

Market Readiness

Virtual reality is slowly but surely creeping into the consciousness of the marketing and business communities. There has been a surge in 2016 with wide range of devices availability with wide capabilities in the market¹⁵.

Over the past several years the retail industry has been focusing on mobile optimization as conversion rates on mobile devices have continued to climb. This makes VR the next logical phase in the evolution of ecommerce marketing and engagement. With innovations like motion sensing, facial recognition software, and wearable tech picking up steam, more customers are beginning to demand personalized shopping experience with delight factors.

¹¹ <http://retail-innovation.com/land-rover-showrooms-with-augmented-reality-headsets>

¹² <http://www.lowesinnovationlabs.com/tango/>

¹³ <http://retail-innovation.com/adidas-body-scanner-lets-you-try-clothes-on-virtually>

¹⁴ <http://retail-innovation.com/view-holiday-in-virtual-reality-at-thomas-cook-stores>

¹⁵ <http://www.pocket-lint.com/news/132945-best-vr-headsets-to-buy-in-2016-whatever-your-budget>

There were lot of failed attempts in bringing the virtual reality in the past where for example the Virtual Boy from Nintendo introduced in 1995 became a massive failure¹⁶. Gartner believes we gone past technology shortcomings, inflated expectations, disillusionments and reached at the beginning of the slope of enlightenment where the VR technology maturity and ecosystem of retail industry combined with shoppers thoroughly embracing the VR experience all converging to make V-commerce the next thing in shopping (see **Exhibit 5**). There are some schools of thought that believe VR is going to be for Generation Z what smartphones are to Millennials.

Retail VR Ecosystem

The VR ecosystem is comprised of four distinct players (see **Exhibit 6**): Hardware, Software-platform, Content Providers and Retailers.

Hardware

The hardware space is further divided into four segments: Semiconductors, Audio and visual, Head-mount display and Motion sensors and haptics.

Semiconductors or Integrated Circuits (IC) form the backbone of any VR hardware. These ICs provide the necessary compute power, simultaneous multi-processing capabilities, low latency and quick response required by a Virtual Reality applications. On this turf, companies such as Nvidia, Intel, Qualcomm are working on respective solutions developing specialized processor ecosystem to address intense graphics needs of VR applications. Nvidia is the far-and-away worldwide leader in the visual technology that makes virtual reality devices work. For example, their Pascal GPU architecture combined with VRWorks design kit (SDK) enables VR headset developers to create amazing virtual reality experience. Similarly Intel's i7 processor Extreme Edition is equally compute intensive and is suitable for high end gaming and VR application. Intel also has recently announced a virtual reality reference design platform called project "Alloy" using its semiconductor solutions and RealSense motion tracking technology.

In order to have an immersive VR experience, both visual and audio plays a big role. Visual is driven by screen characteristics such as pixel density, fast refresh rate (fps), low latency, and optics (field of view).

Since the head-mount display is only inches away from the eye, pixel density could spell the difference between fuzziness and clarity. Refresh rate is an aspect of a display to determine how smoother and crisper motion appears. The higher the pixel density, the crisper the image. Virtual reality is meant to impose a certain sense of immersion and realism, crisp "lifelike" motion and a lack of motion blur is crucial to the overall experience.

¹⁶ <https://www.fastcompany.com/3050016/unraveling-the-enigma-of-nintendos-virtual-boy-20-years-later>

Latency is the term used for the time between input and output. For the layman, that means the time it takes for the picture in your virtual reality world to catch up to your new head position each time. In order for virtual reality technology to fool your brain into thinking that you are in an immersive world, the technology requires very low latencies. An absolutely top-notch experience usually equals latency of 20ms or less; if it is any more, we start to notice an unnatural lag.

In order to create that immersive feeling of inhabiting a virtual world, you have to stretch that flat image to fill your visual field entirely. This is commonly referred to as optics. Experimentation by the University of South California indicated that a HMD would achieve the visuals needed for a convincing virtual reality if it had a field of view (FOV) of between 90 and 100 degrees. This effect is achieved by using the lenses in a HMD to take a flat image and change it into something that fills every nook and cranny of our eye line. Therefore the quality of the lenses used in your headset is vitally important; a HMD that uses cheap lenses may have a poor picture quality, low clarity, and some unwanted distortion. OLED and AMOLED are some the display technologies best suitable for Virtual Reality application hence offering a big market for the makers such as Samsung, Sharp, LG and Sony.

The premise of VR is to create an alternate reality, but without the right audio cues to match the visuals, the brain doesn't buy into the illusion. For the trickery to succeed, the immersive graphics need equally immersive 3D audio that replicates the natural listening experience. This creates market opportunities and area of excellence for companies such as VisiSonics and Sennheiser who are experts in 3D audio technologies.

