

# The AR story



Credit: US Air Force

## AR is not new

The first example of something we might today call augmented reality is the head-up display, developed at the Royal Aircraft Establishment in the 1950s.<sup>5</sup> Early head-up displays showed altitude and airspeed data along with weapon sights and radar feeds, allowing pilots flying in demanding conditions to view critical information without having to look down at an instrument panel.

Military aircraft have remained at the cutting edge of AR technologies: the helmet-mounted display that allows an F35 pilot to effectively see through the aircraft is the latest example.<sup>6</sup>



Credit: Bram Van Oost

## Smartglasses are the archetypal AR hardware

Imagine an augmented reality device, and you're probably picturing smartglasses. They work by projecting a digital image onto clear, prismatic lenses that allow the user to see the real world at the same time as the projection. Glasses for dynamic augmented reality also include sensors to track the user's head motion.

Google Glass is perhaps the best known example. A static augmented reality system, it allows a user to view notifications, capture photos, and control apps via voice commands. The 2013 launch drew mixed reviews, largely due to privacy concerns.<sup>7</sup> Other, more recent smartglasses offer a dynamic experience – perhaps most prominently Microsoft's HoloLens and HoloLens 2.

5. John Kim, 'The origin of the see-through graphical interface', *Convergence*, 21 (2014), 213-227

6. Tim Moynihan, 'It's a good thing the F-35's \$400K helmet is stupid cool', *Wired*, June 2016

7. Charles Arthur, 'Google Glass: is it a threat to our privacy?', *The Guardian*, March 2013



Credit: Houzz

## But mobile AR is the current big thing

Smartglasses are expensive, creating a significant barrier to entry that deters both consumers and enterprise users from adopting augmented reality. But those same users often already have smartphones or tablets that contain all the sensors and processing power needed to offer a basic augmented reality experience. Crucially for industrial applications, ruggedized versions of these devices are widely available.

Apple and Google have both launched software development kits for their mobile operating systems, called ARKit and ARCore respectively, that provide basic augmented reality functions. These make it significantly easier for third parties to develop augmented reality apps.<sup>8</sup> Games like Pokemon Go, and retail apps like that for furniture-seller Houzz, pictured, have used these frameworks to deliver new experiences for consumers.

