Digital Transformation Monitor

Augmented and Virtual Reality

October 2017
Augmented and Virtual Reality

Rapid technological progress in the areas of hardware miniaturization and processing power is enabling the development of compelling devices that allow users to experience new “kinds” of realities. The potential applications of these new interfaces are huge, and major players including Google, Apple and Facebook are investing vast resources in pursuit of the ultimate future reality platform. However, doubts remain about the widespread adoption of such devices in light of ongoing technical and integratory challenges.

Defining new kinds of realities

Concepts of modified reality have long existed, notably in the realm of futuristic sci-fi culture and academic imaginings of a future society. However, in reality these technologies are only just beginning to come to fruition.

Virtual Reality (VR)
VR involves the use of a computer to visually simulate an artificial environment within which a user can interact with objects and be fully immersed. VR has various implementation interfaces, though a VR headset is the current solution providing the most immersive experience for users. If the VR content requires users to perform an action, they generally interact with the interface by using a controller. VR’s primary function is the ‘replacement’ of a real environment with a virtual one, created by blocking a user’s sight/awareness and replacing it with a fully simulated version. This greatly enhances the level of immersion vis-à-vis a regular display such as a television, regardless of whether or not the content is intended to be interactive.

VR is therefore particularly suited to video games because immersion is paramount and highly sought after.

Augmented Reality (AR)
AR refers to the real-time digital overlay of information over physical elements. A user’s real, visible environment is the predominant element, with extra information intended to augment the actual environment a user sees on an ad hoc basis, rather than fully replacing it. As a result, the capacity for immersion with AR is lower than that offered by virtual and mixed realities. Nonetheless, it is likely more useful than VR in many professional contexts as being totally isolated from one’s environment is generally not the desired outcome for professional informatics tools and interfaces.

Mixed Reality - advanced AR
Some companies, like Microsoft, use the term “Mixed Reality” to define the merging of the real and virtual worlds, meaning that virtual objects are ‘anchored’ to the real environment as opposed to being ‘simply’ overlaid. As a result the level of immersion experienced by the user is greater than traditional AR but still less than VR.

The boundaries between MR and AR technologies are still murky⁶, even within the industry itself. Consequently, AR is a much more widely-used term, and generally encompasses both AR and MR.

Figures 1: Characteristics of VR, MR, AR

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Virtual Reality</th>
<th>Mixed Reality</th>
<th>Augmented Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augments the real environment with useful information</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Combines virtual elements with the real environment</td>
<td>×</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Transports the user to a virtual environment</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Completely replaces the real world</td>
<td>✓</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

Source: IDATE DigiWorld - Illustrations from Wired
An immature market with high potential

The market for VR and AR is highly fragmented, with a multitude of players developing products from start-ups to legacy internet giants.

Headsets for VR

As VR is fully immersive (the user’s ‘seen’ environment is fully replaced), a headset is generally required:

Smartphone headset

These headsets have a slot for a user’s smartphone, which is placed inside and worn across the face, acting as both the screen and the content source.

Many companies offer such devices, from low-end (less than €10 for a Google Cardboard) to higher-end headsets (€50 for a Samsung Gear VR). These kinds of relatively affordable headset are currently far more widespread than premium, dedicated VR offerings.

Premium headset

These usually include an actual screen and are connected to a computer that acts as the content source and pushes it to the headset.

Premium headset are designed solely for VR, and as a result provide a far better VR experience than a smartphone headset, albeit with a higher price tag (especially if the user does not already own a compatible computer).

Newer smartphones are offering a better AR experience, thanks to improved processing power and cameras. This is certainly the case for Apple’s newer iPhones, which support ARKit – an SDK developed by Apple (a big proponent of AR) which lets developers create AR apps and content more easily.

Headphones for AR

As AR is primarily about augmenting the user’s real world, a headset is generally not required.

Devices for AR

Currently, the vast majority of users experience AR using a smartphone or a tablet. Indeed, a modern phone’s camera and screen are enough to superimpose virtual objects over the environment in real time. Pokemon Go is arguably the most well-known and widespread application utilising AR on a smartphone.

Such significant potential has seen many companies trying (or having tried and somewhat failed) to develop wearable AR hardware in the form of low-weight, connected glasses (or even lenses).

“I regard [AR] as a big idea, like the smartphone. The smartphone is for everyone, we don’t have to think the iPhone is about a certain demographic, or country or vertical market: it’s for everyone. I think AR is that big, it’s huge. [AR] could improve a lot of lives. And be entertaining.”

Tim Cook – Apple CEO – April 2017
Applications

There are a huge range of possibilities for the deployment of AR/VR technology, with both consumer and enterprise applications being developed across all industries (see figure 4). The B2B applications in particular vary widely, from simulations and training, to task assistance and remote maintenance support.

VR’s high degree of user immersion makes it particularly suitable for creating training simulations, especially in sectors where training is traditionally costly or dangerous such as aviation, disaster mitigation and in the military. Optis, a French virtual prototyping company, is deploying VR solutions for industrial manufacturers, allowing engineers to visualise their ideas using a scale 1 3D mock-up.

The primary strength of AR lies in its ability to display information directly ‘onto’ parts or sections of a user’s view that require operator action. AR also allows the use of ‘hands-free’ displays that do not impede operator movements.

Existing AR applications include:

• Bechtle, a German B2B IT service provider, which relies on Vuzix and Epson AR glasses instead of handheld scanners.

