Digital Heritage Tourism: Reconfiguring the Visitor Experience in Heritage Sites, Museums and Architecture in the Era of Pervasive Computing

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Abstract

Heritage is a very important motivating factor for tourism. In the past decade, the vast amounts of new media information made available to heritage tourists via the World Wide Web have provided a convenient access to the intended destination image of marketeers and the actual destination image of travellers. The onset of Web 2.0 technology, social media, and mobile technology serves only to diffuse these images to a much wider inter-connected audiences. Other Internet services enhance the practicality of travel planning and reservations. As the personal computing era recedes and gives rise to pervasive technology in an increasingly ambient intelligence-based environment, and advances in the digitally-focused academic community expanded into practical solutions to daily issues, new types of personalised, location-based services emerged. It is in these transitions to Web 3.0 that we should explore and adopt new ways of enriching the heritage tourism experience. This paper focuses on new media-enhanced exploration and learning of culture and heritage. It aims to bridge the continuity of the visitor experience prior to, during, and after the visit, tools for urban heritage managers and how data from the continuity of tourist information processing may be used for planning and sustainable development of heritage sites.

Introduction

Various economic analyses have indicated the value of heritage, and the motivational factors natural and cultural heritage generates for tourism in both the rural and the urban environment. Heritage is a legacy from the past worth preserving and transmitted to future generations. Heritage encompasses the original cultural and natural material, the built environment, archaeological resources, the intangible heritage and the natural heritage [1]. The economic benefits that heritage tourism brings are manifold. Take for example, a study conducted by Oxford Economics recently on the economic impacts of heritage tourism in the United Kingdom. According to Oxford Economics [2], heritage tourism (including museums and green spaces) is an industry worth £20.6b annually with visitors amounting to 164.7m. The contribution to gross domestic product is more than the car manufacturing industry, advertising, and entertainment. Spillover benefits suggests a

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link between the visitor economy and other areas of economy such as retail, manufacturing, health and life sciences [3]. Heritage tourism also employs 270,000 people in the UK excluding green spaces, and 466,000 including green spaces. It is estimated that the tourism economy will grow by 2.6% a year from 2009 to 2018, higher than the forecast for manufacturing and similar to retailing and construction [3]. Heritage tourism attracts local, national and global visitors and meets a variety of needs. Greffe [4] on a study of valorisation of heritage in France observed that contemporary societies are keen on the valorisation of our heritage – for individuals and households, heritage satisfies a variety of needs such as artistic, aesthetic, cognitive, and recreation. For owners of public and private monuments, it is a means for mobilising resources for the conservation of monuments. Companies earn profits from spin-offs related to tourism of such sites, local authorities take advantage of the positive image and opportunities for the improvement of the living environment, and countries benefits from the reaffirming of their national identity and for promoting solidarity.

Whilst "one can argue that virtually all tourism in the UK is at least partly motivated by natural or cultural heritage" [1], heritage is a genuine factor for tourism in countries with similar heritage treasures. Tourist visits are for many reasons such as business, leisure, or education. The heritage tourists however, are motivated by their eagerness to learn the heritage and culture associated with a particular site. Tilden [5] observed that a visitor is exposed "to a kind of elective education that is superior in some respects to that of the classroom, for here he meets the Thing itself-whether it be a wonder of nature's work, or the act or work of man" and suggests that "to pay a personal visit to a historic shrine is to receive a concept such as no book can supply". Learning and discovery on-site via participation and interaction [6-8] therefore plays an important role in motivating tourists to actually visit a particular heritage site. Learning and discovery is a major part of heritage tourism. In this context, the questions heritage site managers and stakeholders should frequently ask are as follows – What are the expectations of the tourist? Are the tourists' needs being satisfied? What do the tourists see? Have they discovered new knowledge? What are the tourists' experiences on the site of visit? What have they learned? Have they seen only places that are of importance and missed others that are obscured (hidden)? What are their perceptions of cultural sites and artefacts? What particular sense or symbolic meaning does a site or object on display convey (the nature of an object, in Blumer's definition [9] is that it "consists of meaning that it has for the person for whom it is an object", this includes "activities, events, material realities, and any other phenomena that, in Blumer's terms, can become the focus of self-distance and reflection" [10])? Knowing the answers to these questions will give heritage managers and marketeers a deeper insight into the behaviour of visitors that may assist in schemes that attract future visitors. But the answers to the questions are often inaccessible accept through visitor surveys in the pre-digital era.

