Augmented Tourism: Definitions and Design Principles

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ABSTRACT: *After designing and implementing several iterations of augmented reality(AR) in tourism, this paper takes a deep look into design principles and implementation strategies of using AR at destination tourism settings. The study looks to define augmented tourism from past implementations as well as several cases uses designed and implemented for tourism. The discussion leads to formation of frameworks and best practices for AR as well as virtual reality(VR) to be used in tourism settings. Some main affordances include guest autonomy, customized experiences, visitor data collection and increased electronic word-of-mouth generation for promotion purposes. Some challenges found include the need for high levels of technology infrastructure, low adoption rates or 'buy-in' rates, high levels of calibration and customization, and the need for maintenance and support services. Some suggestions are given as to how to leverage the affordances and meet the challenges to implementing AR for tourism.*

KEYWORDS: *Augmented Tourism, Augmented Reality, eTourism, Virtual Tourism, Tourism Design*

I.   SETTING THE STAGE

Augmented reality (AR) is not a new technology but thanks to advancements in mobile computing and mainly to the proliferation of smartphones, the technology is becoming much more widely used and the experiences created are becoming much more rich (Buhalis, 2006; Hassan & Jung, 2016; Hsu, 2011). AR is just one of many emerging technologies that are disrupting many industries including tourism and especially in tourism marketing (Hassan & Jung, 2016; Hsu, 2011). Other emerging technologies are being combined with AR to enhance the merits and utility for tourism and related industries. Those technologies include virtual reality, the internet of things, and artificial intelligence. The advancement of these technologies are not only connected to AR but are important bringing out the affordances of AR for tourism (Eric Hawkinson, 2014). Although there is much work being done to pull out design principles for using augmented reality in broad terms (Ganapathy, 2012; G. A. Lee, Kim, & Billing Hurst, 2007), there are frontiers to be found in design principles for some more specific fields such as medicine (Zhu, Lilienthal, Shluzas, Masiello, & Zary, 2015), education (Duh & Klopfer, 2013), and also tourism (Hawkinson, 2014). The intent of this paper is to further the discussion of augmented reality design and implementation as it relates to tourism in a broader context while also hinting to possible issues of design for specific areas of tourism such as marketing and events.

Defining Terms : As these emerging technologies mature and move into more widespread use, the terms used to describe them have understandably been in constant change, mainly due to how specialized fields are putting the technology to use and commercial technology companies looking to differentiate products and services based on AR. Mixed reality is a term that is gaining use partly due to its use in academic research (Duh & Klopfer, 2013; Shumaker, 2011; Tamura, Yamamoto, & Katayama, 1999; Young, Sharlin, & Igarashi, 2011), but also due to the term being adopted by Microsoft to distinguish the company's approach to bringing the technology to consumer markets (Ong, 2017). The terms most accepted come from the concept of a reality-virtuality continuum introduced in research in the 1990s. The concept states that there is an entire spectrum between the completely simulated and the completely real (Milgram, Takemura, Utsumi, & Kishino, 1995). Augmented reality has more of the real world represented than virtual; the opposite is true for augmented virtuality which is mostly a simulated environment.

Figure 1. The Virtuality Continuum (Milgram et al., 1995).

An example of AR in this context would be a heads-up-display in the cockpit of a commercial airliner (Eric Hawkinson, Mehran, & Alizadeh, 2017). For the purposes of this paper I define AR as *the blending of digital content in and on the physical world*. This is my own very simplified definition of AR as I believe it captures the intent of the most cited research on these definitions. I define augmented tourism as *the blending of digital content in and on physical environments to enhance and add affordance to travel experiences*. This definition might be considered narrow by some as it suggests that the traveler is the target and focus of the AR tool. AR has big potential as a tool of advertisers to gain user metrics target ads. This is especially true in tourism contexts. But as I will argue, if the design principles do not start with the end user in mind the design is likely to be flawed and while there is no doubt that there will be attempts to create designs that look to exploit business models of advertising technology in AR, it is the focus of these case uses to find how AR can make travel easier and more rewarding for travelers.

There are other terms important to the design of AR and define the key elements of every augmented tourism design. Since AR is bringing digital contents into the physical world, decisions need to be made related to not only what contents to show, how to show them, and where to show them but what dictates where, when, and how those contents are shown. Something from the physical environment must *trigger* and event to then *overlay* digital content onto it. For example, you could design an AR smartphone application to present users with information in the form of video or 3D objects to explain areas of a museum. That application needs to know when and where to place digital content. Perhaps the application uses the camera to search for a painting pre-programmed into the software and when they are recognized, a matching video is displayed about that painting. In this example the painting is the trigger and the video is the overlay. Triggers can be physical objects, a GPS location, a sound, a movement, or anything a device can detect from the physical world. Smartphones already have equipment on them to detect objects with a camera, sound with a microphone, movement with motion sensors and more sensors are being added as they advance, many times in the direct service to AR. So a trigger is something, someone, someplace or some action from the real world that is detected to command the introduction of an overlay, which is digital content in any form.

