

Delivery of Interactive 3D Content via the World Wide Web to Aid in Public Participation in Planning Proposals

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Abstract. *Public participation has become an important task for urban planning projects, but due to a lack of interactivity, immersion and feedback on the tools that has been utilized so far for this purpose, the current practice is limited. In providing a web-based virtual solution the current limitations can be reduced and transparency in the planning process can be increased. This paper presents the outcomes of a small study where three online options were tested by various stake holders.*

Keywords. *City modelling; public participating; virtual reality; web platform.*

INTRODUCTION

Architects are increasingly adopting three-dimensional (3D) modelling tools and virtual city models (VCM) as aids for the design and communication of proposals. This increasing interest in 3D urban simulation is providing innovative possibilities for communicating project designs. One of the forefront simulation tools being applied to urban planning is that of virtual reality (VR), allowing users to interact and explore a simulated environment. With computer technology rapidly becoming more powerful and affordable, the application of this field has grown in recent decades (Howard and Gaborit, 2007). Although VR applications were until recently primarily limited to local use on computers, recent advances in web technology and broadband speeds are allowing virtual environments to be accessed over the World Wide Web (WWW). This solution is providing a very flexible way of interpreting any given model using a suitable browser (Smith et al., 1998).

This study investigates the application of interactive 3D visualisations to improve the understand-

ing and communication of planning proposals. The study highlights how current technology allows for 3D contents to be accessed and explored via the WWW. It is suggested that such a web-based tool would help to improve public participation and engagement in the planning process. Howard and Gaborit (2007) state that public participation has become an important task for urban planning projects, but highlight that due to a lack of interactivity, immersion and feedback, the current practice is limited. In providing a web-based virtual solution, the hope is that current limitations can be reduced and transparency in the planning process can be increased.

Public Participation in Planning Proposals

Public participation has become an important task in the development of major urban planning projects. This fact has been aided in recent years by the EU strengthening its directive for a more open public participation process. However, currently public

consultation in the UK is usually presented as a hearing, often in a public building at a given time. Plans, posters, 2D visualisations and physical scale models are often used to express the developments design and intent. People are free to debate the project and leave feedback, usually comments written in a notebook. However these ways of consultations are often limited (Howard and Gaborit, 2007). Not only in their availability to a wide range of people, but also in the media that is presented. The public are only able to view proposed designs based on the images presented, with no way for people to immerse themselves in the proposed environment and navigate freely to pick their own perspective. Feedback is also restrictive, often subject to informal notes with a lack of precision. Howard and Gaborit (2007) highlights that it is difficult to write a comment on a specific object or view without a clear reference, stating that this is a direct consequence of the lack of interactivity, as it is hard to comment on a specific view that the public cannot see. These limitations lead to non-exploitable results for planners and can explain the lack of interest in urban planning from the public (Allmendigner et al., 2000; Laurini, 2001).

3D City Modelling

Research shows that 3D city models presented using Virtual Reality (VR) technologies as a tool for urban planning are becoming increasingly utilized worldwide. And the number of VCMs being created by municipalities, local and national councils, surveying agencies, educational institutions and other organisations is steadily increasing due to the significant advancements in 3D reconstruction methods (Ross, 2012). Morton et al. (2012) identified more than one-thousand VCMs across the world. Such platforms allow designs to be more accurately and efficiently developed and assessed within their context.

In some cases interactive 3D models have been used as a communication tool in public meetings to facilitate public participation in planning and design development review; however this means that the interested parties need to attend a pre-organized event where the navigation is often controlled by a

single user. Although feedback on such demonstrations has been positive and 3D simulation technology reported to help the public to better understand planning and design proposals (Kim, No Date), in order to increase the transparency of the planning process and to facilitate public participation, such virtual environments would be better accessed online. This is becoming more apparent as acknowledgement of the advantages of utilizing 3D city models becomes more widespread, increasing the likelihood that interested parties will require access to respected city models and 3D contents.