• Google and AGCo, a manufacturer of complex agricultural machines, who partnered to test AR glasses and found a 25% reduction in production time on low volume, complex assemblies.

Currently, in a B2B context, AR devices are more commonly used on a regular or daily basis than VR devices, as VR devices tend to become physically challenging with prolonged use.

Despite positive developments, both VR and AR remain niche products, with a limited number of trials underway worldwide – widespread uptake is not expected until several key challenges are addressed.

<table>
<thead>
<tr>
<th>Field</th>
<th>VR</th>
<th>AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video games</td>
<td>Complete user immersion: both visual and auditory</td>
<td>Partial user immersion, but new possibilities offered through use of the real environment</td>
</tr>
<tr>
<td>Movies / TV</td>
<td>Viewing 360° content (e.g. pickups/VR cinema)</td>
<td>Viewing content in a window as part of the real environment</td>
</tr>
<tr>
<td>Sports</td>
<td>360° immersion in a sports competition immersive training for athletes</td>
<td>Access to additional information in real time: scores, statistics, etc.</td>
</tr>
<tr>
<td>Tourism</td>
<td>Virtual tours of monuments, museums, hotel rooms, etc</td>
<td>Access to additional information and interactive virtual objects during a real tour</td>
</tr>
<tr>
<td>Shopping / e-commerce</td>
<td>Virtual browsing and purchasing in a shop</td>
<td>Identification of products in the real environment with the ability to purchase online</td>
</tr>
<tr>
<td>Education</td>
<td>Distance learning, including abroad</td>
<td>On-site training enhanced with additional information</td>
</tr>
<tr>
<td>Other</td>
<td>Therapeutic applications, including treatment of phobias and addiction</td>
<td>Therapeutic applications, including treatment of phobias and addiction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field</th>
<th>VR</th>
<th>AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical</td>
<td>Simulations with no risk for patients</td>
<td>Easy, real-time access to health data and interactive virtual objects during a medical operation</td>
</tr>
<tr>
<td>Attendance</td>
<td>Remote participation in meetings without the need to travel</td>
<td>See and interact with a person not physically present within the real environment</td>
</tr>
<tr>
<td>3D product</td>
<td>Immersive simulations</td>
<td>Simulations, better view of and better interaction with 3D models compared to a computer screen</td>
</tr>
<tr>
<td>Training</td>
<td>Immersive distance learning</td>
<td>Distance learning and/or enhanced by virtual elements</td>
</tr>
<tr>
<td>Military</td>
<td>Simulations</td>
<td>Simulations, easy, real-time access to information during an operation</td>
</tr>
</tbody>
</table>

Figure 5: Potential of VR/AR software for different use cases in 2025

Source: IDATE DigiWorld

Source: Statista based on Goldman Sachs Global Investment Research

© Agco
Both AR and VR adoption and usage remain very low overall due to several key challenges.

Technical challenges

VR and AR have existed in various forms for many years, but the technology has not been mature enough to be viable in mass market application. Recent technological advances – particularly in the miniaturization of hardware – have driven significant increases in the capabilities of smartphones, with manufacturing and distribution economies of scale allowing today’s devices to offer compelling experiences to much larger numbers of consumers. That said, problems such as ‘VR sickness’ – where some VR users experience symptoms similar to motion sickness – persist, preventing VR from developing beyond the mostly solitary, physically challenging experience it currently is (particularly after extended use). This and other similar issues cast doubt on just how widely-applicable VR interfaces will become in the longer term, especially in professional contexts.

AR on the other hand, with its much-reduced hardware requirements and intuitive usability (user can still see the world around him/her), remains a more practical tool in a professional context from a technical standpoint. Even so, no manufacturer has managed to create a truly compelling, lightweight, connected AR solution thus far.

Premium VR headsets need to be connected to a computer with many cables (e.g. 4 USB ports recommended for the Oculus Rift), which often get in the way during use, impairing the user-friendliness of the technology a lot. Whilst wireless VR headsets are in development, there remains significant progress to be made before the qualms of this medium are rectified.

This level of bespoke customization is generally slow and expensive and has few proven business cases, preventing most smaller companies from making such investments at this point in time.

There is less of a need for VR to be integrated with a company’s environment (as VR does not rely on it). Nonetheless it also requires, in most cases, very focused, specific development in order to be seamlessly integrated with existing software and systems.

References

3 Average calculated on Oculus-ready computers offered on the Oculus website https://www.oculus.com/oculus-ready-pcs/#pc-offers
5 Google, Complex assembly, done faster. https://www.x.company/glass/
About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.


This report was prepared for the European Commission, Directorate-General Internal Market, Industry, Entrepreneurship and SMEs; Directorate F. Innovation and Advanced Manufacturing; Unit F/3 KETs, Digital Manufacturing and Interoperability by the consortium composed of PwC, CARSA, IDATE and ESN, under the contract Digital Entrepreneurship Monitor (EASME/COSME/2014/004)

Authors: Laurent Probst, Bertrand Pedersen & Lauriane Dalkak-Arnoux PwC

DISCLAIMER – The information and views set out in this publication are those of the author(s) and should not be considered as the official opinions or statements of the European Commission. The Commission does not guarantee the accuracy of the data included in this publication. Neither the Commission nor any person acting on the Commission’s behalf may be held responsible for the use which might be made of the information contained in this publication. © 2017 – European Union. All rights reserved.