8. Ron Amadeo, 'Google's ARCore brings augmented reality to millions of android devices', *Ars Technica*, August 2017

9. Lucas Matney, 'Bose calling it quits on audio AR platform, report says', *Techcrunch.Com*, June 2020



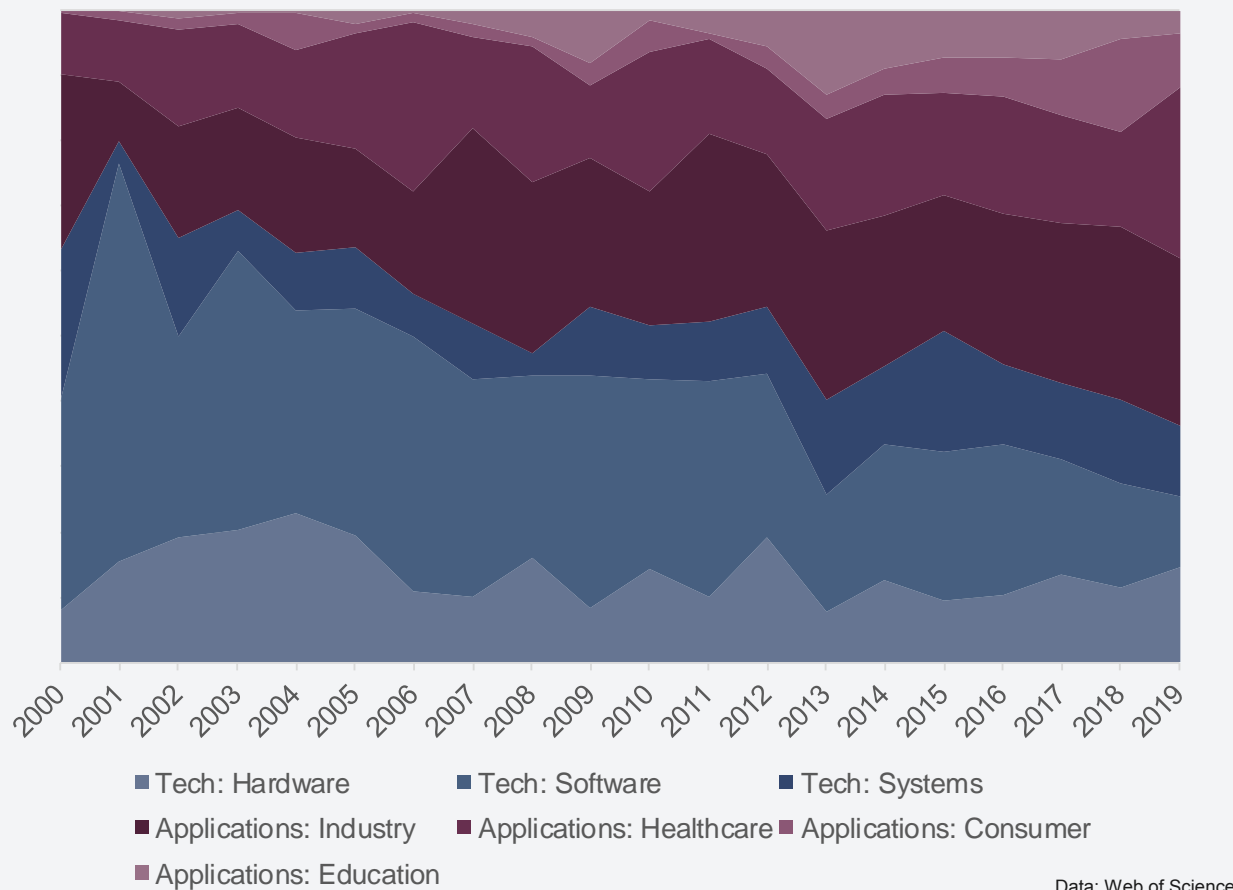
Credit: Bose

## And AR isn't just visual

Augmented reality can be used with other senses as well as sight. Of particular note, a virtual soundscape can be used to produce audio augmented reality. One example of this reality is in-car lane warning or proximity sensing systems, which can use the car's surround-sound system to make the alarm tone come from the relevant direction: if you drift towards the left edge of your lane, the beep will sound on your left.

In 2018, audio company Bose launched an audio augmented reality platform, as well as two lines of audio smartglasses – although it has since cancelled its augmented reality project.<sup>9</sup> Similar to visual smartglasses, audio augmented reality allows a user access to a virtual layer over the world – just one that is made of sounds rather than sights.

# AR today: transitioning



Proportion of AR research papers 2000-2019 by underpinning technology/application

Augmented reality is transitioning from being an 'emerging technology', for which published research largely focuses on the development of the technology itself, to a more mature technology, for which an increasing proportion of research relates to specific applications. The major technical hurdles are solved (although there is further refinement needed), and the greater effort is now on refining those solutions in an applied context, or on tailoring the user experience to best effect.

Although consumer applications of augmented reality, such as games, have attracted attention in the technology press, a much greater proportion of research concentrates on industrial and medical applications of augmented reality. This focus demonstrates its significant potential in these more 'serious' domains.

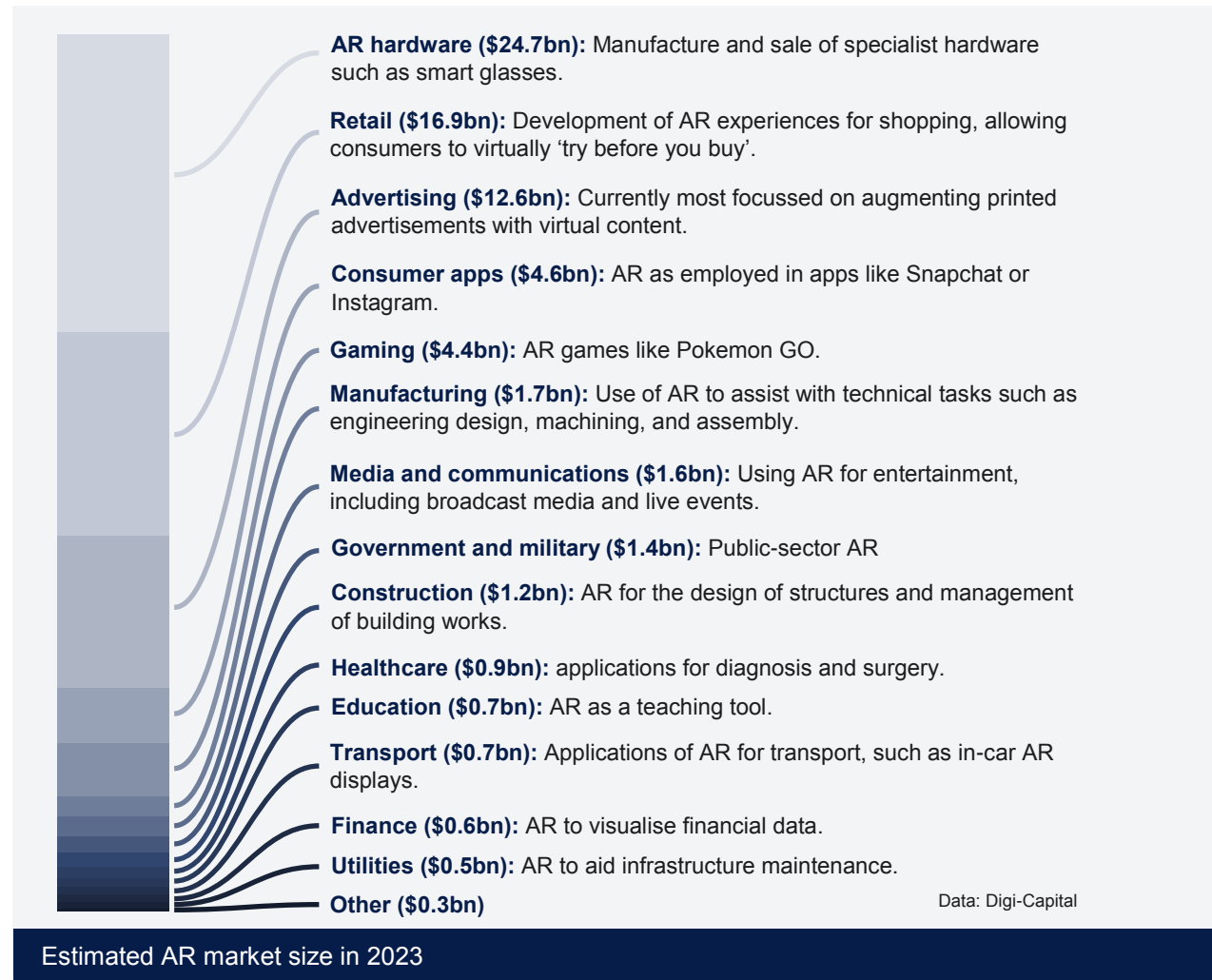
Augmented reality is no longer a lab-based tech curiosity: it's a ready-to-use tool.

