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THE APPLICATION OF 3D VISUALISATION AND HD SURVEYING TO HELP STIMULATE ECONOMIC GROWTH IN HISTORIC URBAN AREAS

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ABSTRACT

This paper concerns the application of cutting edge digital recording techniques within the context of heritage-led urban regeneration. The work is innovative in that it supports the belief of decision makers and local stakeholders that there is potential for the built heritage to contribute directly towards economic development. Against that context, the research explored ways in which innovative or unfamiliar methods of presentation can help to generate user interest and public engagement. The research was undertaken within the Scottish town of Elgin, which has a recorded history dating back almost 900 years. In common with many small towns and cities in the UK, Elgin faces economic challenges related to the performance of retail and tourism in both the town centre and the wider area. A key aim of the wider project was to help stimulate a growth in tourism and locally-based retail, through an exploration, re-presentation and celebration of the rich and culturally significant built heritage of the town. The research used 3D laser scanning to record over 20 selected sites. The research is innovative with regards to the technical use of cutting-edge surveying techniques, particularly within a physically complex historic environment. The paper provides valuable data regarding public engagement with such technologies, including the connections between detail, choice of locations and perceived and actual value.

Keywords: heritage, public engagement, regeneration, scanning, visualisation

INTRODUCTION

This paper concerns the application of 3D heritage scanning, photogrammetry and digital modelling within the context of a heritage-led urban rejuvenation project. The physical context of the work is a town (Elgin, a former Royal Burgh) in Scotland, with a recorded history dating back over 900 years. In common with many towns in the UK, there has over a period of many years been a gradual drift of retail activity away from the town centre (High Street), due in part to the development of retail parks and supermarkets, and a more recent concern over the viability of independent retails against a backdrop of increasing levels of internet sales.

The town has an important place in Scottish history, and many examples of impressive (and protected) ornate sandstone architecture still define the urban core. Therefore, there would appear to be potential to explore and exploit the benefits of an authentic and un-commodified historic urban landscape, with little need to rebuild or redevelop

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the existing constructed environment (unlike in, for example, Waitt 2000). Furthermore, there is a desire to understand and regard that existing environment, embodying physical and intangible heritage value, with this being the focus of any future development within the area (in the spirit of findings of Tweed and Sutherland, 2007). However, there is a feeling locally that the value of this rich heritage is not widely understood or celebrated at present, and that there is great untapped potential for a heritage-led renaissance in local tourism, with Elgin regarded as a potential focus for the region.

The work is important in that it draws together various strands of enquiry, including the development of a clear workflow to support digital models of heritage artefacts, within the context of heritage-led regeneration of a town and region. The research drew on previous work which dealt with user-engagement and related applications of IT, including laser scanning and photogrammetry. The direct use of the digital outputs and artefacts as a core part of the regeneration process is interesting, and suggests paths for future work, including the use of crowd-sourced open data to ensure a sustainable future for the project as a whole.

HERITAGE-LED REGENERATION

Precedent theory and studies

There is a complex relationship between the competing demands of built heritage conservation, a need to preserve that heritage whilst still providing access, and the economic benefits which can follow. ICOMOS (1999) has encouraged a widespread recognition of the need to communicate notions of significance to those who may be responsible for heritage management, and to promote heritage tourism which respects and helps protect the buildings and artifacts being celebrated and visited. ICOMOS also stressed the importance of encouraging dialogue between parties, to ensure that benefits could extend in terms of conservation value and economic revenues from tourism. Within the context of the research reported here, the emphasis on dialogue as well as celebration and awareness were regarded as particularly important. In some ways, this follows the experience of heritage groups was regarded as vital to the successful implementation of very early attempts at building and area conservation, and the manner in which this could be best exploited in a tourism context (Parlett et al 1995).

One point of precedent, which has recently become more apparent, is that of industrial tourism, or tourism which appears to embrace aspects of a country or region which have more in common with industrial heritage than notions of medieval history (Christopher 2014, Gospodini 2006, Oglethorpe 1987). One could argue that a common and widespread understanding of what may constitute 'heritage' is likely to vary from person to person, and that both research and practice should therefore embrace the contributions of individuals, and not pre-judge which aspects of the physical environment merit the processes of recording, digitisation and documenting.

Related to this is the notion of heritage-led regeneration of urban areas, where an understanding of the complex relationships between local culture, local heritage and architectural tradition becomes a central strand of design briefing and design direction (as described in Lazarević et al 2015). Of course, and as is recognised by the research reported here, there is a need to ensure that such recognition of heritage is combined

with tourist infrastructure and facilities in the area itself (Ismagilova et al. 2015), with clear strategy and methodology to support evaluating the impact of heritage initiatives in both economic and environmental terms (Dalmas et al. 2015).

The research context

The research was undertaken within the context of a series of research commissions, all undertaken in Elgin, Scotland. The work concentrated on the combined and crossdisciplinary applications of laser scanning technology, photogrammetric recording of the built heritage and a structured approach to public and stakeholder engagement. The findings of early studies (and in particular '*Bring your own heritage*') suggested that although the main driver for undertaking heritage-led regeneration work was economic (that is, a desire to realise an uplift in the local economy as a the result of such projects), there were consequential benefits in terms of cultural engagement and widespread awareness of heritage in a social and personal levels (Tait et al. 2016).