There is a wide range of learning not only on open spaces but especially in a museum, where information is structured. Hooper-Greenhill [11] stated that "A museum is not a book, or an encyclopaedia, although it has been compared with both; a museum is a complex cultural organization, which is made up of a site that is frequently spectacular, a body of people with rare and fascinating expertise, a collection of objects that in its totality is unique, and a range of values that are currently under intense scrutiny from within the institution, from the academy and from government. All of these elements are susceptible to study, and therefore present learning opportunities. The level of learning can range from early childhood education to postgraduate research." Museums provide a wide range of interactions from which visitors could use for making their own meanings [12, 13]. Focused learning is in the Museum, but the depth of learning and the extent of the availability of the broad range of collections have a limit – there are obstacles due to the limitations of space as we shall soon see.

An old rule of thumb for museum displays is that it typically has only 10 to 20 percent of its collection on display at any given time. As Burcaw [14] states "The museum objects on exhibit at any time may actually constitute less than half of the total collections", or "the well-known 40-40-20 proportion" where 40 percent are for the collections, 40 for exhibits and 20 percent for everything else (offices, rest rooms, etc). Some museums with larger archives have only 10% on display.

This means that collections have to be rotated through to storage-preservation-display cycle, and that information associated with individual objects are complex and impractical due to the limitations of physical spaces. This also implies that the majority of museum objects are not shown to the public due to these limitations.

One way of drawing out museum objects from the archives is through digital media via high definition displays. Another way is to allow visitors to explore the archives via interactive multi-touch tables; this enables a range of audiences the means to delve deeper into the networks of digital databases and interact with laser scanned 3D models, paintings, illustrations, articles, oral history and even explore past virtual worlds and learning through games. Yet another way is to transmit digital information via mobile devices into a fun and accessible format. The archives then become an asset to heritage tourism. In the same way, using the digital approach, on-site discovery and learning can be mediated through interactive media, Augmented Reality, location-based services and Pervasive Computing (or Ubiquitous Computing). The information that is embedded within objects, if appropriately structured for learning and teaching, can become an enriching experience for visitors. Related but obscured objects can be linked via RFID and GPS so that users are 'notified' when they are within range of the objects. The embedding and dissemination of thoughts, feelings and visitor destination image on objects via the 'viral' nature of Social Media

means that active marketing becomes secondary. The increase in user generated contents embedded within a particular object will also reveal the significance of that object to the public. The benefits in adopting not just digital technologies, but connected digital technologies for heritage tourism are indeed manifold.

This paper provides arguments on the benefits of digital technologies for heritage tourism in spaces and landscapes. It aims to provide a conceptual platform within the transformation of the digital era from which visitor experience can be reconfigured, and the digital data of user behaviour that heritage managers and marketeers can take advantage of.

Digital Revolution

We are living in a post-industrial society, where the novel and central feature is the "codification of theoretical knowledge and the new relation of science to technology" – According to Bell [15], it is a society where manufacturing gives rise to services, occupational changes saw the rise of professional and technical employment as compared to skilled and labour workers, where human and social capital integrated with technology becomes the primary resource, the observed increase of intellectual technology (based on mathematics and linguistics) which uses algorithms (decision rules), programming (software) models and simulations in running new 'high' technology, where communication becomes the infrastructure, and where knowledge is the collective good. This is where value is generated with the increase of knowledge and ideas [16]. And this is where technology is the initiator, the instrument of change.

