The Use of Mobile Devices in Participatory Decision-making

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Abstract: Simulations have always been used for public participation in the form of maps, photos, sketches and models. Technological developments in computing and mobile platform have brought a new perspective to simulations and their use for participation. To our best knowledge, no in-depth study has been conducted related to the strengths and weaknesses of mobile device 3D visualisation use in landscape architecture. Therefore, this paper investigates the opportunities and challenges and mobile device use during a participatory decision-making process, with the help of related literature and experiences from the surveys conducted. Although pre-prepared visualisations have positive influence on engaging the public and enhancing the understanding, there is still need for future research to decide which specific mobile visualisation technique is advantageous compared to the rest of visualisation techniques.

Keywords: Mobile device visualisation, 3D landscape visualisation, participatory decision-making, public participation

1 Introduction

Mobile Devices (MD) have entered into the daily life of millions and become an important part of it thanks to the advantages in the fields ranging from communication to navigation. Mobile device use has increased considerably in recent years as they allow users to perform various tasks. They have been in use for making calls, texting, browsing internet, checking emails, downloading apps, paying bills, playing games, downloading and listening to music, social networking, taking pictures and recently for accessing and acquiring information and manipulating data. Although MD are still not as capable as computers for performing tasks, they have the advantages of ubiquity, portability and of being lightweight and context aware compared to their predecessors (MOSMONDOR et al. 2006, LEBUSA et al. 2014). People have adopted these compact devices quickly as it is advantageous to be reachable anytime, anywhere and to do nearly everything that used to be done with larger computers. Unlike computers, MD give more freedom to users without requiring any kind of dedication for place and time of use. Their penetration into all areas of life and are simultaneous has brought significant advantages to engage people wherever they are.

But what does it mean for visualisation and public participation? LOVETT et al. (2015) indicated the increase in use of visual realism for landscape visualisation and the necessity for visualisations to be more understandable for the intended audience, as it is required to engage public during decision-making processes. Simulation has long been used in landscape research. With the advent of mobile devices, previous simulation techniques can be supported or replaced by this new technology. Mobile technology allows users to use their MD whilst on the move with a varied selection of applications. Users can explore, experience and evaluate the visualisations on these devices thanks to new advancements on the platform. These advancements, with the help of interactivity on mobile devices, support engagement during

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a visualisation process (LEBUSA 2014). MD also allow users a better understanding of a space or plan (BILGE et al. 2014) by letting them move between and beyond different environments or contexts in order to investigate and evaluate them.

This paper essentially focuses on the use of pre-prepared mobile 3D visualisation during the participatory decision-making process and the opportunities and challenges for landscape architecture. Section 2 offers an overview on visualisation for participation, while Section 3 provides a synopsis of mobile technologies for visualisation. In Section 4 strengths and weaknesses of mobile devices for visualisation and participation are discussed. Finally, a conclusion is given in Section 5.

2 Visualisation for Participatory Decision-making

BRUCE, GREEN & GEORGESON (1996) estimate that 80 % of man's perception is based on sight. It is stated that compared to audio and textual, visual information is perceived by the human brain in a more effective way. Visualisation materialises abstract ideas into simulations and models by transforming invisible plans to visible translations and simulations have long been in use for landscape design and planning (LOVETT et al. 2015). Various tools have been adopted and improved for this transformation process as technology advances. The advances in the computing field and mobile platform have led improvements in landscape visualisation and interactivity on MD.

Landscape visualisation is a representation of the real world that can be displayed as 3D simulations with various levels of realism (LANGE 2001). It may demonstrate past, present conditions or future scenarios (LEWIS et al. 2005). Therefore, landscape visualisation makes it possible to display scenes that are non-existent (e. g. current state visualisation of altered land use, possible future design scenarios). These can be represented as static, animated or interactive scenes (SHEPPARD & SALTER 2004) and immersive or outside of context (LANGE & BISHOP 2005). MORGAN et al. (2009) defines interactive 3D visualisation as "simulation employing real time 3D graphics to represent the visual form of an area of landscape in which the user can control the viewing position to freely explore all the aspects of the land form." Landscape visualisation is used to represent the experience of standing at predetermined viewpoints displaying fixed images (LEWIS & SHEPPARD 2006). Several studies have adopted an interactive approach, using a walk through presentation, for the participation process to allow participants to walk or fly through the virtual environment (AL-KODMANY 2011). The findings from the studies suggest that visualisations can enhance public participation by allowing lay people to meet experts and professionals for proposed projects (HAYEK 2011, SCHROTH 2010). Visualisation has been adopted for a range of projects associated with the participatory planning approach (AL-KODMANY 2011, HAYEK 2011, LANGE & HEHL-LANGE 2005).

