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Citation: Horne, Margaret (2009) A Tale of Two Cities: A Strategic Approach for City Modelling on a Regional Scale. In: CUPUM09 11th International Conference on Computers in Urban Planning and Urban Management, 16-18 June 2009, Hong Kong.

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A Tale of Two Cities: A Strategic Approach for City Modelling on a Regional Scale

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Abstract: This paper presents an analysis of the issues emerging for the development of Virtual NewcastleGateshead (VNG), a project which is exploring the creation of a three-dimensional computer model for two adjacent cities, Newcastle upon Tyne and Gateshead, in the north eastern region of the UK. It builds upon previous research into virtual city modelling which examined the role played by academia in the development of city models and describes a strategic approach focused on developing a regional virtual model which supports particular organisational aims. It adopts a case study methodology to present a systematic analysis of discussions over a two-year period, 2007 to date, between key stakeholders. The paper analyses requirements, benefits and issues emerging if academic institutions are to extend their existing roles as research providers and city model builders, and consider a *hosting role* in the development of regional city models.

Keywords: NewcastleGateshead, city modelling, urban planning, strategic management, hosting

1. INTRODUCTION

Virtual Reality (VR) technologies emerged in the 1950's, but at that time were expensive, relying on specialised computer hardware and software, with initial applications mainly focused on the military and engineering sectors. The concept of a virtual city model of Newcastle upon Tyne, a city in the North East of England, can be traced back to the mid 1990s, and many major developments in both Newcastle and neighboring city Gateshead have used interactive computer models to help visualize development proposals. Since that time, and in particular post 2000, there have been major advances in the performance of hardware and software, and three-dimensional computer modeling and VR can now offer a more affordable way in which buildings can be prototyped and sites and cities visualised. The city authority of Newcastle upon Tyne has long recognized the value that a three-dimensional model can bring to the urban planning process. The city has successfully utilized a wooden physical scale model (1:500) since the 1960's. Urban planners have also acknowledged the usefulness of three-dimensional computer representations when these have been presented, alongside more traditional visualizations, as part of development proposal submissions. This paper offers a case study which analyses the many issues local authorities are presented with when considering the development of a virtual city model. It offers insight into

the role universities can play in serving their cities and contributing to the strategic development of a sustainable city model to meet the needs of all interested parties.

2. CURRENT POSITION

There are many decisions that city authorities have to take when embarking on the creation of a city model. City models worldwide are offering examples of what is now possible to achieve with today’s technology, but the choice of options available, in terms of computer platforms, data capture, service providers etc can be daunting to those starting out in this field. Indeed, several cities around the world have now more than one city model, supporting the argument (Bourdakis 2008) that not one single type of 3D digital model can be suitable for the wide range of applications demanded from them. Even in cities without a city model to date, many *parts* of the city will have been modeled to support individual development proposals, or to market new projects etc, resulting in a jig-saw of 3D models using incompatible computer platforms and diverse scales (Figure 1). This has been the case with NewcastleGateshead in recent years, and is one of the economic drivers for the creation of one definitive, interactive model of both cities.



Figure 1 City Modelling Scenarios

A particular challenge to all city authorities is how to keep models up-to-date once created. Cities themselves are constantly being developed and regenerated and any city model will need to undergo a similar process to ensure long term sustainability of the model. For this reason, the aims of Virtual NewcastleGateshead has been defined from the outset to link to the urban planning process for both cities, currently challenged by significant levels of regeneration activity. These have now grown to such a degree that it would be inefficient for Newcastle City Council and Gateshead Council to develop digital models independently, each using differing standards, procedures and protocols. Northumbria University has proposed to *host the development* of Virtual NewcastleGateshead as it shares a need to utilise such a model for the purposes of education and research and recognises that the long term success and sustainability of such a model will only be assured if it is updated as the real city develops.