The advancement of information and communications technology plays a central role in propelling our society into the 21st century where exchange of information transpires at an exponential rate. Knowledge encoded in bits streamed through exchange hubs connected via the information superhighway emerge as 'mash-ups' of new media enhanced ideas that will only propel us further into unpredictable territories. The Internet has reshaped the traditional means of communication. The shift from the passive viewing of content in the World Wide Web where pages are linked via hyperlinks, to Web 2.0 [17] – the 'social web' means that humans now interact, share and collaborate differently. Social networking and micro-blogging sites such as Facebook, Google+ and Twitter, video sharing sites such as YouTube, and instant messaging with real-time videos have changed the interaction behaviour of society, empowering self-expression and creativity and the sharing of information. Even the political landscapes are not spared from social media [18]. These changes mean that information sharing, interaction and collaboration becomes the driving force for digital citizens. Web 2.0 is borderless, powerful and effortless in its usability due to technological advancement. Social media-ready Smartphones and various software applications that have pre-installed operating systems and downloadable Apps (mobile software applications) in virtual

market-places allow users to edit and manipulate media contents such as videos and images. These contents, together with textual information are immediately shareable on the web via 3G network (3rd generation mobile telecommunications) tagged with geo-location information, allowing immediate access by peers to users' whereabouts and their experiences.

The transition to Web 3.0, the 'semantic web' [19] will see a host of very personalised services due to intelligent software agents that make sense of our web activities and preferences. This allows users to request for services whilst agents are automatically delegated tasks, collating information and services into a personalised consumable format. Over time, these intelligent agents learn our behaviour and form a model of their 'master', they generate on-demand relevant information and services where needed, therefore simplifying and automating user requests.

The Web and mobile phones are not the only connected 'things'. Radio Frequency Identification (RFID) and microprocessors are pervading daily objects, allowing them to be tracked and inventoried within a vast information network. This network of digital information, sensor embedded physical objects and their virtual information-rich representations on the Internet will allow them to be 'smart' with capabilities to organise themselves based on their contexts and environments. The 'Internet of Things' will eventually pervade every physical objects, activities, and contexts [20].

The progression aforementioned implies that we are very much transitioning into a world where digitised information and devices are becoming indispensable. From Computers to Smartphones, 2D image scanners to 3D laser scanners, audio recorders to HD digital camcorders with features such as panoramic, stereoscopic 3D and High Dynamic Range (HDR), information is being captured, stored, created and processed digitally at an exponential rate. The whole working culture is centred upon digital information. Digital resilience is needed in businesses to cope with this change, and digital resilience is also needed in heritage tourism. Are heritage sites digital-ready? Digital natives [21] who interacted with digital technology at an early age will be the tourists of the future, they are those whose brains are wired differently. They think differently and crave interactivity, being so accustomed to the "twitch-speed, multitasking, random-access, graphics-first, active, connected, fun, fantasy, quick-payoff world of their video games, MTV, and Internet" [22], and recent social media enabled mobile devices. The digital natives and the older generation of digital immigrants who are open to new ways of thinking are adopting digital technology for both work and leisure. In fact, digital technology is subtly pervading our society; they are gradually being integrated into objects and activities that they have become quite invisible.

Negroponte [23], in his 1995 'Being Digital' book gave an uncanny prediction on the saturation of every aspects of our lives with digital information and how we will be moving and manipulating bits (Binary digITS – the DNA of digital information) rather than atoms, and "like a force of nature,

the digital age cannot be denied or stopped. It has four very powerful qualities that will result in its ultimate triumph: decentralizing, globalizing, harmonizing, and empowering. …in the digital world, previously impossible solutions become viable".

The Changing Landscape of Heritage Tourism

The first virtual tour using digital technology was presented at a conference hosted by the British Museum [24]. Since then, many natural and cultural heritage sites have been digitally reconstructed (e.g., [25-31]). Where physical reconstructions were impossible before, Virtual Reality (VR) and games technology allows a complete reconstruction of present ruins to its former glory thousands of years ago. The technology allows remote access to heritage sites at any given space and time without the site damaged by visitor pressure. Animals, human agents [30] and vegetation as agent-based models populate landscapes and react to environmental parameters [32]. Virtual users could be tracked to an extremely high resolution and any objects that they looked at, the location and orientation of their gaze are stored for data analysis by site managers. This allows for the understanding of visitor behaviour and the plans for visitor tours of heritage sites. Technology that merges the real and the virtual are also being used for assisting tourists with local information. Augmented Reality (AR) was originally developed to superimpose 3D models onto the real world using markers as a basis. It eventually found its way into better use for mobile phones, coupled with geo-location data, AR allows the display of computer generated information in the users' surroundings using the mobile phone's inbuilt camera. This allows visitors the ability to navigate a heritage site through a digital display and see the context of a monument in relation with other monuments. Deep media content (audio, videos, animation, 3D objects and text) can be embedded within the display for learning purposes.