2016 looks like the most important year yet and has seen a big surge in VR headset (see **Exhibit 8**). With Oculus, Samsung, Sony and Google all vying for positions in the market, VR hardware gear offering is rapidly growing. It started with headsets using smartphones running specialty apps for content like Samsung's Gear VR, Google Cardboard and more recent Google Daydream. It is then followed by headsets tethered to a PC, examples of which are Oculus Rift and HTC Vive and more recently Sony PlayStation VR. Another type of headset is built with PC capabilities such as the Microsoft Hololens.

Motion tracking sensors and haptics are another important piece of a VR hardware, providing a good playing field for several companies in this arena, each having unique approach to address real time motion tracking and feel requirements of a VR application. Motion tracking could be done using optical methods or non-optical methods. Optical methods relies on use of special infrared and depth sensing cameras whereas non-optical methods uses electromechanical sensors such as accelerometers, gyroscopes and magnetometers. Some of the leaders in non-optical sensor arena are

Invensense, Bosch, STM and NXP. Other non-optical tracking technologies such as direct electro-mechanical sensing uses body movement to activate and convert that movement into electrical signals for motion tracking. On the Haptics side, technologies from companies like NeuroDigital, and Senseg claims to add a feel experience while touching a virtual object. Although these technologies are not yet ready for mass adoption, feel experience could be a game changer for any virtual reality application such as VR shopping. Just imagine if we could touch and feel a virtual objects as if it's real while in the comforts of our home.

In the crowded hardware space, the winning factors that would catapult players to the top are ease of use, cost, computing power, realism and system integration. Undoubtedly high cost of ownership is the biggest barrier to VR's mass adoption. Additionally since a VR hardware needs to be head mounted or body worn, without a well-designed and ergonomically convenient hardware, users could have trouble with sense of balance, disorientation, and a decrease sense of virtual presence defeating the whole purpose. Therefore a well-integrated hardware will also be a key decider on this turf.

Software-platform and Content Providers

The software-platform providers are the one that retailers use to develop their shopping experience while the content providers is a mix of different product contents such as games, movies, music, goods, et cetera.

Facebook/Oculus, who is the leader among VR companies was adopted early by major game developers and now also showing traction into other business use cases. Google is pushing Google Play as the market platform VR developers use to make and sell VR applications.

Bricks & Goggles transforms construction designs from CAD and other 3D modeling software into three-dimensional VR environments. The environment created can then be viewed in a life-like 3D image using any of several headsets, including Oculus and Google Cardboard. This gives people a chance to "walk through" a design, as it were, and see how it would look when completed, so they can make changes. Similarly, Marxent Lab has VisualCommerce which enables virtual 3D product visualization, customization and configuration to create an emotional, connected sales experience¹⁷. Other Virtual Reality studios such as Visualise and VRstudios who produce and provide 360 degree video and VR platforms to top brands, business and retailers with a focus on storytelling, craft and quality.

In the software categories, the winning factors are inter-operability, content quality and user interface (UI). Interoperability is important because there are big range of

¹⁷ http://www.marxentlabs.com/ar-solution/visual-commerce/?utm_source=google&utm_medium=adwords&utm_campaign=tracking/

hardware available and the software segment needs to easily adapt to different hardware.

Retailers

eBay launching the first virtual store and Alibaba introducing VR Pay, a virtual reality payment system are one of the v-commerce players. The fashion industry are also early adopters with North Face VR providing customers outdoor experience in-stores and Sephora using Magic Mirror to showcase different shades of make-up without having to physically put them on.

Specialty shopping such as the travel industry, real estate and automotive are also onboard in experimenting with virtual reality. In travel, Thomas Cook's "Try Before You Fly" campaign is leading the effort. Matterport's partnership with leading real estate companies to showcase properties for sale virtually for would-be buyers in the comfort of their homes. In the automobile industry, Land Rover and Audi that are enhancing their showrooms with virtual reality experience to easily showcase upwards of millions of configuration across their product range.

Among retailers, Amazon, Alibaba, Facebook and Sony have great advantage since they play in more than one space in the virtual reality ecosystem. Sony's footprint in people's homes gives it an extra edge.

Regulatory and Societal impact

Copyright

As our world is going more and more virtual, new VR products in various market segments are increasing, where virtual stores, virtual fitting rooms and virtual travel sites are coming up. With the rise of virtual worlds comes a number of questions about how different parties are going to create, use and enforce their intellectual property in VR. This opens up unique IP and copyright infringement challenges for users, content providers and platform providers as the real world legal laws may not directly apply to virtual world and have not caught up with the technology they represent.