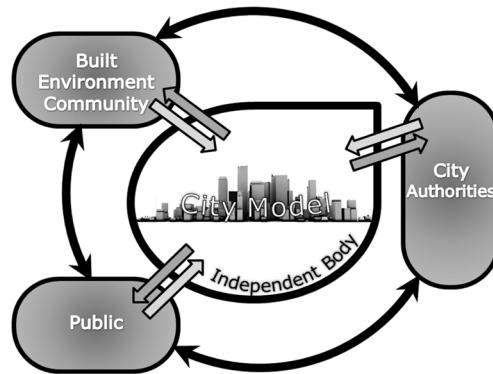
By adopting a delivery via the internet Knapp et al. (2007) highlight that public participation could take place independently of time and space: with the user free to choose, when, where and how often they wish to view the project and to participate in the process. It is clear that such a solution could widen the range of people already participating in planning processes, as those who did not have the opportunity to do so, due to handicaps, inconvenient working times, etc. would be free to access 3D simulations without such restraints.

VIRTUAL NEWCASTLEGATESHEAD (VNG)

Newcastle upon Tyne are neighbouring urban centres in the North East of England. VNG is a collaborative venture between Northumbria University, Newcastle City Council and Gateshead Council to create a 3D digital model of the city centres of both Newcastle and Gateshead. Hosted and managed by The Department of Architecture and built environment in the Engineering and Environment Faculty at Northumbria University, VNG has a proven record of being significantly more precise than alternative global visualization engines and as such is regarded by both local authorities as an appropriate and accurate tool for urban planning related activities.

The aims of the VNG project, defined from the outset, were to support the urban planning process for both local authorities, currently challenged by significant levels of regeneration activity (Horne M., 2009). The coverage of the model is currently being

Figure 1
Sharing VNG (Horne, Thompson, Charlton, 2013).



extended to approximately 104 km² in order to accommodate the city's future development targets to the north and north-west of Newcastle including land around Newcastle International Airport and northeast towards the Port of Tyne.

As part of the urban planning process the VNG model is providing a tool with greater accuracy and efficiency for all parties, by way of effective and efficient communication, greater certainty, quicker decisions and significant time and cost saving (Thompson E et al., 2011). As outputs, a number of visual options are available to assist in communicating proposed developments; virtual snapshots, Accurate Visual Representations (AVRs – or photo-montages); animated fly-overs and walk-throughs and even 3D printed models. However, currently the outputs from VNG and many similar applications of virtual city models are restrictive in what is presented to the user.

Table 1
Scoping Study- tools.

Tool	Type
Sketchfab flat colours	WebGL
Sketchfab textures	WebGL
3DVia plugin	Bespoke plugin
Sculpteo	WebGL, Java, Flash and JS
Autodesk Project Freewheel	Cloud based rendering
Unity	Bespoke pulg-in

Sharing VNG

From the outset of VNG the aim was to share and utilize this model with all stakeholders (*built environment community, councils and public*) (Figure 1). Currently this is only possible via direct 3D data exchange between the hosts (Northumbria Univeristy) and the two local councils. Although this interaction currently meets the needs of the two councils by facilitating better collaboration between planners, architects and decision-makers, the current process is limited to those have the rights to access and to the amount of data that can be released. For the accessibility and useability of VNG to increase, easier secure and more open access methods need to be established. In particular, public access to asses new developments in the city is an essential service that needs to be established in order to showcase the possibilities and use of VNG. Such access is more likely be made available via the WWW.

In order to assess possible web application to aid in public access to VNG, various internal investigations have been conducted. Within each completed scoping study two key considerations took central focus; data security and usability and accessibility. It is essential that any final tool is considered secure, preventing unauthorized access to the data, and user friendly and easily accessible.

One of the initial scoping studies completed early on in the investigation aimed to identify current possibilities for showcasing 3D data on the internet. Several web based browser applications were identified and considered accessible and usable for publishing 3D contents online (Table 1).