Virtual Reality facilitates the exploration of heritage sites in fully computer generated environments. Augmented Reality blends the real and the virtual by overlaying computer generated information onto the real world via digital displays, trends in Ubiquitous Computing sees networked devices pervading objects, activities and contexts with digital information where the user interface recedes into the ambient environment. The digital age, like the force of nature cannot be stopped. Having a positive outlook and realising the digital as having real value can help shape the future of heritage tourism in a constructive manner.

Reconfiguring the User Experience

Tourist visits can be logically segmented into three sections – Before the visit, during the visit, and after the visit. This section illustrates the tourist experience in different eras of the digital revolution. An increasing trend that can be observed is the depth of access of multimedia

information and connectedness of the experience as we transition into the future of digitally enhanced heritage.

The Heritage Tourist in the Web 1.0 Era

In the Web 1.0 era, prior to the visit, tourists make preparations by using the web browser for arrangements such as flights and accommodation bookings, compare prices from separate websites, and read reviews and information related to the site of interest. During the trip, based on the destination image of marketeers posted on advertisement web sites, the general tourist visit their intended destination and explore the landscape via oral recommendations, occasionally discovering new places of interest only during the visit. Some websites may provide a 360° panoramic view of the destination, hotel facilities, and etc. After the visit the user may upload pictures to online photo albums and blogs. Site managers have no access to tourist information.

The Heritage Tourist in the Web 2.0 and the Smartphone Era (Current Era)

Tourists in the Web 2.0 era use a wide variety of social networking tools in the entirety of the journey. User participation is encouraged in every process and the online data generated by the user is becoming connected. Bookings and arrangements are made on comparative websites that draw upon services that list their information on standard consumable formats. On the same website, the user may check ratings, read reviews from other tourists, share the page via Twitter and Google+ for example, or click the 'like' link on the page so that it posts the page onto the user's Facebook feeds. The online rating system facilitates the survival of the fittest – good deals and exciting packages get more views; this prompts competition and adds value to consumers. The user may check the location on Google maps and street views and also browse pictures uploaded by other tourists, and perhaps get immediate response from the online 'chat' feature. The user may begin to brag about the upcoming trip on social networking sites and have friends in their circles who have been to the same destination comment upon and advice on the 'must see' and 'must eat' places. Occasionally, the tourist will discover that a group of friends will be travelling at the same time and may plan to be together, or make appointments to meet at a local pub, all within the social networking circles. Some websites, especially museums are beginning to provide virtual tours and interactive 3D objects that users could explore, leading to greater enthusiasms nearing the date of visit. The experience during the visit will be digitally networked, unless of course the user chose to switch off the Smartphone and be alone. Location-based services accessible via mobile phones provide access to the identification of information and services within the vicinity of the tourist. These are viewable on interactive map and on augmented information on the mobile display for ease of navigation using the device GPS and inbuilt digital compass. This allows the tourist to discover places of interest on location. The tourist may also search Twitter using the hash tag (e.g., #Catania, #Etna) to discover what other tourists are currently talking about around these topics.

Digital sharing becomes part of the experience as tourists take geo-location tagged photos, videos and instant 360° panoramas and posts them via the mobile network, allowing friends and families to have instant access to a second-hand experience of the trip. A direct on-the-moment second-hand experience is possible via online video calls (e.g., Skype) during the visit. Shared media on social networking sites are immediately commented upon by friends and families. After the visit, the tourist completes the sharing of the full set of digitally captured media depicting the experience. The information that is shared may become 'viral', spreading across the social network and becomes a free advertisement for the destination through the actual eyes of the tourist. Site managers if socially networked now have access to more information related to tourist behaviours via the use of 'web scraping' – a way of gleaning information from websites by software agents.