Is the experience of climbing Mt Everest in virtual world, infringe on the city or country's exclusive rights to it? Can it be copyrighted? Would someone who creates a shirt with real world logo and sells it in virtual world with no real world money involved, be liable for trademark infringement? Would someone creating avatars in virtual world using real world celebrities step into gray areas where they could be violating celebrities' trademark.

While existing real world IP protection laws can cover the vast majority of current interactions between users and content providers in virtual worlds, it is inevitable that

the evolving nature of these virtual worlds will prompt novel questions of law which will have to be addressed through new IP laws more tailored for virtual world.

Privacy

There is no privacy in virtual worlds. Everything you look at or pay attention to will be collected for analysis. Let's say someone who attends a NBA game virtually and happens to glance for more than a fraction of a second on a brand of chips. Even if that person does not "buy it" virtually, the virtual-reality host will know. They can then use this information to upsell and cross sell around.

And going back to the example on real world celebrities as sellable avatars in virtual world, does it also infringe on their privacy rights?

Isolation

There are concerns now that social media lessens real life interactions. Virtual reality will further push this towards isolation. The lure of VR worlds where everything is simplified to being very good or very bad makes it more attractive than the grayness of the real world. People may tend to stay in virtual worlds where interactions are simpler regardless of side effects.

Challenges

As virtual reality prepares to go mainstream, it needs to address issues that any new technologies faces which are cost, adoption and possible side effects.

Cost

VR headsets are every expensive and will remain expensive until mass market takes off. Content creation for retailers is also very expensive. At this time, it takes \$50 to render a model of an object. To be cost effective, this needs to get down to \$1.

Adoption

There is no dominant software platform yet and there is no standard format for content creation. Content needs duplication across various hardware platforms. It may take few years for VR to go mainstream for the content customers want, and are willing to pay for.

Side Effects

Lag between user movement and rendering can cause nausea, headache and dizziness. VR sickness or cyber sickness occurs sometimes when user goes through VR experience something similar to motion sickness. It occurs due to the disagreement between what the stimuli from the eyes and the inner ear are sending to the brain.

Stepping into the Future

The best indicators that virtual reality is here to stay is the number of headsets that are coming out in 2016 as well as the innovation labs that are being formed by retailers such as Wayfair, eBay, Lowe's and Land Rover.

VR adoption within the brick-and-mortar stores will continue to outpace e-tailers until the price barrier with VR hardware is overcome and there is at least one VR gear in most people's home. As they continue to consolidate their physical stores and find optimal locations that has the best foot-traffic, brick-and-mortar stores need technology-savvy ways on how to stage their limited and expensive retail space. Audio City's publicized success gives a good blueprint for bulky high-dollar products where they could easily showcase huge amount of choices without having to sacrifice cost in paying premium for a large physical store. The blueprint also works well with the fashion industry where color choices across products can be shown digitally instead of occupying premium physical space.

Another reason why brick-and-mortar store will see faster adoption is to address relevance. Every brand wants to forge an emotional connection with its customers. And North Face and Toms virtual reality campaign is good blueprint to address that just that.

There is an expectation that development on mobile VR technologies will get more focus in the next two years to keep the VR adoption momentum. This technology is the most likely usage model for e-tailers as they wait for VR hardware barriers in cost and adoption to be crossed.

By 2021, VR hardware is expected to mature enough that the cost problem will be overcome (see **Exhibit 10**) which can lead to better adoption methods employed by e-tailers. With cheaper and better-wearable VR gear, mass adoption within brick-and-mortar store is expected to continue to enhance product and lifestyle experiences or enable access improved product selection; possibly both. This may mean that even big-box stores will partition space for immersive experience on their higher-end product.

By 2025, mass adoption for virtual reality enhanced lifestyle will become norm especially for Millennials and Z-Generation that v-commerce will become a mainstream alternative commerce platform.

