Disruptive Technologies

Augmented Reality Teacher Briefing

Authors
David Barlex
Nick Givens
Torben Steeg
These briefing notes are organised as follows. Sections 1 and 2 discuss the disruptive technology in broad terms. Section 3 considers a few particular examples in some detail. Section 4 discusses how the technology might be disruptive using the McKinsey criteria for disruption (McKinsey 2013). Section 5 considers trends in uptake and impact. Section 6 discusses contentious issues that might arise in relation to the deployment of the disruptive technology. Section 7 discusses briefly the interaction of the technology under consideration with other disruptive technologies. Section 8 lists useful web references that will allow the reader to keep up to date. These briefing notes should be read in conjunction with the Teachers’ Guides especially the section on Teaching Augmented Reality in Part 2.

**What is augmented reality?**

In short, Augmented Reality (AR) is a live, direct or indirect view of a physical real-world environment whose elements are augmented (or overlaid) by computer generated sensory input such as sound, video, graphics or GPS data. A longer definition is that AR is a real-time direct or indirect view of a physical real-world environment that is enhanced or augmented by adding virtual computer-generated information to it. Accordingly, an AR system: (i) combines real and virtual objects in a real environment, (ii) aligns real and virtual objects with each other so that as the view to a real object changes, the augmented object connected to it changes accordingly, and (iii) runs interactively, in three dimensions, and in real time. AR technologies enhance human perception and help seeing, hearing, and feeling the surrounding environment in new and enriched ways. This is achieved by making people sense virtual objects, which appear to coexist in the real world. AR can also be used to hide visual elements of the real world to allow people to focus on specific aspects (Diminished Reality).

AR is distinguished from Virtual Reality (VR) systems in which the user is immersed in a computer-generated environment that completely replaces sensory input from the real world.

A third approach, Mixed Reality (MR), has recently been gaining attention; here VR elements are not only overlaid on a view of the real world but incorporated into it so that, for example, the VR elements appear to ‘know’ where doors walls, windows etc. are in the real world. See Kelly (2016).

**2. Where might we find augmented reality?**

A recent manifestation of this technology is “Google Glass” – a wearable computer in the form of spectacles which displays information and can interact with the internet by natural language commands (Future Apps 2013). Google Glass has now been withdrawn from sale to the public, but continues to be supported as a workplace tool, a very recent example of its use is in the Irvine School of Medicine (2014) in the training of doctors and surgeons.

Despite the withdrawal of Google Glass from the public, AR is currently making its way to the market place, most prominently in the form of Microsoft’s HoloLens (Microsoft, 2016) – currently only available as a ‘Development Edition’ – and the Magic Leap (Kelly, 2016) which is not yet available but is generating high expectations.
However, it is possible to experience a form of AR today as smart devices, and especially products such as smart phones, tablets, and wearable devices, are rapidly bringing this new and exciting kind of human-computer interaction into everyday life. There is a range of smartphone and tablet apps such as Aurasma (2016), Layar (2016), Skignz (2016) and Blippar (2016) that all, in various ways, use a device’s camera to provide a view of the world and then overlay information onto that view. They all also provide accessible tools to enable users to create their own AR experiences within the application.

As a result of these first generation AR applications, AR is spreading in domains such as advertising, entertainment, education, games, health, culture, tourism and design. In work applications AR is applied in maintenance, training, and in supporting a range of work tasks with contextual guidance.

AR faces two development barriers before it becomes accepted as part of everyday life. The first is the technical limitations of existing technologies, which include issues such as cost, weight and power usage. The second is a range of human computer interaction (HCI) issues regarding intuitive and natural interaction, ergonomics and human factors, appearance and compatibility with social practices. In relation to the latter, Google Glass wearers were, in some circles, known as ‘Glassholes’, which brings to mind the scorn that some early adopters of mobile phones had to endure.

3. Exemplification

*AR in education and training*

New Scientist (Rutkin 2016) reports on a project to use AR in training new workers on an assembly line by projecting the hands of experts in front of their own:

A video of hands doing a particular task is displayed by an overhead projector, with explanatory text and outlines of important objects or schematics shown alongside. Virtual buttons projected on the work surface let the user pause and rewind the video if they want to go back over something they missed.

The trial indicated that those using the AR system completed the tasks required twice as fast as those following the instructions on standard video.