During the scoping study two important attributes of viewing 3D web content; file format of the original digital data and platform for presenting this data, were established as key factors in determining the overall accessibility of the data. The ability to use bespoke or non-native web browser plugins that enable a user view 3D data can differ greatly between a member of the public who accesses the internet from home and who is free to try different web browser and plugins, to a member of a corporation/government body that has robust IT security

policies which disable users to download these different plugins etc.

INVESTIGATING THE POSSIBILITIES OF USING INTERACTIVE 3D CONTENT ON WWW

The origins of the project came from regular consultations with Newcastle City Council and Gateshead Council about the future development of the VNG model. It was identified that a web platform where planning proposals could be viewed by public could potentially assist and enhance the public participation process. In providing a web-based virtual solution, the current limitations could be reduced and transparency in the planning process increased.

From the outset, data security in any VNG project is of upmost importance, since some data can be commercially sensitive and all data has copyright issues attached to them. In parallel to the aforementioned scoping study, an analysis of online data security issues was also completed in order to identify solutions which allow for legitimate access to the model for authorized viewing, whilst preventing that access being exploited so that the complete model may be downloaded.

Data Security Issues and Hosting the 3D Model

The main requirement behind the data security issues was to enable authorized users to view and navigate through the VNG data over the Internet on a standard pc, laptop, or tablet etc. and in the meantime not allowing users to copy the VNG data in digital format for sale, or unauthorized reuse.

After some investigation, it is believed that a secure architecture is possible to allow VNG to be made available over the internet in a way that its data may be protected. Possible secure network architecture consisted of (Figure 2):

- VNG browser is a software that can ideally run on any computer
- Public accessible portal computer is connected to the Internet. However it will only accept Internet connections from the VNG browser

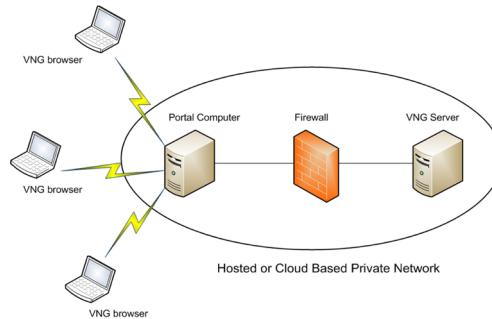


Figure 2
Secure Network Architecture
for VNG (Ellman J., 2013).

identified by secret key

- Firewall is configured to accept connections from the portal computer's IP ONLY and using distinctive port.
- VNC Server holds the VNG model. There is no direct public Internet access to the VNG server (Ellman J., 2013).

The secure architecture described above refers to a number of servers. This might imply a significant upfront investment, but this is not necessarily the case. Cloud computing now allows server capacity to be rented at very modest cost. In addition, several companies offer services based on Cloud Computing at a reasonable cost.

Any of the above solution to secure and host the model on the internet will come with a cost. It is believed that any possible solution will offer security in proportion to their costs. A cloud based hosting solution can be implemented reliably and securely. This way hardware costs are transferred into the revenue budget, and will be considerably lower than the purchased hardware. However, software configuration and installation time could be around two-three weeks. This configuration though would resist most attackers. The most expensive and most secure configuration would be through locally owned, operated and hosted hardware (Ellman J., 2013).

3D Data Delivery Options

Following feedback and findings from the initial scoping studies it was decided that three separate solutions should be developed in order to evalu-

ate showcasing VNG on the WWW. Two solutions; SketchFab and Sculpteo would take advantage of Cloud Hosted Service Providers, the first requiring a non-native plugin to be downloaded and the second adopting native web technology. The final solution; Unity, would take advantage of games engine technology and as such would require a bespoke plugin to be downloaded in order to view 3D contents in a web browser. This final solution is considered the least secure as it requires data to be downloaded to the user's computer, but such a solution would be expected to offer the best user experience for viewing the 3D contents. In order to keep the VNG data secure and keep live planning applications safe, a hypothetical development had been develop to showcase the technologies and test its use.