Appendix

Exhibit 1 The Amazon business model as drawn by Jeff Bezos on a napkin

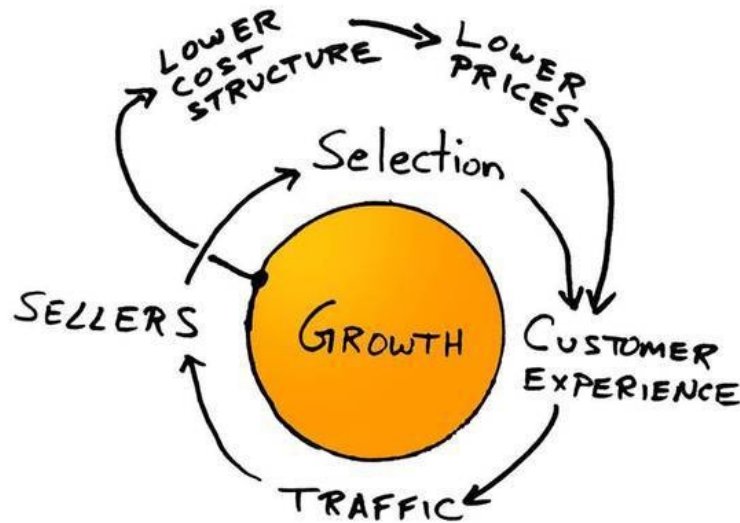


Exhibit 2 Characteristics Comparison of Brick-and-Mortar Retailer and E-Tailer

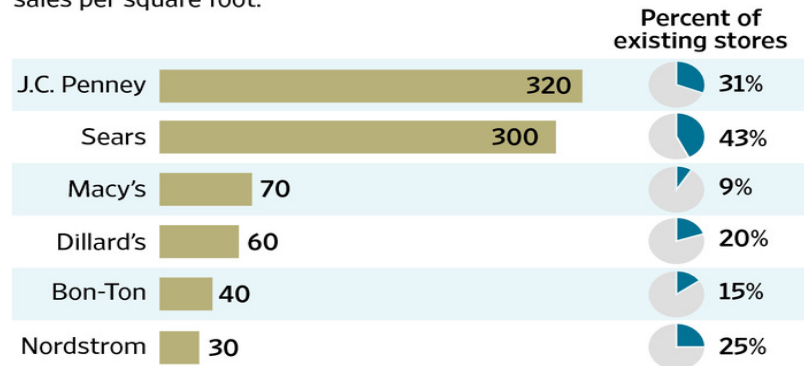
Attribute	Brick-and-Mortar retailer	e-tail
Selection	Limited	Virtually unlimited
Personalization	Very low	Highly personalized
Look 'n feel	Mostly great	Non existent
Convenience	Works well for limited use cases	Choosing, Buying & Returning are easy
Pricing & Promotions	Suboptimal	Global optimality
Returns	~10%	~30%
Cart abandonment	Mild concern	Strong concern

Source: (for Returns Info) <http://www.slideshare.net/SamsungBusinessUSA/1014-samsung-futureofretailfinal010815-46466865>

Exhibit 3 Brick-and-Mortar Store Closure statistics

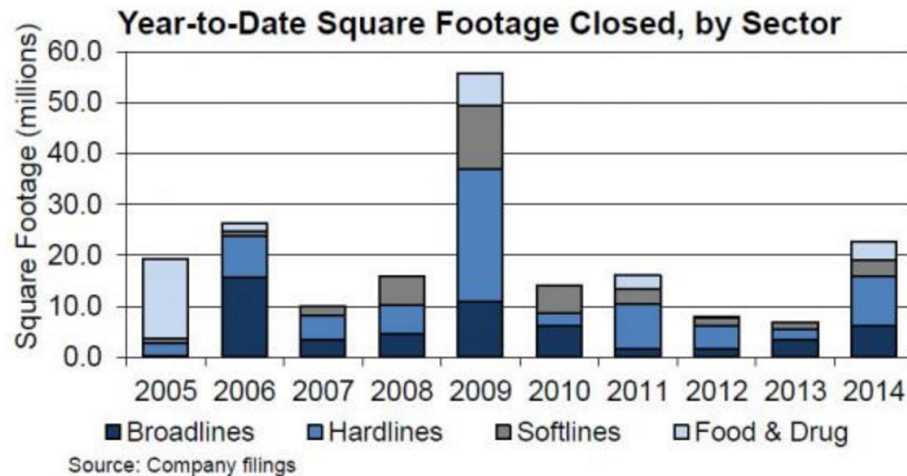
Back to Square One

The number of stores major retailers need to close to achieve 2006 sales per square foot.*



Source: Green Street Advisors *Adjusted for inflation THE WALL STREET JOURNAL.