2.1 Establishing Relationships with Local Authorities

Models of cities within the UK are either created and used in house by the city authorities, or alternatively outsourced to private sector companies or academic institutions that are specialized in, or currently researching, the creation of urban

models. However previous research (Whyte 2002) observed a lack of utilization of models that had been created by academia. An alternative collaborative relationship between academia, local authorities and other interested parties was suggested as a way forward for the creation and maintenance of city models (Horne et al, 2007). Northumbria University's School of the Built Environment has well established professional relationships with urban planners, developers and architects in the region. Recent activities have included the integration of Virtual Reality into the built environment academic curriculum (Horne and Thomson, 2008) and the creation of a city model for teaching, learning and research purposes (Figure 2). The university is in a position to now undertake a coordinating and collaborative role with all stakeholders to further develop and maintain a city model.



Figure 2 city model to date (Context model © Zmapping Ltd 2008)

To establish the requirement and potential uptake of a Virtual NewcastleGateshead the following have been undertaken:

- Meetings with key stakeholders to analyse service requirements (Table 1)
- Meetings with potential stakeholders from both the public and private sectors
- Analysis of origins of data for city modelling
- Discussions on proposed process and licensing arrangements
- An audit of city models worldwide (Podevyn et al, 2009)
- Awareness raising seminars with interested parties (eg Newcastle Conservation Advisory Panel, English Heritage, City Planning Working Group etc)
- Pilot studies to assess information sharing and data compatibility issues between organisations and computer software applications
- Establishment of working group (September 2008) to develop a business proposal to take the project forward.

A working group, composed of six members, two from each of the university and local authorities, is currently preparing a business proposal to demonstrate that a synergy of activity could be gained by developing the model in the first instance for the purposes of urban planning and education via a partnership between Northumbria University, Newcastle City Council and Gateshead Council. Once established for the primary purposes of urban planning and education, access to the model for subsequent derivative projects and applications could potentially generate income to be used for the maintenance and further development of the model, bringing benefits to all stakeholders.

3. ORGANISATIONAL AIMS

For a partnership to develop between an academic institution and two local authorities it should be based on an analysis of the requirements and benefits for each organisation, and options to consider in making the shared service work. The development of Virtual NewcastleGateshead also needs to align with current institutional strategies and policies. Table 1 offers an analysis of the requirements.

Table 1: Analysis of Requirements

Newcastle City Council	Gateshead Council	Northumbria University
Massing model to support urban planning process	Massing model to support urban planning process	Massing model to support education and research projects
Total geographic area to be modelled of approximately 20 sq km (total area of Newcastle 11507 hectares)	Total geographic area to be modelled of approximately 20 sq km (total area of Gateshead 14304 hectares)	Currently owns data of approximately 8 sq km
Model to be regularly updated with major planning applications	Model to be regularly updated with major planning applications	Model to be up to date to support analytical research.
Model based on standards and protocols agreed by professional community	Model based on standards and protocols agreed by professional community	Model based on standards and protocols agreed by professional community
Interactive navigation	Interactive navigation	Interactive navigation
Optimised version for use on www platform	Optimised version for use on www platform	Optimised version for use on www platform
Remote access to model	Remote access to model	Host model
Security of data - assurance of confidentiality for planning applications and commercially sensitive information	Security of data - assurance of confidentiality for planning applications and commercially sensitive information	Internal protocols to be set up, and agreed by councils, to conform to those already in operation by NCC and GC
Production of 2D images of strategic views	Production of 2D images of strategic views	Production of 2D images of strategic views
Version control of model	Version control of model	Version control of model
Creation of texture mapped model (for Stage D development proposals)	Creation of texture mapped model (for Stage D development proposals)	Creation of texture mapped model (for Stage D development proposals)
Model optimised for public consultation purposes	Model optimised for public consultation purposes	
Integration with GIS	Integration with GIS	Integration with GIS
Production of physical prototypes from the model	Production of physical prototypes from the model	Production of physical prototypes from the model
Technical accuracy required	Technical accuracy required	Technical accuracy required

Table 2 offers an analysis of benefits of Virtual NewcastleGateshead to the key stakeholders.