*AR in reading*

The book *iDinosaur* (Carlton Books 2013) is a good example of the use of AR to enhance a reading experience. The book consists of 14 double page spreads and on four of these spreads there is an augmented reality panel. When the double page spread is viewed through a smart phone or tablet using the iDinosaur App (free to download) the viewer can activate a video clip of the dinosaur featured on that double page spread. There is a tool bar which allows the viewer to control the actions of the dinosaur – move around, roar etc. Moving the book allows the animation to be viewed from all sides. Watching this AR certainly adds to the experience of reading the book; as one colleague said to authors, “OMG it’s just roared at me!” Sharing the AR experience stimulates conversations between viewers in a way difficult to achieve with just reading the same book and then talking about it.
**AR in museums and art galleries**

AR has a long history in museums and art galleries. In its most primitive form it consists of simple audio players which the visitor switches on when reaching a particular place as instructed by displayed information and then off on leaving making progress to the next set of displayed information. This has been in operation in many museums and art galleries since the 1980s. Now a museum of art gallery is likely to provide visitors with a dedicated smart phone or tablet to use as they move through the exhibition. Shelley Mannion (2012), Digital Learning Programmes Manager at The British Museum identified four different categories of AR Interaction in museums:

1) **Outdoor guides and explorers**
   - These rely on GPS positioning and cannot be used indoors

2) **Interpretive mediation**
   - An important distinction between this style of AR and location-based applications is that virtual content is triggered by the markers rather than the user’s location. Marker-based AR is ideally suited to museums where user’s location cannot be determined either by GPS, Wi-Fi triangulation or other means.

3) **New media art and sculpture**

4) **Virtual exhibitions**
   - Innovation in these last two categories has come from artists, who push the boundaries of AR with guerrilla interventions in museum galleries that challenge the curatorial hegemony in galleries. By installing their own artworks virtually and telling the public where to find them, succeeded in exhibiting their work in some of the most famous venues in the world without an invitation.

Shelly notes that AR is one of the few technologies that uses all of the functions available on a mobile device. As a result, the potential interactions it offers are incredibly varied. The categories above have given way to a set of questions focused on both technical issues (Is the application location-based or marker-based? Does it deliver 2D or 3D content?) and user experience paradigms (Does it involve physical interaction? How is content delivered?).

**AR in Retail**

Modiface allows consumers to virtually try on makeup:

> Fire up the camera on your phone or a store makeup counter’s tablet, choose different styles of lipstick, eye shadow or whatever else, and ModiFace applies them to your skin in real-time on your screen. Move around, wink and smile, and you’ll see your new style without the work or cost.

(TechCrunch, 2016)

It’s not difficult to imagine similar applications for hairstyles or clothing.

**AR in personal protection**

Proposals for AR that enhances personal protection include a heads-up display for cyclists that can both provide directions and also project on the road ahead the blind spots of large vehicles such as buses (Dezeen, 2015a) and an AR system for car drivers that effectively makes the opaque parts of the car transparent thus enhancing visibility (Dezeen, 2015b)
**AR in maintenance and construction**

Dezeen (2016) reports on an AR hard-hat for construction workers that can provide a range of location-aware data such as the temperature of fluid in pipes as well as health and safety or maintenance instructions.

4. In what ways is augmented reality being or likely to be disruptive?

- **How might this technology disrupt the status quo?**
  When people wear AR devices for much of their waking lives, their experiences of the world will be quite different from those who reject or do not have access to this technology. And this experience will be manipulated by those who control the sensory input into the AR devices. Who might control the input; commercial concerns like Google, Amazon or Facebook, or perhaps governments? A dystopic view of this situation is described by David Brin (2013) in his Insistence of Vision short story. All people wear the glasses and the state controls what you can see such that convicted criminals are ostracized because their glasses ‘augment’ their perceived reality by making other citizens appear ‘blurred’, unrecognisable and unavailable for interaction. When only some have access to AR and when the augmentation provided varies according to status or AR provision, it is almost certain that disruption of the status quo will follow with different groups having more or less power depending on the extent of their access to AR and what they use this access for and how much control they have over it.

- **How might this technology alter the way people live and work?**
  It is easy to imagine workplaces such as factories, distribution centres and offices where information provided by AR devices is used by workers in carrying out their day-to-day work. For example, the science fiction novel Rule 39 (Stross 2011) describes AR glasses worn by police that have access to face recognition software and can provide criminal record information on those the police meet with during investigations. The potential of AR to support leisure activities is also easy to envisage. Spectator sports could easily be augmented, for example with player statistics, as could theatre and TV. At social gatherings people could choose to display AR information about themselves visible only to those wearing the appropriate reader. It is easy to envisage AR enhancing tourism through the display of relevant background information at historic sites or through automatic translation of signage. It seems likely that AR will creep into educational practice to enhance learning.

- **How might this technology rearrange value pools?**
  Those who provide AR services will do it as a commercial venture. Much of the money they make will come from advertising. Imagine if you are looking at items in a shop window that have been tagged to be recognised by your glasses. It would be easy for the glasses to overlay access to new products and services related to the item you are looking at, put you in touch with people you know who have bought such products and services etc. And of course the way in which people respond to their AR experience will generate massive amounts of data.
about them as potential consumers. Many companies will pay for such information as it provides significant market intelligence.

• Will this technology lead to new products and services?
The provision of AR through wearable technology is itself a new product/service but clearly there is considerable potential for providers of AR to develop a wide range of new services for those who adopt their initial services. Exactly what these services might be is a matter of speculation but an intriguing possibility is somehow capitalising on users’ responses to AR and adding a new layer of services concerned with sharing responses.