II. AR IN TOURISM

Augmented tourism how I have defined the term has been in practice for many years and in a variety of contexts (Hassan & Jung, 2016; Eric Hawkinson, 2014). Tourism is well suited for implementations of AR due to many factors. Users are moving around and in new locations and makes getting contextualized information about where you are and what you are looking at very useful. Tourism settings benefit from connecting expert and curated content to places, people and objects. It also allows the creation of individually customized experiences that connect user preferences to possible differentiated tours and options. AR has already been used in museums as interactive guides that provide contextualized information about where visitors wonder (Fornasari, 2017; D.-H. Lee & Park, 2007; Miyashita et al., 2008). AR is also seen in libraries to orientate visitors to facilities and available periodicals (Malespina, 2016). AR has also been used in events of many kinds including live sporting events (Bielli & Harris, 2015), concerts, and international conferences (Eric Hawkinson, Stack, & Noxon, 2015).

The most notable use in tourism is that related to navigation and how it connects to user preferences. Most mobile devices have equiped with Global Positioning Service (GPS) receivers that allow the device to know where in the world it is. This has allowed for large scale adoption of AR-like tourism applications. An early version of GPS gaming is geocaching. Geocaching is where public lockboxes are placed at specific GPS coordinates so explorers equipped with GPS radios. It has been great for nature enthusiasts and park administration to add fun and engaging elements to visitors (Battista, West, Mackenzie, & Son, 2016). One great example of this is a location-based check-in platform known as Foursquare. Foursquare took the GPS coordinates from your mobile device and gave you a list of nearby places to eat, drink, rest or play. It also allowed users to 'check-in' to a location while they were physically there. Users add the ability to rate and review quality of product and service when they checked-in. It quickly became a convenient and powerful tool for travelers and locals alike to find high quality food and service in their current area. Business models around the platform began to form. Business offered discounts and other perks for check-ins and favorable reviews. A major system was made to denote the user who has the longest streak of daily check-ins. Starbucks coffee gave free coffee to the major of their establishments, another way to reward brand loyalty and encourage social sharing. The data generated from the Foursquare platform can inform us how the technology can offer a new level of customer behaviour understanding for marketing and promotion (Hudson & Hudson, 2017; Williams & Currid-Halkett, 2014). This is an important understanding to the design of AR environments and what makes the use of this technology to attractive to marketers. To overlay digital content in and on the physical world requires a device to search for triggers and that requires the acquisition of a lot of data.

In the case of Foursquare it has facilitated the collection and analysis of the movements of large amounts of people with very large sets of GPS coordinates. It has allowed for a detailed breakdown of consumer movements and preferences in local areas, and has even been used to track urban activity and growth (Battista et al., 2016; Daggitt, Noulas, Shaw, & Mascolo, 2016).

More sophisticated large scale AR experiences became popular in large scale social GPS gaming. Software developer Niantic created the hit mobile gaming platform Ingress, which pitted two teams in battle over control of physical locations. The game enjoyed great success and inspired city wide campaigns all over the world mobilizing hundreds of thousands of players. The game requires players to to out and explore physical locations and the game's popularity was harnessed to create connections between local populations and local tourist points of interest (Stark, 2015). This game was very important was it showed design challenges and opportunities in AR environments. The designers knew that they could not possibly create the needed catalog of physical locations around the world from which players would battle to control, so they built a submission tool into the game that allowed users to add their favorite local statutes, stations, and other interesting neighborhood locations. This became very important because over the course of 10 years of gameplay, the company cataloged millions of locations around the world. Those locations were the basis from which Niantic built their next AR gaming platform, Pokemon Go. Pokemon Go could possibly be the most important AR platform to date in terms of learning design principles. The platform had record breaking success in terms of user base and in game purchases, but there were also a host of unforeseen problems, both legal and social with the game's large scale use. Users went into private and dangerous place, they overcrowded areas, and got into accidents from being distracted to what was digitally there instead of what was really there (Barbieri et al., 2017). Many local municipalities as well as local businesses have tried to harness the power of Pokemon Go to get consumers moving around and engaging in commerce. Kyoto, Japan which is the home of Nintendo, the holder of the Pokemon intellectual property, have tried to broker deals to incorporate the platform to serve local tourism, but the initiative has not shown any traction as the game had little connection to the corporate headquarters. This did not stop local businesses and municipalities from creating maps of Pokemon Go world items and locations and how they relate to local attractions. Pokemon Go showed us some hints into the future of digitally augmented environments.