The Heritage Tourist in the Web 3.0 and Pervasive Computing Era

The transition into this era from Web 2.0 will be subtle, it in fact is happening now. Major search engines and Social Networking sites have begun tracking user behaviour and preferences in the Web 2.0 era. For example, Google's Privacy Policy [33] states that "...Analysing logs data helps our engineers both improve your search quality and build helpful innovative services... We believe that anonymising IP addresses after 9 months and cookies in our search engine logs after 18 months strikes the right balance." Facebook recently files for US patents to track users outside of the Social Networking site, this includes what users view on television and the places they visit from GPS data [34]. These are trends leading to personalised services in the future of Semantic Web and Ubiquitous Computing. As tourist behaviours and preferences are being learned across different domains, software agents are making sense of scattered data, through this personalisation occurs. The tourist experience in making arrangements for a trip becomes easy. The tourist need only to indicate in natural language (perhaps still via keyboard input, or voice input) a place of interest and the tourist's virtual butler (the intelligent agents or shopbots as a collective entity) negotiated and coordinated all the services on market overview 'menu' awaiting confirmation. The travel information will include not only the best choice across all services in terms of pricing and value, but also with an added personal touch – based on the user's history from across his digital device domain. For example, the user may wish to visit Georgetown in Penang, Malaysia, a UNESCO World Heritage Site. Based on his previous spending in another destination a list of exclusive beach resorts at Batu Ferringhi appears on the user's Smartphone. This together with nearby restaurants of the user's favourite food menus and prices are provided. Information is multifaceted through social sharing, and is deep and rich with textual, video and image contents embedded within each item. Automatic scheduling of day trips places travel times and schedule on the tourist's digital calendar, including a 'must have' favourite local dessert 'Ice Kacang' for 30 minutes at the town centre after lunch and prior to the shopping trip for hand-crafted souvenirs at the heart of the culturally rich

world heritage site. During the trip and before lunch, the mobile phone notifies the user of a local friend in the social network having the same dessert just 10 minutes after the tourist leaves, a swipe of a finger on the mobile phone reschedules the event and all events during the day just so that they could be together. Shopping for the best deals becomes easy as all objects are digitally connected. Take a picture of a product and intelligent shopbots survey nearby stores for best prices and bargained with other retail bots for best deals, RFID readers on the phone does the same job. Having spent more than expected, the user decides to re-organise the trip, cutting some costs on the final days with coordination from the agents. A swipe of a finger coordinates the arrangements into a more economic price package for the remaining days. Such is the flexibility of the Web 3.0 era. The simple scenario presented here implies that services that are not able to adapt to the digital age will be at the bottom of business survivability.

At the local national history museum in a geological region, the tourist walks into an exhibition featuring prehistoric creatures that crawls on the seabed 250 million years ago. The tourist picks up a fossil of a Trilobite and places it onto a Surface Computer (a multitouch computer table), the camera underneath the screen detects the tag and displays layers of multimedia information, including interactive 3D models of live Trilobites in an ecosystem of virtual prehistoric vegetation, planktons and other organisms. The tourist touches the screen and drops thousands of plankton onto the virtual world, Trilobites swarm around the food. Attracted by the commotion, an Anomalocaris swims by, capturing an unsuspecting Trilobite in its mouth, it darts away into the distant foggy waters as children gasps in horror around the digital window. A moment later, observing that some baby Trilobites have come into the virtual world recently, the tourist picks one and transfers it to his mobile phone to keep as a pet. Payment is made instantly through the phone and a thumbnail of the baby Trilobite is displayed on the tourist's social networking site with information related to its biodata. As crowds begin to gather around the table, sensors in the tiles detect their presence and begin changing the local climate around the table. The on-screen user interface adapts to the demand by providing separate instances of tools to meet the need. Intelligent displays nearby change appearance in an attempt to attract the group's attention in order to balance the crowd around the space. In this short episode at the museum, the user learns much more about Trilobites and their prehistoric environment than in a formal classroom.

Other museum objects both on display and in the archives have embedded RFID tags and sensors that monitor the environment, notifying the curator via an information system of any threats unobservable by the human eye.