Gathering Feedback

As mentioned above the three options identified for delivering 3D contents via the WWW were:

- *Option 1:* Web browser application with widely used plug-in (WebGL) [1]
- *Option 2:* Web browser application native to all web browsers (Java, Adobe Flash Player, etc.) [2]
- *Option 3:* Web browser application with one off specific plug-in upload for viewing 3D contents [3]

In order to gather a wide spread feedback on the above three options and find out how users interact with this technology, an online questionnaire was prepared and distributed to local government, industry partners and to the general public.

RESULTS AND DISCUSSIONS

In total 324 questionnaires were sent, with a return rate of 20.3%. Questions were organized around three main sections; understanding the user (oc-

cupation, access point, access tool, access software, whether they are able to install software on the computer they are using), 3D data options and their usability and general feedback.

The survey designed to find out three key interconnected issues with regards to presenting 3D City Models on the internet: *accessibility, usability and potential.*

Respondent's profile

Results from the questionnaire indicated that more than half of the respondents were from a design professions that engaged with the planning application process, with only a small percentage (12.1%) of respondents a member of the local council. Although this small percentage can be directly related to the local authorities' internet access policies, it is encouraging to see that design professionals are interested in using diverse technologies to represent their designs in the city context (Table 2).

Of the completed questionnaires, 87.5% of these respondents were participating from work, where in some cases a secure network access to internet and robust IT protocols are in place. This is echoed by the results which show that more than half of the respondents did not have admin rights on the computer they were using (Table 4) and as such would have not been able to install any necessary plug-ins. Similarly, 78.1% of them were using Internet Explorer to access the 3D City Models, followed by 12.5% with Chrome and 3.1% with Safari and 3.1% Opera web browser. These latter results are key findings, since Internet Explorer requires the installation of plugin to view two of the three options and the majority of respondents would be prevented in doing so. This is an important point for any future, permanent solution which would need to consider these restrictions.

The finding also showed that the majority of respondents were using a PC or a laptop which we believe it directly related to where they are answering these questions from (Table 3). None of the respondents used iPhone, Android tablet or a phone, windows tablet or a phone. If and when the 3D City

Table 2
Respondents.

Member of a local council	12.1%
General public	28.8%
Architect, urban designer, other design professional, etc.	59.1%

Models on the internet become widely used accessibility from tablet format computers will be increasingly important. This also leads of using augmented reality applications with regards to observing the new proposals in context at the real site.

Potential solutions for showcasing VNG on the WWW

Accessibility of the options (Table 5) and the plug-in installation shows a direct correlation (Table 6) and as stresses the point that any future, permanent solution which would need to consider the advantages and restrictions a plug-in solution offers.

Overall rating for all the options (Figure 3) showed that Option 3 was popular due to fact that it was smooth to navigate and had the better visual appearance.

58.8% of the respondents stated that the techniques presented in the questionnaire is an easy and effective method for communicating for planning proposals (Table 7), and 80% of the respondents would like to see such techniques used for major developments within the region to aid in communication of the proposal and for public participation purposes (Table 8).

This small sample of respondents showed that presenting new developments in the city via using 3D City Models on the internet will be a desirable option overall. However accessibility and usability issues need to be tackled in order to get wider participation, especially in council workplaces where robust IT protocols prohibit the installation of plugins. As such any solution will require collaborations with the councils in order for the planners to access the information via their work computers.

The results show that such restrictions do not play such an important role in public, home access, but they would need to be consider if public access to proposals where to be granted from public computers, such as those located in a library. With any final solution, it is also important to sort the data security and network architecture for hosting the model on the internet.

A PC/laptop	90.6%
A Mac	4.7%
Other (Thin Client)	3.1%
IPad	1.6%

Table 3
Access technology.

Yes	35.9%
No	57.8%
Don't Know	6.3%

Table 4
Admin Rights.