Table 2: Analysis of Benefits

City Councils	<p>enhance the understanding of the built environment</p> <p>assist the regeneration of the cities</p> <p>accurate assessment of the appearance of tall buildings within the urban fabric</p> <p>improve the participation and consultation process for future development proposals</p> <p>provide visual aids to help explain the impact of a development to the public, elected members and developers</p> <p>provide a versatile promotional tool to showcase development in both cities</p> <p>improve the quality of all development on the ground</p> <p>visually record and track changes during pre-planning application discussions.</p> <p>provide visual impact assessments across boundaries (River Tyne).</p> <p>coordinated gathering of 3D data, avoiding inefficiencies due to duplication of modelling effort</p> <p>virtual model will be kept at leading edge, benefitting from latest research and best practice networks</p> <p>control over costs – peaks and troughs in workload more cost effective, and development of VNG faster, by pooling the modelling requirements of more than one organisation</p> <p>model will be based on technology of proven value, which could support VR / GIS integration and traffic modelling</p> <p>provide an accurate model base for secondary projects such as pedestrian simulation, safety planning, emergency planning, environmental studies, sun/shadow studies, marketing, tourism, cultural, historical, retail analysis, etc</p> <p>satisfy future demands related to e-government</p> <p>support investment decision making and promote economic development</p>
University	<p>enhance the understanding of the built environment</p> <p>support an increasing range of teaching and research projects which require access to, and analysis of, urban data</p> <p>improve communication with students</p> <p>maintain versions of the city at different time periods, traces evolution of the city</p> <p>support innovation and need to develop and share knowledge for the benefit of the wider community</p> <p>prestige / PR advantages in developing VNG as a regional city model</p>
Architects	<p>continuation of current 3D computer modelling practices but efficiencies gained in providing 3D development proposals to agreed standards and protocols</p>
Developers	<p>access to VNG would offer a cost effective way to understand the wider context of applications.</p> <p>access to city context data (read only) for the production of images and/or interactive models for</p> <ul style="list-style-type: none"> design exploration, Stage C pre-planning stage Stage D planning stage marketing strategy, post construction stage secondary projects <p>access to accurate up-to-date data.</p> <p>Greater certainty in the city councils' visual / presentation / consultation requirements</p> <p>avoidance of duplication of effort</p>

4. ISSUES EMERGING

4.1 Legal

Local Authorities in the UK are being encouraged to consider strategic service delivery partnerships as a means to improving service delivery (ODPM 2003). For a local strategic partnership to be developed between an academic institution and one or more local authorities several models could be considered:

- Public Sector Consortium, pooled budgets, joint commissioning
 - Joint committee
 - Non-profit distributing organisation, eg limited company
 - For profit entity, eg company limited by shares
- Joint Venture
 - Joint venture company (provision of services)
 - Joint venture company (investment)
 - Joint venture company (development)
- Partnering Contract

Meetings are currently ongoing, between legal advisors of Northumbria University, Newcastle City Council and Gateshead Council to consider the most appropriate option for the development of Virtual NewcastleGateshead. Discussions are also ongoing with the supplier of 3D model data purchased to date and indicate that appropriate license arrangements can be made to enable the hosting of Virtual NewcastleGateshead by an academic institution to ensure the development and update of a well managed city model. Specialist 3D data suppliers have recognition as the owner and author of the original model data, yet further clarification of ownership and protection of intellectual property is being investigated for the future development and maintenance of the model by an academic host.

4.2 Technical

Origin of data. An analysis of the origin of data suitable for three-dimensional city modeling, together with consideration of the level of technical accuracy required for the urban planning process has resulted in a selection of aerial photogrammetry combined with terrestrial 3D HDS (high definition surveying) laser scanning as the two preferred methods for data origin for Virtual NewcastleGateshead. In the UK there are an increasing number of data providers who are specializing in city modeling and who offer license agreements for the use of their data for specific purposes.

Remote access and version control. Information and communication technologies are available to enable different versions of Virtual NewcastleGateshead to be developed and accessed from remote locations by different stakeholders. An internet-enabled version could be used for marketing, tourism, and for public consultation purposes. For urban planning purposes, secure server technology will be deployed to ensure confidentiality in relation to planning applications and commercially sensitive information.

Level of detail. Once an accurate geometric massing model of VNG has been created, further levels of detail, of streetscapes, buildings etc, can be added to enable assessment of more detailed planning proposals. Figure 2 illustrates several detail levels taken from the current model. Secure version control of the model has

been identified as a key requirement by all participants.