# AR markets

As augmented reality has matured, the initial hype surrounding it has subsided, and attention has shifted from the technology itself to its applications. Augmented reality has the potential to bring significant change to how people interact with and experience many kinds of digital content, and it is therefore relevant in many, disparate markets. Among these, analysts predict a significant, if comparatively small, market in dedicated government and military AR. But public sector use-cases can benefit from technology development targeting other markets, too.

Specialist augmented reality hardware is likely to be the largest short-term market. After sales of hardware, retail and advertising segments are likely to account for most revenue. There is unlikely to be much public sector read-across here, but most of the other, more enterprise-focussed segments are likely to have significant relevance. In particular, augmented reality use-cases in manufacturing, communications, healthcare, education, and transport are likely to have direct parallels in a military context. Developments in gaming and other consumer apps may also provide indirect benefit.

The following pages highlight a small number of case studies in these markets. Augmented reality's transitional status means that many of these are prototype or experimental applications, although a small number already show a proven track record in live use.



# AR markets: manufacturing & construction



Credit: Lockheed Martin via MIT Technology Review

## Showing, not telling

Lockheed Martin has employed AR in its space division, using its ability to communicate three-dimensional information more intuitively to speed up design reviews, train technicians, provide instructions for assembling spacecraft, and perform some basic quality checks.<sup>10</sup> The company has experienced a significant reduction in the time spent in training or interpreting complex schematics, contributing to an estimated 40% improvement in productivity.



Credit: Shell

## Tapping into remote expertise

Shell has used another of AR's major use-cases – telepresence – in its operations. It is trialling smart helmets for on-site maintenance technicians across 12 countries.<sup>11</sup> The helmets, which are specially designed and certified for use in dangerous environments, allow for remote over-the-shoulder assistance from a central pool of experts, speeding up repairs and other work.

10. Sara Castellanos, 'Lockheed Martin deploys augmented reality for spacecraft manufacturing', *WSJ*, August 2018

11. Alan Smithson, 'The right displays for challenging tasks: XR On Oil Rigs, With Shell's Michael Kaldenbach', *XR For Business*, July 2019



# AR markets: communications



Credit Spatial

## Collaborating in digital spaces

AR start-up Spatial has attracted US\$22M investment to date, and captured trade press attention at the global electronics show CES in January 2020. Their product aims to help remote teams collaborate more effectively, through providing telepresence for meetings and a virtual shared working space that the company claims offers an experience that is 'better than being in the same room'.<sup>12</sup> Augmented reality remote collaboration systems have been shown to offer a more intuitive and natural experience than existing tele-conferencing facilities.<sup>13</sup>