Human perception towards 3D visualisations has been studied in recent years by comparing visualisation and its effectiveness. According to comparisons made between visualisations and realism, computer generated environments still need to be developed in order to demonstrate a high degree of realism. There have been numerous studies investigating the degree of realism depicted in images, especially in regard to vegetation and moving objects within the virtual environment (LANGE 2001, BISHOP et al. 2001, LANGE & BISHOP 2005, LOVETT et al. 2009). However, further study is required for future projects to improve the degree of realism, as well as to raise awareness and stimulate public participation.

3 Mobile Device 3D Visualisation, a Case Study

Mobile device 3D visualisation presentations can be presented under three titles: "AR mobile", "pre-prepared mobile" and "on demand mobile" (GILL & LANGE 2015). "AR mobile" renders and integrates virtual content with real world environments; "pre-prepared mobile" displays visualisations rendered in advance for the predetermined areas of a site, and "on demand mobile" represents user specific visualisations from a pre-prepared 3D model (GILL & LANGE 2015). Our work concentrated on pre-prepared mobile visualisations. A pre-prepared walkthrough video was displayed to share possible future changes with the public in Edward Street Park, Sheffield.

Edward Street Park was chosen for the European Union VALUE+ project as one of the six real world project sites in North-west Europe. And because of its location in an urban development area, St Vincent Quarter; its close proximity to the city centre and two universities in Sheffield; poor layout and multicultural population of immigrants and students (INTERREG IVB, 2010). Sheffield City Council redesigned started the renovation in 2012 and it was officially opened on 28th September 2013. At that stage there was extra funding to make additional changes: about 30 percent of the whole project area.

Fig. 1:
Pre-prepared representation on-site

Fig. 2:
Making sketches on ZoomNotes

To be able to test the usefulness of mobile device visualisations, the current condition model of the site was prepared in Trimble Sketchup. Additionally, a-minute-long walk through animation was prepared with the help of Walkabout3D (Deliverance Software) in order to have the public's opinion about the tool. The researcher was located in front of Castle House onsite this had been determined to be most used location within the site: inhabitants and visitors pass by on their way to grocery shopping (Tesco); or are transiting through this location by using the stairs from Solly Street or Upper Allen Street; tram users also arrive at the tram station and cross this area. The survey was proposed to any person passing by on site, without discrimination, and briefly explained as related to the amelioration of the area. Those willing to participate were first shown a one-minute-long video on an iPad (Figure 1) and then asked to answer survey questions. Those were based on the visualisation, the design of the park itself and the use of mobile device. 125 people participated in the survey.

Fig. 3:
Walkabout 3D application on an iPad

The same video was shown asking the public their opinions regarding possible changes to the site later that year. All participants were asked to suggest changes by drawing sketches using ZoomNotes (a mobile note-taking application by Deliverance Software) for iPad: the software is accessible to all without pre-requisite drawing skills, and a short induction was provided. Moreover, students from the University of Sheffield were informed about the study by email, resulting in 173 student volunteers to try the application (ZoomNotes) and to agree to give feedback about both the tool and the visualisation. Those volunteers were invited to the University of Sheffield Information Commons Library Café (Figure 2) to be informed about the tool application and made familiar with the site. Another sample of 100 people was asked while passing by on site if they would be willing to take part in the study. People interested in participating were informed about the project and the application and asked to make sketches as well. After these different phases of data collection, all the public suggestions were gathered and used to create possible future scenarios for the area. Part of the previous participants was contacted once again to explore the new visualisations with the suggested modifications, using on Walkabout3D mobile application (an app by Deliverance Software which allows generating panoramic walk-throughs). Walkabout3D (Figure 3) process for this research is still in progress.

4 Strengths and Weaknesses of Mobile Device Use for Participatory Decision-making

MD's ubiquitous use has strengths and weaknesses when it comes to landscape visualisation compared to other traditional methods. As technology advances, applicability and usability of visualisation on MD is being developed (CHI et al. 2013). The advancement in mobile technology and interactivity makes rendering visualisations on smartphones or tablets (LEBUSA et al. 2014). GILL & LANGE (2015) suggested that it is possible to classify visualisation tools according to their usability on-site, interactivity, connectivity, context and details provided in the model and number of audience reached. In this section, we will focus on the strengths of mobile device visualisations, particularly "on demand mobile" and "pre-prepared mobile" representations, and their use for planning and design processes. Through this work we have identified several advantages and disadvantages of mobile device use during participatory decision-making.