Case Uses in Events : First time users to AR can be prone to cognitive overload. The mix of virtual and real can take some time for the senses to get used to. Also, some practice is sometimes needs to correctly position devices in relation to the content to be scanned. Add the fact that you are also to be charged with a new task that requires the use of AR and first-time users can struggle (Dunleavy, Dede, & Mitchell, 2008). To help alleviate these effects for first time users some simple tasks to first learn to use the technology are suggested for the design. A research team I lead designed a scaffolding scheme to graduate visitors of a TEDx conference in Japan to higher and higher levels of AR technology use. The design had participants of the international event start with simple pen and paper and connected stages of activities that would ultimately ask participants to download smartphone applications and explore the venue (Eric Hawkinson et al., 2015). This attempt was useful in later iterations as it showed when and why participants would discontinue the activities and thus gave some insights as to how much motivation or acceptance AR had with general audiences.

Case Uses in Libraries and Museums : Libraries and museums have been an interest of technologists looking to deploy augmented reality, mainly due to the value AR can add to these spaces by adding supplementary digital information. There have been many case studies using AR in these contexts (Fornasari, 2017; Hahn, 2012; D.-H. Lee & Park, 2007; Miyashita et al., 2008). At the University of Fukuchiyama Media Center, students with the supervision of myself created an orientation activity for new students. The students created a narrative where a chief of police enlists you to help find some important information that was taken. Clues were given that directed users to different areas of the media center until the quest is completed. By the end of the short activity participants were acquainted with the facilities of the media center and knew how to access the various books and periodicals (E. Hawkinson, 2014).

Case Uses in Destination Tourism : Location based gaming and marketing has been developing for many years (Arora & Bhatia, 2011; Gana & Thomas, 2016; Wijesinghe & Zhang, 2015). Marketers and consumers alike have found value in getting information and offers from attractions that are currently nearby (Gana & Thomas, 2016; Pitta, 2011). Location based marketing and gaming is considered a form of augmented tourism as it is taking a physical location in for form of GPS coordinates and delivering customized digital content based on that location. Geocaching where people hunt for treasure at specific GPS locations is an early form of this connected to tourism and in particular outdoor and nature tourism(Boulaire & Hervet, 2012; Boys, White, & Groover, 2017).

Later social media elements were integrated and platforms like Foursquare became popular (Amstutz, 1994; Frith, 2014). More sophisticated designs came into the popular use with social location-based games like Ingress and Pokemon Go that got people out and moving around to random local artifacts and locations (Aluri, 2017; Stark, 2015). In Fukuchiyama, Japan I led a research team to design a full day AR rally that took about 200 participants in teams of 10 around the city to learn about its history and get to know the community. The design of the activity was based around two goals. The first was to orientate participants to the city and each other. The second was to create connections between participants and community members. This design also shows how much more value is added to the experience when it is calibrated and customized to particular locations. This is a contrast to the broad designs of Foursquare and Pokemon Go. Game elements were incorporated into the activities over the course of the day that forced teams to work together to solve puzzles and complete challenges. Those activities required gathering knowledge of the city's history and also required interaction with locals. This design was an iteration of a similar event that took place a year earlier and each new version along with the other examples have informed a set of design principles for creating these augmented tourism environments (E. Hawkinson, 2014; Eric Hawkinson et al., 2017, 2015).

III.   DESIGN PRINCIPLES

There are a number of design theories I pull from that I argue work well when looking to design AR environments for tourism contexts There are a number of approaches considered and some tried and discussed in the example case studies in this study. One approach is to first to consider AR as both a media and and communication technology. In taking this approach it is helpful to consider models for effective media communication (Gruen, 2005; MacInnis, Moorman, & Jaworski, 1991). These theories attempt to explain the efficacy of communication in marketing media. They measure consumer's motivation, opportunity, and ability to process brand information. While the authors of this construct intended it to explain consumer behavior, this study attempts to adapt and apply the ideas to technology integration design for tourism as well as how end users might accept and be satisfied with augmented tourism environments.

MOA Theory of Communication in Augmented Tourism Design : First, to understand how this could be applied to how end user will accept of AR environments and also see how the ideas could be applied to the design of AR, let's use the Pokemon Go as an example. Using the three elements of the MOA communication framework we can breakdown how users came to use and the platform.