Figure 2 Several levels of detail within Virtual NewcastleGateshead

Accuracy. As Virtual NewcastleGateshead is being developed to be used within the urban planning process, confidence is required in relation to the degree of accuracy of the data. Data and models used by planners in their forecasting efforts often contain large amounts of error (Klosterman, 2007). A pilot study has been conducted to compare the accuracy of the current 3D data by comparing specific views from the model with traditional photomontage and surveying techniques.

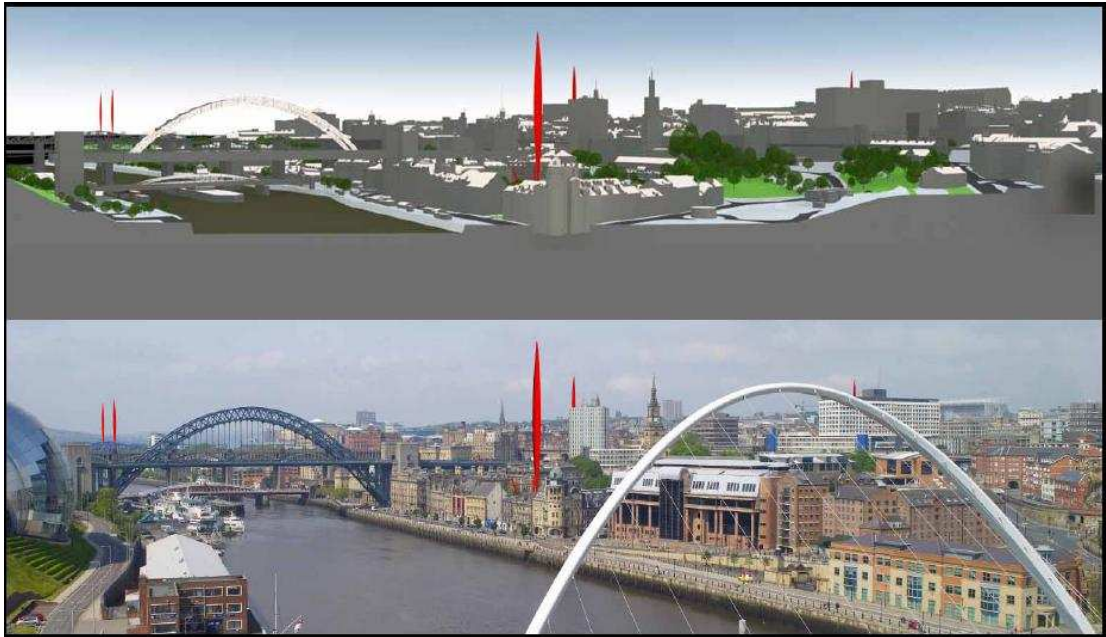


Figure 3 Verification of accuracy of Virtual NewcastleGateshead (Neil Clark, 2008)

Standards

VNG will offer urban planners, designers and clients a faster and more interactive way to assess the visual impact of proposed developments. Currently organisations offering 3D representations are working to different standards of accuracy and quality. VNG will create a working party to investigate standards such as CityGML, ifcXML – ifcGML and X3D as well more established formats (Ewald and Coors, 2005). CityGML is currently being developed to support the attribution and geo-referencing required by GIS applications (Kolbe et al, 2005). This will play a major role in supporting a growing number of 3D city models being created worldwide (Dokonal, 2008). A major development project in the private sector has enabled an assessment of the information sharing issues and compatibility of the city model data with regard to current 3D computer modelling practices. It has highlighted the need in providing 3D development proposals to agreed standards and protocols.