Credit: Alexandre Haefeli via Wired

## Augmenting communication

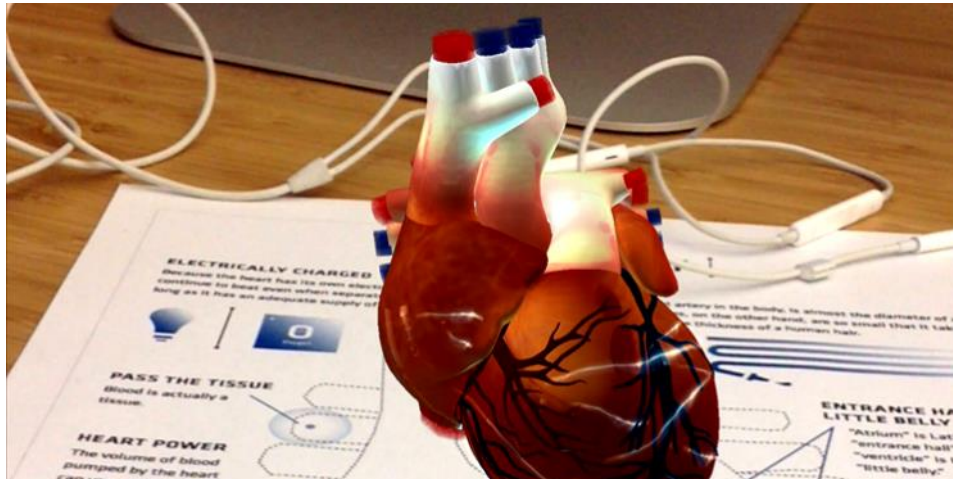
AR filters on Instagram and Snapchat allow users to augment their appearance in photos and videos transmitted through these platforms. They have enjoyed huge popularity, as well as providing an effective marketing channel, with branded filters and AR experiences that are triggered by patterns printed on clothing.<sup>14</sup> Spending on AR advertising on social media is estimated at US\$1.6Bn for 2019.

12. Peter Graham, 'Collaborating in Spatial offers a vision of hands-on teamwork', *VR Focus*, February 2020

13. Mark Miller and others, 'Social interaction in augmented reality', *PLOS ONE*, 14(5) (2019), e0216290

14. Anna Behrmann, 'This AR designer turns instagram and snapchat filters into fine art', *WIRED UK*, October 2019

# AR markets: healthcare



Credit: Anatomy 4D

## Adding a dimension to educational material

There are opportunities for AR in education in many contexts, but medical education is perhaps one of the most significant. Anatomy 4D is a smartphone app that augments printed diagrams with animated three-dimensional models to provide a more intuitive description of anatomical features.<sup>15</sup> At more advanced levels, AR can reduce the need for physical training materials such as animal tissues by allowing students to use real tools to practise procedures on virtual patients.



Credit: Philips

## Seeing hidden detail

Philips and Microsoft are collaborating to bring AR to the operating theatre, drawing on their Azurion image-guided therapy and HoloLens AR products respectively.<sup>16</sup> By integrating needed data into the surgeon's view and providing overlaid imagery that shows, for example, the current position of a surgical tool being used in keyhole surgery, the system will make it easier to perform minimally-invasive surgical procedures. These significantly reduce the amount of post-surgery healing time needed, providing a better experience for the patient as well as reducing the cost of care.

15. Tasneem Khan, Kevin Johnston, and Jacques Ophoff, 'The Impact of an Augmented Reality Application on Learning Motivation of Students', *Advances in Human-Computer Interaction*, vol. 2019 (2019)

16. Philips, 'Philips showcases unique augmented reality concept for image-guided minimally invasive therapies developed with Microsoft', February 2019

# AR markets: transport



Credit: Wayray

## Wayfinding and driver training

WayRay is developing in-car AR. The primary consumer use case is navigation, something already easily accomplished using a screen or voice prompts: AR's unique advantage is that it does not require the driver to divert their attention away from the road in front, making it a safer way of providing the same capability. This quality also opens up new possibilities that would require more continuous attention. For instance, WayRay are collaborating with Porsche for racing driver training, displaying the ideal racing line on the track ahead of the car using a display that integrates with the windscreen.<sup>17</sup>



Credit: DHL

## Visualising metadata

DHL is investing in AR in several areas of its operations. It sees particular promise in applications for freight-handling roles. For loading aircraft, AR can be used to automatically recognise containers and provide staff with details on weight and loading order, cutting out the need to constantly refer to manifests. For 'last mile' delivery, AR can help drivers load and locate packages, again significantly reducing the time needed. And for warehouse operations AR can speed up locating and packing items – DHL's trial of AR for its warehouses showed a 15% efficiency gain.<sup>18</sup>

17. Tom Harrison, 'Porsche has invested in race instructor head-up displays', *Top Gear*, September 2018

18. Deutsche Post DHL, 'DHL Supply Chain makes smart glasses new standard in logistics', February 2017