MOA Element	End User	Tourism AR Environment by Design
Motivation	(HIGH) The intellectual property (fans of Pokemon) and the demographics attached to it were ripe for a new experience for the franchise and also high smartphone adopters.	(MODERATE) The design of the activity does encourage movement and users to go outside. But not to specific locations nor does the design allow connections to local attractions.
Opportunity	(HIGH) The platform was available on iOS and Android smartphones on most markets worldwide. It was also free to download and play.	(MODERATE) Local businesses if lucky could suggest to players that they could come to their attractions or businesses and earn points or items. They could
Ability	(MODERATE) Users who had some ability to use smartphones and had adequate data transmission reception could play the game. Those in inner-cities enjoyed a better experience to rural players due to more frequent and closer virtual locations and items.	(LOW) The ability of users to access the game and connect the contents to local tourism attractions was solely based on the ability of local marketing efforts. The design of the game itself did not help users find wireless tourist wi-fi hotspots nor did it meld well with seasonal changes and business hours of tourist destinations.

Table 1. MOA Theory Applied to Pokemon GO related to Tourism Affordances

The two lenses of end user and the AR environment itself ask different questions in the analysis. When considering the end user questions are asked as to how and why people will engage with the environment.

When analyzing from the design of the environment, questions are asked as to how to add value to already existing tourism experiences of the physical area. When looking to design an AR environment the MOA theory can be used to formulate questions to inform design decisions. With regards to motivation, example questions are- 'What is compelling users to use the environment?' and 'How does the environment add value to the physical surroundings?'. The design of the tools and the environment need to peak interest enough for users to 'buy in' to using the tool and then the design must add enough value or amusement to keep them using it. Augmented reality has great novelty with many first time users as it is a new and interesting way of looking at the world. This may make it easier to get users to try the tool or environment initially, but as the novelty wears off there needs to be something to keep users engaged and that can best come from incorporating physical surroundings (Eric Hawkinson, 2014; Eric Hawkinson et al., 2015).

Speaking about opportunity, a good question to ask is 'Does the environment facilitate users and the supporting technology?'. This is often related to technology infrastructure and how it can facilitate users and AR environments. AR is a very bandwidth heavy technology as it requires constant data to be sent to and from a mobile device. For travelers usually on roaming or limited data plans while away from home, this means a strong public Wi-Fi system is often required for these environments to be accessible. AR also is graphically and computationally intense and means older devices that do not have adequate processing power many give poor experiences. The last issue of ability begs the question- 'Are users affluent enough to set up and use the environment?'. Issues here relate to how savvy users are with using newer technologies. Most case studies in tourism and education have needed on-site facilitators to guide users in installing and using the environment. Like all newer technologies, it may need some troubleshooting when something goes wrong, such as software glitches or hardware malfunctions. On-site staff can be hard to sustain when looking to sustain these environments for long periods of time.

IV. TECHNOLOGY CATEGORIES AND DESIGN

These concepts and the questions derived from them can be very useful tools in the overall design of the environment, but there are also of course more detailed design considerations. When looking to decide on triggers and overlays for any AR environment, there are several considerations to be made. A large one is based on the technology available. AR can be categorized by technology as the available sensors and input devices can dictate what triggers can be implemented.

Figure 2. Categorizing AR by Technology (Hawkinson, 2014).

The technology available and the tracking methods chosen are foundations to the design of augmented tourism environments. There are several reasons for this, the most important being that the sensors being used and the tracking technology available will dictate what information can be collected to then be used as a trigger to bring digital content into play.

V. CONCLUSIONS

Although augmented tourism is not new, the term has not come into mainstream use because the potential of the technology is not yet realized. I define augmented tourism as *the blending of digital content in and on physical environments to enhance and add affordance to travel experiences*. Augmented tourism environments take in data about a user's physical surroundings such as GPS location and visual information from a camera.

That information can be sifted through for a trigger, which is a pre-configured element of the physical world that gets detected to then start incorporating digital contents. The design of augmented tourism should be based on the motivation, opportunity and ability of users to engage in the environments. The design also needs to consider the location and the physical environment and its ability to motivate, give opportunity and be accessible to users. In simple terms, augmented tourism must consider digital and analog designs together, consider software and physical contexts, and also incorporate the limits of technology and the real world in which the environment is to be placed.

Future Vision : Next iterations for these augmented tourism environments can be built for data gathering tools for destination managers as well as informational tools for consumers. Next steps in the evolution in making best practices and design principles for augmented tourism should look to ask questions as to how much data is acceptable to take and use from the technology use. There are issues not only of privacy and personal security, but also customer satisfaction and how much consumers are willing to give up as far as personal information to use these environments.

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