Source: Green Street Advisors and The Wall Street Journal

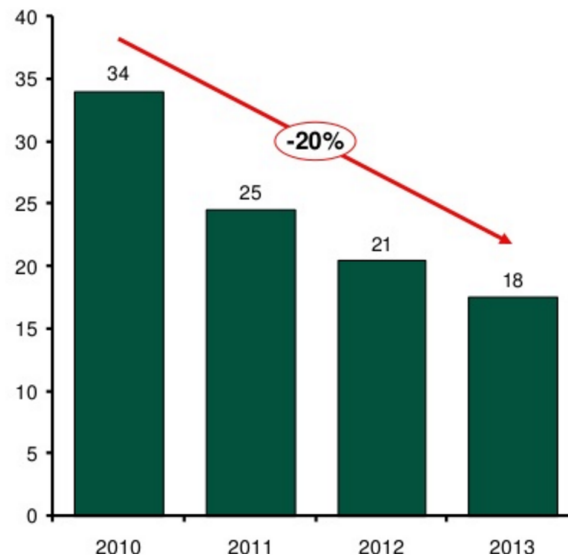


Source: <http://www.zerohedge.com/news/2014-04-21/retail-store-closures-soar-2014-highest-pace-lehman-collapse>

Exhibit 4

Brick-and-Mortar stores foot traffic in the US from 2010 to 2013

Total mall and large retailer foot traffic for November and December 2010-2013 (ShopperTrak)
Billions of Visits*

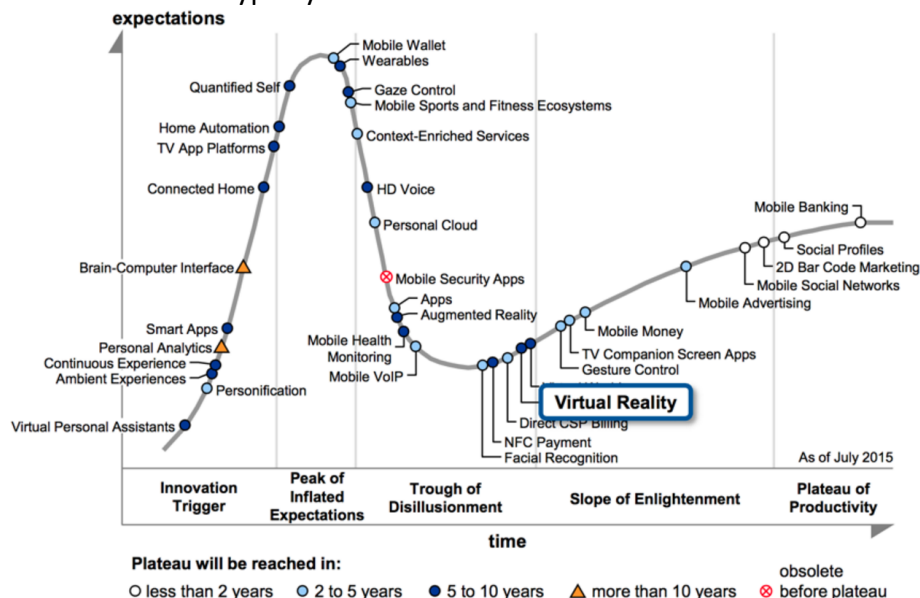


*Note: Traffic data is collected from 60,000 traffic-tracking devices installed at malls and large retailers
Source: Wall Street Journal, ShopperTrak, L.E.K. research and analysis
©2014 L.E.K. Consulting

Source: http://www.slideshare.net/LEK_Consulting/the-new-face-of-retail-retail-and-consumer-trends-reshaping-the-landscape

Exhibit 5

VR on the Hype cycle for Consumer Services



Source:

Gartner, Hype Cycle for Consumer Services and Mobile Applications, 2015," 21 July 2015 (G00274100)