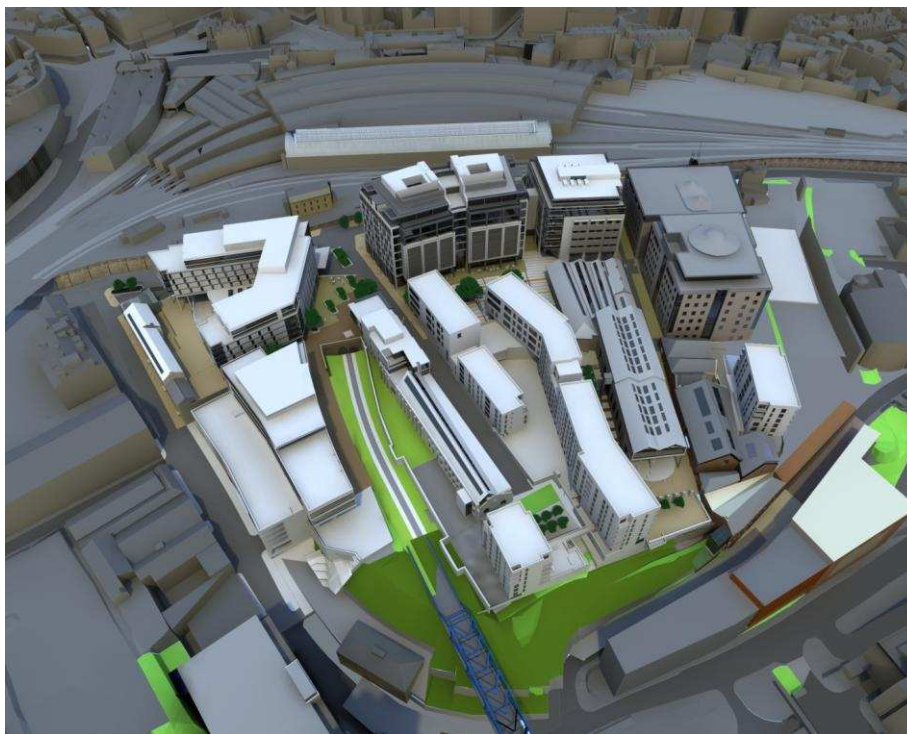


Figure 4 Stephenson Quarter Development Project (Silverlink Holdings Ltd, 2008)

4.3 Financial

One of the aims of the Virtual NewcastleGateshead project is to develop a financially sustainable modelling process. A regularly updated VNG, developed by more than one participating organisation and backed by current research, together with a management structure in place to phase the employment of personnel necessary for the management, financial control, technical expertise, administrative support and marketing of the project is likely to develop faster and become more widely trusted. Letters of support have been gathered from the private sector and provide indication that subsequent derivative projects would provide income generation to ensure the financial sustainability of the virtual model.

Set up costs, shared between partners, will be less than if each council develops their own model in isolation. Cost has been recognised as a key barrier to the

adoption of computer modelling and visualisation for planners (Bishop and Forster, 2007). Also funding applications from a partnership, rather than individual organisations, will be more convincing to potential funders with a wider geographic remit. Profits arising from income streams from secondary projects could be utilised as re-investment into Virtual NewcastleGateshead to ensure the sustainability of the model and its long-term maintenance and development.

5. CONCLUSIONS

This case study has offered insight into issues emerging if an academic institution undertakes a hosting role for the creation, management and update of a virtual city model for the urban planning process. Such a partnership would result in:

- **VNG based upon leading edge research** related to digital city models. Without a partnership, smaller in-house 3D modelling teams are unlikely to be able to develop the peer support to solve technical problems, or have the time to research into emerging techniques. Councils would benefit from the combined strength of a dedicated School of the Built Environment and wider academic and best practice networks.
- **Cost effectiveness.** By pooling the 3D modelling requirements of more than one organisation, it is more likely that a service absorbing peaks and troughs in workload can be accommodated cost effectively. Councils would have access to a forum where they can share and learn from common problems.
- **Development of standards.** Planning applicants and other organisations providing 3D development proposals and as-built information are often working to different standards and accuracy. A partnership approach would result in the development and maintenance of standards in this area and offer the benefit of this knowledge to a wider audience, thus avoiding duplication, loss and conflict
- **Research** many areas of built environment research are looking at key issues (sustainability, renewable energies, safety etc), on an urban scale. VNG could offer significant time savings in providing credible data to feed into such research

6. FUTURE RESEARCH

Future research will evaluate the development of Virtual NewcastleGateshead and offer findings in relation to the management, update and financial sustainability of the modeling process adopted. This research would also support the development of guidelines for city authorities embarking on the creation, management and update of a city model.

ACKNOWLEDGEMENTS

Acknowledgement is made to urban planners at Newcastle City Council, Gateshead Council, and all regional organisations from both the public and private sector who have expressed support for this project. Acknowledgement is made to data provider ZMapping for supplying model data to date.

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