5. Trends in uptake and impact
McKinsey and Company (Baur & Wee 2015) has coined the term Industry 4.0 and noted four disruptions in the digitization of the manufacturing. One of the disruptions is new forms of human-machine interaction such as touch interfaces and augmented-reality systems. They argue that these disruptions will be far reaching, affecting every corner of the factory and the supply chain. But that the pace of change, will be relatively slow. The coming of steam power and, later, the rise of robotics both resulted in the outright replacement of 80 to 90 percent of industrial equipment. In coming years this kind of capital investment is unlikely but note that the executives surveyed estimated that 40 to 50 percent of today’s machines will need upgrading or replacement.

Goldman Sachs (2016) has produced a report that argues the Virtual Reality (VR) which immerses the user in a virtual world and AR which overlays digital information onto the physical world have the potential to become the next big computing platform and expect new markets to be created and existing markets to be disrupted. The report produces an estimate of the growth in VR/AR services across the following sectors:
• Video games
• Live events
• Video entertainment
• Real Estate
• Retail
• Education
• Healthcare
• Engineering
• Military
In total the report predicts 95 million users globally, and $13.1 billion in software revenue for 2020 and 315 million users creating $35.0 billion in software revenue for 2025.

The research indicates that AR technology still needs to mature, especially in display technology and the real time processing and calibration of real-world physical environment. But as AR matures it will attract significant investment because AR enables the user to see his/her physical environment whereas VR blocks this completely.
6. Contentious augmented reality
In the science fiction novel Nightwalk (Shaw 1979) the main character develops a pair of spectacles that can pick up the signals in the optic nerves of nearby animals and feed them directly into his brain so that although he is blind he can ‘see through the eyes of other creatures’ nearby. Whilst making love to his partner he realises that she is wearing his spectacle and has them tuned to receive the sights of the alley cats which are mating outside! A hi-tech take on the old sin of a person imagining they are having sex with someone other than their partner whilst having sex with their partner. Augmenting sexual experiences by providing a range of erotica/pornography will almost certainly become a service offered by those selling augmented reality.

In another short story, Water, Naam (2015) describes a near-future where AR devices are pretty much a requirement for everyday living; those who can afford it pay for ad-free AR devices while others get free AR devices that are funded through intrusive advertising. An alternative to Naam’s story is that only those who are wealthy and powerful can afford AR devices and that they use these to maintain and entrench their positions.

7. Interaction with other disruptive technologies
AR is likely to interact particularly strongly with both Big Data and Artificial Intelligence (AI). AR devices can be a source of data, including knowing where you are, what you are looking at, who you re interacting with and so on. Perhaps more significantly, it seems likely that the vast majority of (non-work) augmented experiences a user of AR enjoys will be driven by AIs making decisions based on huge data sets about her music and film tastes, her social graph, political views, shopping habits, health and fitness data and so forth allied to more immediate data such as location, time of day and weather conditions.

In a less fundamental way, AR is already used to interact with robotics in the case of robot drones being remotely controlled, whether these be hobby aircraft, military drones (in the air, in water or on land) or search and rescue drones.

8. Useful websites


http://www.strategyr.com/MarketResearch/Mobile_Augmented_RealityMAR_Market_Trends.asp
References


Available at this url:


Dezeen (2015a) Prototype designs use augmented reality to make urban cycling safer, http://www.dezeen.com/2015/06/02/future-cities-catapult-prototype-designs-augmented-reality-urban-cycling-safer/

Dezeen (2015b) MINI's augmented-reality glasses allow drivers to see through the body of their car, http://www.dezeen.com/2015/04/24/mini-augmented-reality-glasses-allow-drivers-to-see-through-the-body-of-their-car/


Goldman Sachs (2016) Profiles in Innovation Virtual and Augmented Reality Understanding the race for the next computing platform


Skignz (2016) [http://www.skignz.com](http://www.skignz.com)


The authors

David Barlex directed the Nuffield Design & Technology Project. He is an acknowledged leader in design & technology education, curriculum design and curriculum materials development. He taught science and technology in schools for 15 years before becoming a teacher educator.

Nick Givens is a teacher educator specializing in secondary design & technology. He was an author and a CPD provider for the Nuffield D&T Project. He also worked in schools for 15 years, teaching design & technology and science.

Torben Steeg is an educational consultant with a background in secondary school teaching of design & technology, science and computing in teacher education, in CPD and in curriculum development. He is particularly interested in new technologies and the maker movement.

Fair use of this material

These materials have been provided by David Barlex, Nick Givens and Torben Steeg. They are released under a ‘Creative Commons Attribution-Noncommercial-Share Alike 4.0’ Licence.
This licence lets you remix, tweak, and build upon this work non-commercially, as long as you credit the original authors and licence your new creations under the identical terms.
All new work based on this material must carry the same licence, so any derivatives will also be non-commercial in nature.
For further information see: https://creativecommons.org/licenses/by-nc-sa/4.0/

For more information on the Disruptive Technologies project, see https://dandtfordandt.wordpress.com/projects/disruptive-technologies/