Exhibit 6 Virtual Reality Hardware Ecosystem

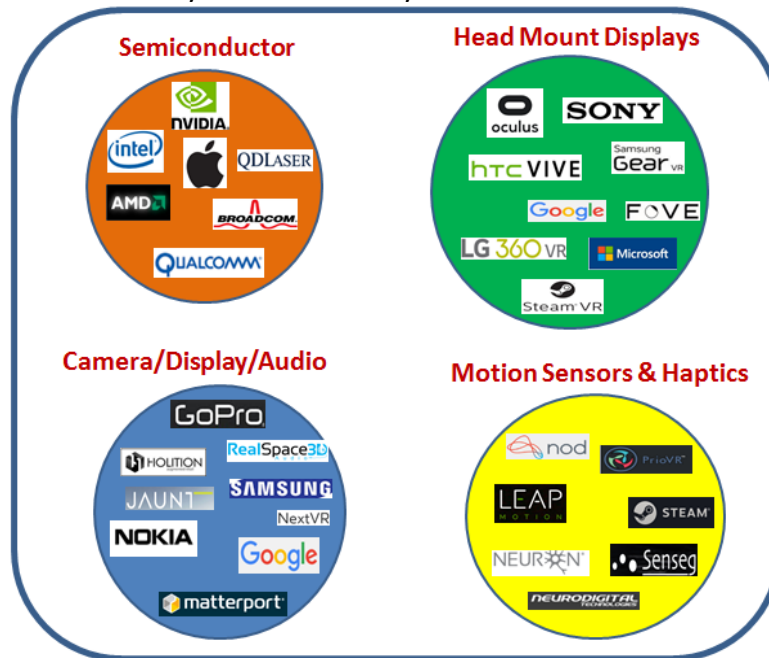


Exhibit 7 Virtual Reality Software Platform and Content Provider Ecosystem

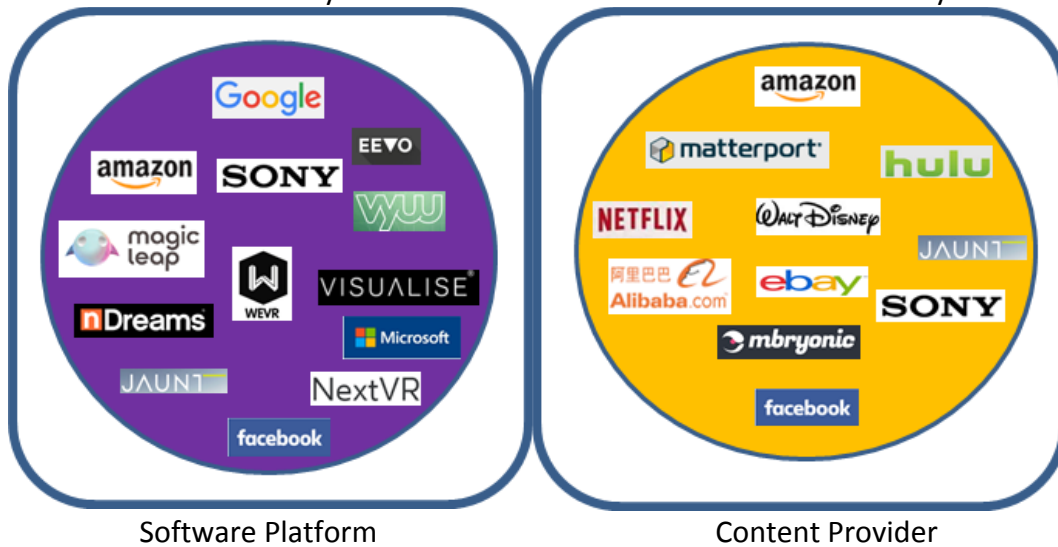
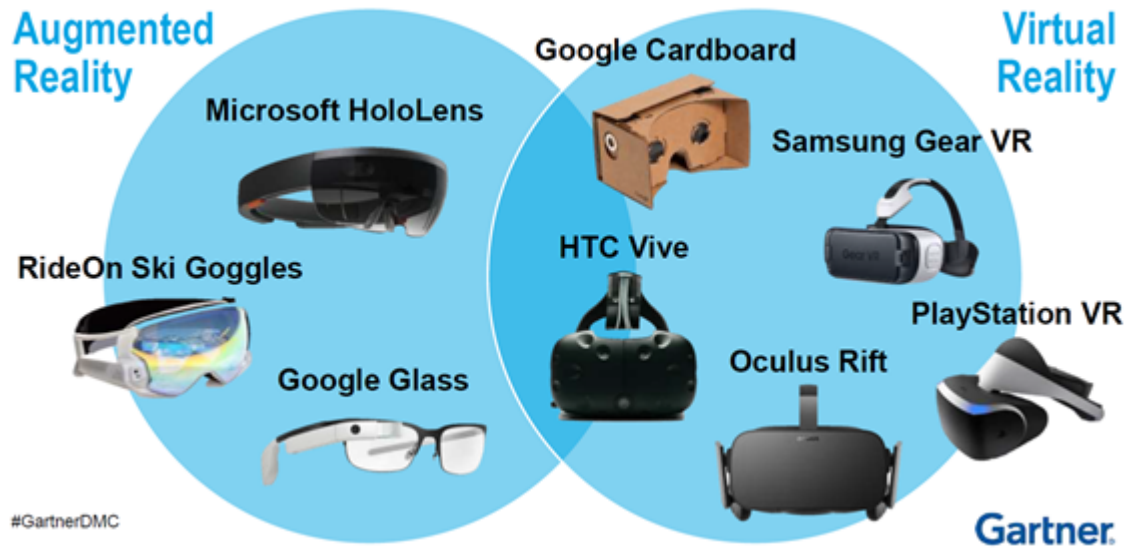


Exhibit 8 VR Headset players



Source:

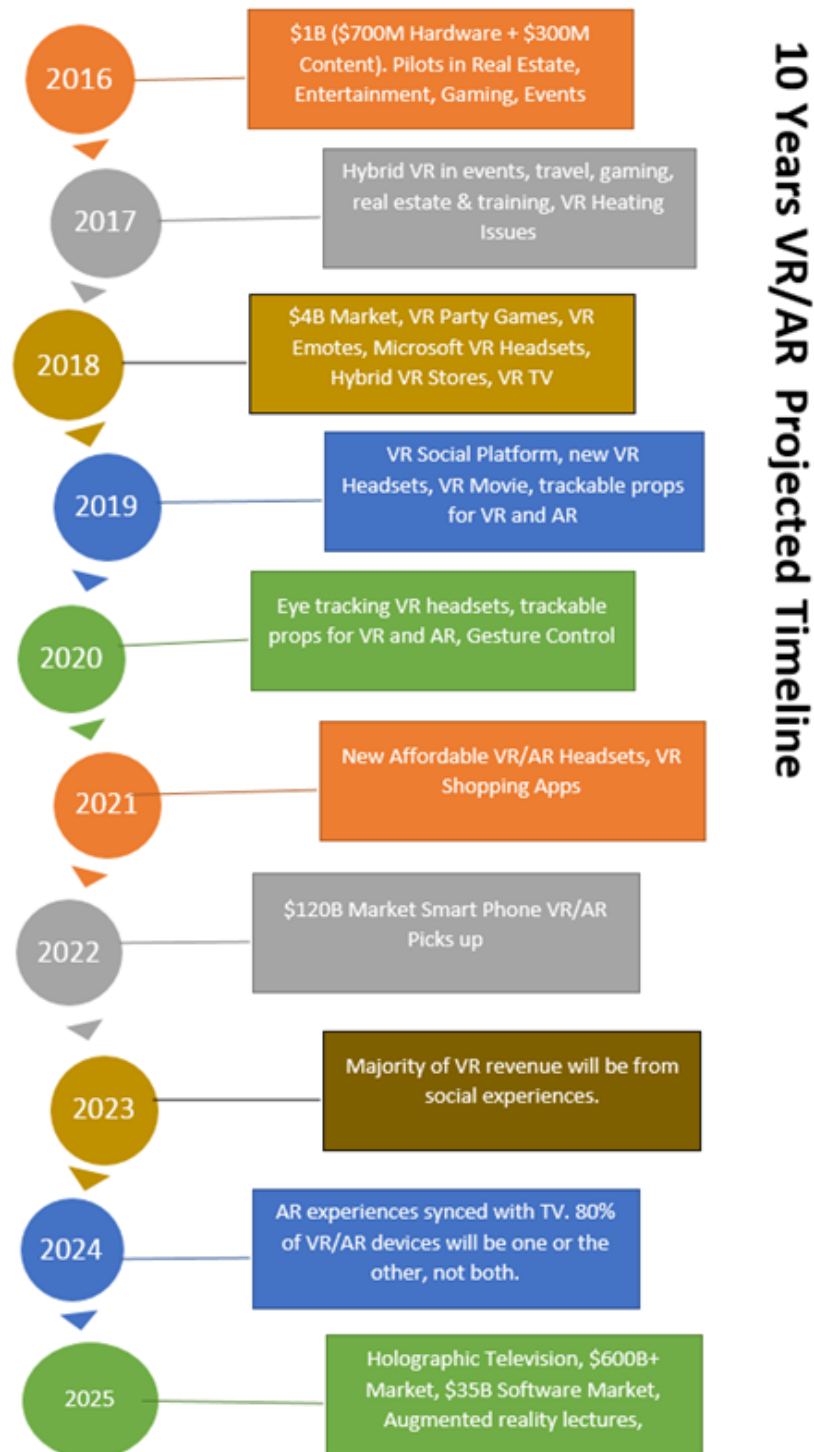
Gartner, Hype Cycle for Consumer Services and Mobile Applications, 2015," 21 July 2015 (G00274100)

Exhibit 9 Survey of VR's Impact on E-commerce



Source: Walker Sands Future of Retail Study, 2016

Exhibit 10 10 Years VR/AR Projected Timeline



Source: Jesse Schell's 40 predictions for VR by 2025

Glossary

Electronic Data Interchange (EDI): a standard format for a business send information to another business electronically versus using paper

Customer Relation Management (CRM): refers to how businesses manage and analyze customer behavior to gain customer loyalty and improve sales

Kaizen: a Japanese business philosophy of continuous improvement of working practices, personal efficiency, etc.¹⁸

Andon cord: is a manufacturing term referring to a system to notify management, maintenance, and other workers of a quality or process problem¹⁹