The funding context of the work was an applied study, undertaken in partnership between the local Council, a local University, local economic development bodies and voluntary organisation, and supported through a combination of public and private money, including the Heritage Lottery Fund. The project aimed to utilise digitally documented information pertaining to the built heritage, with a view to these being used to (re)present that heritage to the local population, tourists and potential visitors to the area. Therefore, the work aimed to follow the lead of previous research work, and use an innovative combination of digital tools as a method to generate interest and foster engagement in the wider population.

3D HIGH DEFINITION LASER SCANNING

The technology applied during the research involved surveying techniques including 3D scanning, photogrammetry, and the provision of online access to selected 3D models for representation and modelling purposes. Laser scanning has been developing into a standard tool for cultural heritage, and research applications have ranged from heritage preservation and sites conservation to architectural heritage (Hakonen et al. 2015, S. Al-kheder et al. 2009, Lambers, et al. 2007). Sites and structures, statues and monuments with historic significance can be monitored in their existing situation, hence allowing relevant professionals and organisations to consider conservation or restoration issues.

Laser scanning was the predominant surveying technique used as it facilitated data capture to a high degree of accuracy and covered entire urban areas. The scanner utilised for the project was Leica C10 3D scanner (Figure 1), and provided a rapid and accurate record of the built environment, not only in relation to buildings but also with a focus on monuments and landmarks. The scanner is suitable both for interior and exterior scanning, and has a scanning range of up to 300m (Leica Scanstation). The end result consisted of a point cloud that represented the collected (scanned) points, while photogrammetry methods were overlapped to provide site specific colour data. The resultant point clouds are dense, precise and highly accurate, and represent precise geometric detail from the physical environments.



Figure 1: The Leica P10 3D scanner on site (Elgin, High Street)

Advances in the fields of photogrammetry, online access of data and 3D mapping meant that the data could be translated into formats which were accessible and comprehensible for the wider public. This was achievable through transforming the raw data/ point clouds and by combining them with other visualisation methods for 3D modelling and data exploration. The widespread availability of mobile applications supporting the creation of 3D surface models from photographs (photogrammetry) was one of the additional techniques used, which allowed the data to be publicly available. The software packages used for this purpose were Autodesk Memento and 123D catch. Furthermore, the transformation of the point clouds into 3D mesh objects, allowed for the public viewing of models online (via Autodesk Memento). Hence, even though the initial data collection was rather technical, required professional equipment and was time consuming, the final results were immediately available.



Figure 2: Bracos Banking House, Elgin High Street



Figure 3: 3D surface model of Bracos, developed from point cloud data

20 selected sites were digitally recorded, by applying these cutting edge HD surveying and 3D visualisation techniques. The sites were selected due to their perceived high heritage value, and for purposes of conservation and visual recording. The specific sites involved monumental buildings, including Saint Giles Church, the former building of Royal Bank of Scotland, Thunderton House (a former Royal Palace), and larger sites, including the entire central (High) street of Elgin (as shown in Figures 2 and 3), side streets and closes. Furthermore, smaller elements, including statues, crosses and carved coats of arms were also part of the project requirements, thus conveying the genius loci, the feeling of the town and the environmental character, which is the essence of the place (Norberg-Schulz, C., 1980).

STAKEHOLDER PARTICIPATION AND PUBLIC ENGAGEMENT

A novel dimension to this project was the involvement of a wide constituency of stakeholders and public engagement. A focus group was conducted in October 2015 with the project partners (Moray Council and Elgin Library) to agree the project activities. Following this, a series of 12 in-depth qualitative interviews were conducted. The interviews were mainly drawn from the partnership group of the Castle to Cathedral to Cashmere project and included a diverse range of local stakeholders including: local and regional economic development institutions, local heritage groups, representatives from the business community and the library. These interviews were conducted to determine the strategic perspectives and motivations for local communities to undertake heritage projects and explored themes such as economic development, tourism and cultural resilience. The interviews were particularly focused on the opportunities and challenges of using digital technologies such as laser scanning and visualisation in local heritage initiatives.

Interviewees were very positive about the history and heritage of the area drawing attention to the links with Macbeth and other historically significant events. It was noted, however, that Elgin had challenges related to its geographical location and the fact that heritage sites tend to be dispersed rather than in a clear trail. Further, some noted that in the past there had been a lack of a 'joined up' approach to cultural heritage strategy with some groups operating in isolation. The interviews revealed the local political and economic drivers for capitalizing on local heritage. Several respondents commented that the local Council viewed heritage as a key economic asset and that they were keen to develop initiatives that showcased heritage including involving digital technologies to attract greater numbers of tourists to the area.