4.1 Strengths and Opportunities

In the technology era, people often prefer accessing the information in a quite shorter time and with less effort. With the ever-increasing improvement of existing technologies, mobile technology is becoming more powerful and versatile (CHI et al. 2013). As a result of their being smaller and cheaper, these compact machines become more popular.

Portability and Mobility: MD take advantage of being placeless as they allow users to be reachable anywhere anytime because of their size and weight (CHI et al. 2013). Moreover MD can reach various audiences (MILLER et al. 2008 as cited in Lovett et al. 2015) as the number of users in the general public increases. With the consideration of not being expected to put any effort or extra time in compared to other visualisation techniques, it could be treated as a departure point to suggest that MD are the standard technique to entice users.

Ubiquity and availability: Nowadays MD are ubiquitous thanks to their easy accessibility (GILL & LANGE 2015). The advancement in technology and their accessibility have contributed to the ubiquity of 3D enabled smart phones and other MD. In the near future with the oncoming advancements, it seems possible that MD 3D visualisations, out of lab or on-site, could be adopted as the standard approach for landscape planning or decision-making processes (LANGE 2011).

Accessibility, location and time: Mobile phone applications have mushroomed over the last couple of decades. It is possible to find any kind of application in any field. In the landscape planning and design field, there are applications ranging from sketching, designing and sharing to identifying plants apps using various instruments such as cameras on the mobile device itself or stylus pens as mentioned above. These applications are available to anyone freely or for a certain fee. The ubiquity of these compact machines (LANGE 2011) and the increase in the number of people owning/using a smartphone (GILL & LANGE 2015) could influence the number of people reached correspondingly. MD let users render visualisations anytime and anywhere by using already entered geographical data. The timeless and placeless quality of these devices makes it possible to reach a vast number of users. As the number of users able to access visualisations expands, so does the opportunity to increase public participation during planning, design and the decision-making processes.

Interactivity: Interactivity is one of the most influential aspects of content for 3D visualisations (LOVETT et al. 2015). In 3D visualisations it is increasingly adopted increasingly by planners and landscape designers and interactivity for 3D mobile visualisation have become even more convenient (GILL & LANGE 2015). Graphic capabilities on MD, which were inconceivable before, have been boosted significantly in the last few years. Although MD do not have sufficient space for physical buttons to experience interaction, researchers have been examining new methods for interaction on these devices (HARRISON et al. 2013). Interactivity on MD gives users the freedom to choose any viewpoint and to explore the area without putting in any extra time, money or effort (LOVETT et al. 2015). Therefore, mobile device visualisations can be seen as a useful enhancement tool for public participation.

Context awareness: Immersion is another significant aspect of 3D visualisations. One of the latest developments in the area is that MD allows users to see the visualisations on these "movable windows" as a real-time superimposed view (LOVETT et al. 2015). This development can provide an opportunity to display the future proposals or other information pertaining to the real environment in which users are immersed. The user is expected to position the device toward the point they wish to view. With the movement of the screen, the viewer can see the virtual space within the real-world view. Latest developments in this area have removed the barriers of pre-rendering. MD, now, give the freedom to display the environment from several of angles and distances (LOVETT et al. 2015). Although viewing the areas in real-time without pre-preparation is part of the strengths that mobile device visualisations offer, it still needs to be improved to reach a higher degree of realism especially in the rural areas (TAIGEL et al. 2014 as cited in LOVETT et al. 2015).

User: From the user point of view, the choices are endless for MD. Since MD's 3D visualisation displays virtual elements superimposed and renders the viewpoints from the location where the user stands, it allows convenient comparison between current condition and future changes (GILL & LANGE 2015), therefore, it has great potential in engaging the public.

In spite of the strengths mentioned above, there are still barriers to be overcome. If these improvements are implemented, there is a strong potential that MD 3D visualisations will become a standard technique for landscape planning and design processes by means of public participation.

4.2 Weaknesses and Limitations

Although remarkable developments have been made in the computing field and mobile technology sector, several limitations still exist for MD that need to be overcome considering their use for landscape architecture. In spite of the advancements, MD may still lag behind for specific tasks compared to desktop devices due to comparatively limited capabilities. In this section, we present the weaknesses and limitations of the current state of the art of mobile device use pertaining to landscape planning and the decision-making processes. The significant barriers are elaborated as follows under five categories:

Display, detail and realism: One of the significant aspects of the content of 3D visualisations is the degree of realism reached. LOVETT et al. (2015) state that "we consider "detail" as meaning the representation of smaller-scale visual variation (such as a representation of blades or clumps of grass as opposed to flat green ground) and "realism" as meaning the degree to which a visualised scene or element resembles its real-world counterpart." However, fast technology advances, the real environment surrounding us will always be larger than the virtual environment (ERVIN 2001 as cited in LOVETT et al. 2015). Ongoing advancements in the computing field (especially graphics and processing capabilities) have allowed the creation of increasingly detailed visualisations on computers (MEKNI & LEMIEUX 2014). Nonetheless, MD still need to overcome limitations pertaining to display, details and quality (HARRISON et al. 2013). Realism requires transparency and trust between the user and producer, as potential changes may not end up looking the same as the producer rendered and the user saw in the visualisations (LOVETT et al. 2015). However, it is more of a visualisation matter than a limitation for MD. Though it is not possible to create more detailed visualisations on MD yet, as mentioned above, it could be considered a comparison tool to see real environment current condition and potential future scenarios.

Immersion: The third and hardest to achieve characteristic of the content of 3D visualisation is immersion (LOVETT et al. 2015). Large panoramic presentations have proven influence on public participation events, notably to trigger and sustain the discussions and provide a base for workshops and activities (SALTER et al. 2009). Although LOVETT et al. (2015) determined that the content and interactivity of visualisations' being salient and valid does not have a significant effect on immersion, it is however a disadvantage not being able to provide a full immersive environment as yet, as it could improve communication and collaboration to pass information on MD still stays as a disadvantage. Another weakness of the MD lies in their being placeless (HARRISON et al. 2013), in respect to immersion and context. As people can use MD anywhere, therefore it is anticipated that they could be distracted by surroundings, people, activities or objects while using the device for visualisations.

Connectivity, speed & processing capability: As a compromise to provide mobility and portability, the computational power of MD is not as high as desired for MD, and connectivity is usually not reliable and slow (MEKNI & LEMIEUX 2014). There have been recent improvements in graphic capabilities, color displays, powerful processor, and the ability to render at "interactive frame rates" (MOSMONDOR et al. 2006). In comparison to computers, mobile technology offers greater room for improvements in terms of processors and graphic capabilities. MD does not mostly provide large memories for users to save/store bigger files or visualisations (MOSMONDOR et al. 2006). In addition to insufficiency in speed, memory and processing capability, there is also another concern about the batteries. Since MD is not mainly designed for visualisation, the use of visualisation applications drains the small, powered battery in a short time (NOGUERA & TORRES 2012).

Small screen size: MD were designed by setting portability as one of the priorities, therefore it logically led to smaller sized gadgets with smaller screen sizes (HARRISON et al. 2013). Small screen sizes can only display a certain section of the visualisation (MEKNI & LEMIEUX 2014), otherwise it results in loss of details in the visualisation.

Users and usability: The human factor can be seen as both an advantage and disadvantage. In spite of the increase of the general public's use of MD, some parts of society still have poor access to it (e. g., the poor and elderly). Moreover there might be people refusing to accept the concept (MEKNI & LEMIEUX 2014). If the mobile device is only used with the guidance of the researcher, then MD may not be as successful in reaching a larger number of people. A mobile device usually allows only one person to display the visualisations unlike larger panoramic screens that can serve multiple audiences simultaneously (LOVETT et al. 2015).

5 Outlook

The advent of technology affected the way people interact and communicate with others. According to the survey results, the level of realism of mobile device visualisations has been rated as good. Participants agree that MD support an understanding of the space and scenarios presented and they regard these compact tools quite helpful. Almost 80% of participants are in favour of using the devices again for visualisation purposes if they are given the chance. For the preparation of the video, timing of the video was one of the key issues. It proved difficult to sustain people's attention for a long time with a pre-prepared walkthrough video of the whole area. Additionally, if the pre-prepared visualisation was walking through the site at a faster pace; it was again difficult for users to process the surroundings.

People who were asked on-site to participate in the study were not willing to try the features ZoomNotes offered. The longest time spent on ZoomNotes on-site was 7 minutes while the longest time spent for the volunteers off-site was 45 minutes trialing all the features the application offered. It can be interpreted in different ways. On the one hand, local people knew the site and future changes in question; therefore they might have restrained their imagination by drawing only what they deemed realistic changes, using a shorter time. On the other hand, volunteer non-local participants did not know the site and therefore were more prone to suggesting not-to-scale solutions or activities such as preparation of bike races in the area. Another interpretation is to question the willingness of participants to spend time on the survey: as locals were recruited arbitrarily on site whereas the second sample was consisted of students recruited by voluntarily participation.

After reviewing the relevant literature, conducting surveys and observations, it can be deducted that 3D visualisations have a strong potential for overcoming the barriers of communication issues between users and professionals.

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