Option 1	42.3%
Option 2	2.8%
Option 3	85.7%

Table 5
Accessibility of the options.

Option 1	56.9%
Option 2	81.8%
Option 3	34.1%

Table 6
Requirement of plug-in installation.

Yes	58.5%
No	14.6%
Don't Know	26.8%

Table 7
Easy and effective method of communicating.

Yes	80.5%
No	9.8%
Don't Know	9.8%

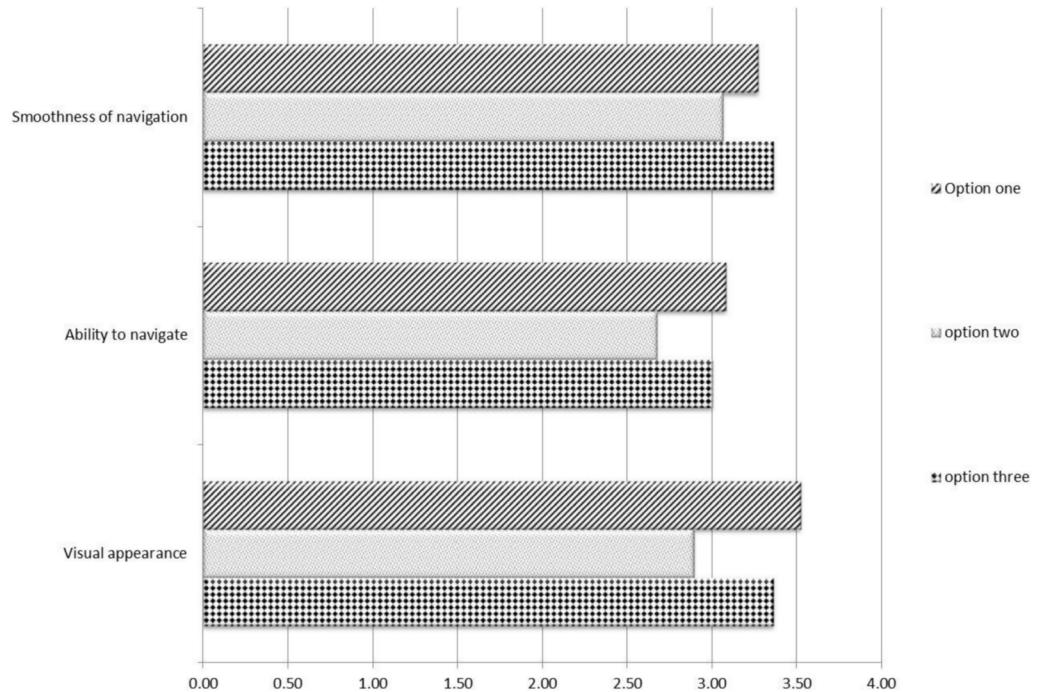
Table 8
Like to see such techniques used.

CONCLUSION AND RECOMMENDATIONS

Based on the finding of this project, further projects implementing the solution for delivering 3D contents via the internet securely will be executed. As such, this can now be adopted into the business framework of VNG to allow for future planning proposals to be placed within the context of the VNG city model, and showcased via the WWW. This solution can be offered as tool for increasing public participation for proposed developments. Such a solution would be seen as a benefit to all parties (planners, architects, local councils and the general public) involved in planning applications.

Next steps will be furthering this pilot study and engaging with Newcastle City Council and Gateshead Council in order to find ways of linking VNG on WWW with their online planning portals. They have expressed support for this initiative which would move them towards a 3D virtual model optimised

Figure 3
All three options' overall
rating.



for public consultation purposes, allowing greater access to, and understanding of, the development of the city.

Also by utilizing already established links with RIBA and Northern Architecture commercial opportunities for a web-enabled VNG could come from offering a version for architects / developers to promote their projects / services.

Also investigations on use of VNG on WWW for marketing and tourism to promote / market retail activities can be done.

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