Outside the museum, the user remembers very clearly from a tour of the virtual city at home a week ago that there is an archaeological excavation nearby, familiar with the surrounding from the virtual tour, the tourist walks through the street towards the site. On the way, digital display outside

retail stores pick up the signal from the mobile phone and presents personalised advertisements. Electronic sensors at various locations determine the density of the crowd and the safety of the environment, occasionally prompting tourist police to head to a region where tourists might need help. Tour guides and helpers come to tourists on demand. At the archaeological site, whilst excavation is taking place and archaeologists record information on their tablet computers, the tourist's Smartphone picks up the information formatted for the touristic audience. Together with a panoramic photo, the tourist posts a blog of the visit onto the social networking site. Meanwhile, intelligent agents (the tourist's butler) are collecting and coordinating data from the trip and processing important information for future use. Intelligent agents that belonged to heritage managers and retailers on the other hand, processes open information (information allowed by users) for analysis.

At dinner whilst the drinks were being served, the tourist swipes the Trilobite from the phone onto the digital table and lets it fall beneath the menu system onto a modern day virtual aquarium desktop wallpaper. The information-rich table shows not only the ingredients, but also the calories of the dishes and their historical origin. Some health symbols suggest the healthiest dishes based on user profiling without intruding into the occasional rights to indulge in good food, and drink. The waitress brings food and the table picks up signals from the electronic tags on the plates and indicated to the waitress which dishes are ordered by the tourist's group of friends. Waitresses refill drinks when sensors on the glasses request for it.

After the visit, objects, monuments and the services that the users subscribe to during the visit continues to send updates to the user's Twitter account, informing him of progress of the archaeological dig for example, and to which museums the excavated artefacts have travelled to. There is not the need to upload travel albums, in fact the photos were automatically synchronised with the Cloud (a network of remote servers hosted on the Internet for data storage, processing and access). All that is needed for the tourist is to pick which media gets published on the social network. The loss of a mobile device is of no great concern to the tourist for any devices could be used to access data. The store that had sold the hand-crafted souvenirs now have more information about the destination that the goods go to so that at the end of the business cycle, the retailer gets a report of the purchasing behaviour of tourists across the globe. In this coming era, true leisure and ambient learning becomes a reality as intelligent technology fades into the background and user interfaces are in everyday objects. At the background, governmental organisations on tourism relate anonymous but important data on visitor pressure, and retail earnings on the city-wide distributed computers. The data continuity in this era is apparent. We are living in and witnessing such a transformation, but the potential value of digital information to heritage managers remains to be seen until widespread adoption becomes a reality.

Conclusion

Web 3.0 and pervasive computing are quickly coming. The story told in the previous section does not need rigorous scientific research. They are easily within reach with some creative engineering endeavours, for every scenario mentioned in the text is possible with current technology. The digital era and the rise of intelligent agents are changing the tourist landscape. As digital natives and digital immigrants applaud and embrace connected technology, businesses will need to reconsider their strategy in order to survive in the highly competitive markets. Businesses and local councils wishing to promote the tourism industry will need to become social. Facebook has 350 million global users and 80,000 sites using Facebook connect. Google+ has about 10 million users and Twitter has 175 million user accounts. The population is increasing so much so that Japan is considering giving 10,000 flights to social media users to promote tourism [35]). Besides, Facebook users spend almost an hour a day browsing through their feeds and interacting with friends. Heritage managers on the other hand have the responsibility to make sure that their heritage assets are properly preserved through digitisation. Digitised objects do not corrupt nor degrade over time. They are weightless, they do not take up physical storage space, they are easily reproducible and efficiently transmitted across networks. Rich media information can be embedded within digitised objects. Increasingly, personal items such as books are being digitised at a low cost (e.g., book transubstantiation [36], Google Books, Amazon Kindle Books, etc). Heritage managers will also need to make sure that their assets are digital resilient by making sure that they have the right means of dissemination either through interactive media or virtual worlds that suits the taste of a wide range of audiences. Particularly, promotion of heritage learning to the younger generation of digital natives will need to be considered. Their learning styles and digital behaviour demand alternate pedagogy. Only when we have successfully observed that our heritage is understood and absorbed by the younger generation will knowledge of our heritage and culture survive in the future. Perhaps the digital means is the only way that this can be achieved.

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