Interviewees discussed how the technologies could be used for this by encouraging tourists to come to the area with online exhibits and promotional activities, and also by using technologies in interactive exhibits and digital tourism trails which could provide visitors with additional information on areas of local significance. One interviewee commented:

I think the experience is about the story of the place through the buildings, through the people, and through the events. So a visitor gets an idea of not just the famous people who visited Elgin: Daniel Defoe, Bonnie Prince Charlie, Mary Queen of Scots, Edward the First, but begin to get the experience through the eyes of those who lived and worked there, the ordinary people, and of course the church people and the others. So there's that access to material that can help tell the story of a variety of levels. (Interview 1)

An interesting finding regarding the perceived benefit of digital technologies was that respondents viewed advanced technologies as being a mechanism for adding value to the built environment heritage by providing a 'wow factor' that was a distinctive offering that would make Elgin stand out from other areas that were competitors for tourists. Some interviewees reported that digital technologies could be particularly effective for engaging young people and the ability show how areas were in the past.

I think the problem with heritage and history is how do you bring it alive? How do you make it interesting? How do you make it something that's moving? ... And

that's where your technology can play a great part in that because with the 3-D images and suchlike you then can start taking bits away, you can introduce some other imagery and you can introduce background voiceovers, you can bring in music and so on. And it's just fantastic that what you do can be used to bring heritage and history alive, because that is, frankly, utterly key. (Interview 5)

Interviewees were, however, also aware of the limitations and potential challenges of technologies. For example, the restrictions and pressures on the local authorities' IT departments was raised as a challenge whereby the strict rules on IT policies and procurement mean that there can be lengthy delays. The fact that many projects area also dependent on project funding means that there are challenges of the sustainability of initiatives. These demonstrate the need for a partnership approach involving academics, heritage stakeholders and potentially private sector organisations which has been a critical success factor in the projects undertaken to date.

A series of user engagement events have been held during the course of the projects which have been developed in collaboration with the partner organisations. The first of these incorporated a public laser scanning demonstration. Attendees were recruited through a variety of channels and in order to make local expertise a part of the day we arranged for a local historian and author, Andrew Wright, to lead with a presentation about the scan area at Little Cross. Following this, 20 people came to Little Cross to view the scanning demonstration. A high definition scan was undertaken followed by a question and answer session, with the audience showing a keen interest in both local heritage and the ways in which scanning could be used to showcase it. The success of this initiative led to an invitation to conduct further public engagement workshops including a public lecture and demonstration at Elgin Museum attended by approximately 70 people which received very positive evaluations and, in keeping with the project objectives of engaging children and young people, a further participative workshop was held at Elgin Academy to around 100 schoolchildren.

A further two user engagement sessions were conducted with smaller numbers of participants to gain more in depth feedback about usability, functionality and design. Laser scan data was developed into an interactive 'townscape' using the Leica TruView, which facilitates the process for viewing HTML visualisations and were explored with a select group of six participants in individuals sessions lasting around 45 minutes each. Each participant was given a brief demonstration of how to control an interactive fly through of a 'High Street' scan and were then asked to navigate the model in whatever way they liked. It was noted that the degree of ease of interaction with the visualisation varied from person to person. Even so, all were able to navigate their way along the High Street, switch between different scanning points, with a little assistance from the researchers.

Several key points were revealed by the actions and comments of the participants. They were all impressed by the range of views that it gave them, especially that the scanner captured high features on the buildings and intricate architectural details. Most of the participants felt that the preponderance of signs indicating business properties for sale and to let gave a poor impression of Elgin, and several commented that the signs seemed more prominent in the visualisation than in real life. Each person found something in the flythrough that was of particular interest to them, such as historic dates stones or a milestone marking the centre of Elgin. Finally, participants all

reported that the flythrough visualisations might be enhanced by incorporating contextual information such as old photographs, narration, links to external content. Some respondents also suggested gamification and the integration of user generated content. Therefore, an interactive point cloud viewer with custom information overlays was developed to allow the users to explore the environment. The web based viewer was created using the open source Potree software library (http://potree.org/).



Figure 4: Potree interactive model

SUMMARY

This paper has described an innovative series of interventions regarding the built heritage, and the manner in which cutting edge technologies can be used to stimulate activity geared towards the adoption of heritage-led regeneration schemes. The multidisciplinary approach taken through the study is central to the methodology, and the importance of this technical/social ethos has been borne out through valuable data that can feed directly into local heritage policy and practice. The combined use of visualisation technology and qualitative stakeholder engagement supported an exploration of human-computer interaction, against the context of a desire to support heritage-led urban development and economic growth.

CONCLUSIONS AND RECOMMENDATIONS

This research offers important results which relate to both the methodology and findings from the engagement work. Firstly, the study has established a clear working method to support the collection of digital models pertaining to the historic built environment, including the mixed use of digital scanning and photogrammetry. The engagement work also provides evidence of the outputs from these technical phases being a route through which participants can find a way into the subject matter. This relates directly to the literature, and suggests a path for future research. It is recommended that further research be undertaken exploring that interaction, and to ensure that technical advances (particularly related to virtual and augmented reality) are incorporated in heritage strategies in a manner that embraces these findings. The wider aims of the local study, which concern drawing links between the intact built heritage and economic growth, connect with precedent in the literature, whilst building on findings concerning the demonstrated value of using visualisation to encourage and support debate regarding heritage, town centres and economic vitality.

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