E-tailers: Internet Retail firms

E-Commerce: Technology platform used by E-tailers

Brick-and-Mortar: Retailers with physical stores only

Sources

http://www.investopedia.com/terms/b/big_box_retailer.asp

https://en.wikipedia.org/wiki/Big-box_store

https://en.wikipedia.org/wiki/Warehouse_club

https://en.wikipedia.org/wiki/Category_killer

<http://www.ccs.neu.edu/home/amislove/publications/Amazon-WWW.pdf>

<https://hbr.org/2016/09/virtual-and-augmented-reality-will-reshape-retail>

<http://www.emarketer.com/Article/Shoppers-Downloading-More-Mobile-Retail-Apps/1014041>

<https://www.thinkwithgoogle.com/articles/omni-channel-shoppers-an-emerging-retail-reality.html>

<http://pages.experts-exchange.com/processing-power-compared/>

<http://fortune.com/2016/04/06/ikea-vr-virtual-kitchen/>

<http://retail-innovation.com/lowes-in-store-augmented-reality-room-designer>

<http://retail-innovation.com/land-rover-showrooms-with-augmented-reality-headsets>

<http://retail-innovation.com/adidas-body-scanner-lets-you-try-clothes-on-virtually>

<http://retail-innovation.com/view-holiday-in-virtual-reality-at-thomas-cook-stores>

<http://www.lowesinnovationlabs.com/tango>

http://www.ikea.com/us/en/about_ikea/newsitem/040516_Virtual-Reality

<http://www.digitaltrends.com/cars/audi-unveils-the-audi-virtual-reality-experience/>

<http://www.emergingexperiences.com/work-audi/>

<http://www.pocket-lint.com/news/132945-best-vr-headsets-to-buy-in-2016-whatever-your-budget>

<https://www.fastcompany.com/3050016/unraveling-the-enigma-of-nintendos-virtual-boy-20-years-later>

<http://www.makeuseof.com/tag/virtual-reality-still-5-big-problems-overcome/>

¹⁸ <https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=kaizen>

¹⁹ [https://en.wikipedia.org/wiki/Andon_\(manufacturing\)](https://en.wikipedia.org/wiki/Andon_(manufacturing))

<http://www.zerohedge.com/news/2014-04-21/retail-store-closures-soar-2014-highest-pace-lehman-collapse>
<http://www.chainstoreage.com/article/increasing-relevance-retail-store-environment>
<http://www.wsj.com/articles/department-stores-need-to-cull-hundreds-of-sites-study-says-1461520952>
<http://www.wealthdaily.com/articles/3-virtual-reality-stocks-to-buy-today/8167>
<http://www.invespcro.com/blog/ecommerce-product-return-rate-statistics/>
<https://www.quora.com/Is-a-3-conversion-rate-reasonable-for-high-end-clothing-sites>
<http://www.slideshare.net/SamsungBusinessUSA/1014-samsung-futureofretailfinal010815-46466865>
<http://www.businessinsider.com/here-is-oculus-vision-for-the-future-of-vr-2016-10>
<http://trends.richards.com/the-rise-of-v-commerce/>
<http://scet.berkeley.edu/vrarticle-today-different-yesterday/>
<http://uploadvr.com/jesse-schells-40-predictions-for-vr-by-2025/>
<http://www.vrs.org.uk/virtual-reality-gear/head-mounted-displays/>
<http://www.vrs.org.uk/virtual-reality-gear/motion-tracking/>
<https://www.engadget.com/2016/01/22/vr-needs-3d-audio/>
<https://www.engadget.com/2016/01/06/sennheiser-3d-audio-will-make-vr-complete/>
<https://developer.nvidia.com/vrworks>
<http://www.theverge.com/2016/8/16/12503948/intel-project-allow-vr-headset-cordless-mixed-reality>
<http://www.intel.com/content/www/us/en/architecture-and-technology/virtual-reality-overview.html>
<http://www.intel.com/buy/us/en/audience/extreme-performance/>
<http://www.mondaq.com/unitedstates/x/412502/Trademark/Virtual+Reality+Creates+Potentially+Real+Legal+Issues>
<http://searchcrm.techtarget.com/definition/CRM>
<https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=kaizen>
[https://en.wikipedia.org/wiki/Andon_\(manufacturing\)](https://en.wikipedia.org/wiki/Andon_(manufacturing))
http://www.slideshare.net/LEK_Consulting/the-new-face-of-retail-retail-and-consumer-trends-reshaping-the-landscape
Hype Cycle for Consumer Services and Mobile Applications, 2015," 21 July 2015 (G00274100)
Worldwide Semiannual Augmented and Virtual Reality Spending Guide