VIRTUAL BEIRUT

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Abstract: This paper describes how urban planners in Beirut are applying three-dimensional computer modelling to aid design decision making in the regeneration programme for the city. The study reports on the recent developments of a computer model of Beirut and its effectiveness in communicating the spatial characteristics of Martyr's Square, a place of historic significance in the city. An international urban design competition for Martyr's Square, and its new axis to the sea, is underway to identify new ideas for the development of this area. This paper reports on the process of creating the computer model and feedback from users. It considers future plans for further 3D modelling of the city centre to meet the needs of urban designers.

Keywords: Beirut, 3D Modelling, Urban Planning, Virtual Reality

1 INTRODUCTION

Beirut is the capital city of Lebanon, situated on the eastern coast of the Mediterranean Sea. The city was badly damaged during a long period of civil war which ended in 1990. An extensive urban regeneration programme is currently underway to bring the city back to life, and an area of 1.9 million square metres in the city centre is being reconstructed by Solidere (Société Libanaise pour le Développement et la Reconstruction du Centre-Ville de Beyrouth), a Lebanese joint-stock company created by Government decree in 1994.

An extensive and ambitious Master Plan has been developed to form a framework for the restoration of the city. The plan and its subsequent detailed development have been directed at key urban design issues including the definition of an extensive public domain and the application of planning controls that enhance streetscape, protect the historic fabric and guide the massing, bulk and disposition of new development. This concentration, from the outset, on three-dimensional and urban design issues distinguished the Beirut master plan from the traditional two-dimensional land use plans approach. The plan has evolved flexibly to encompass new guidelines, priorities and refinements, but it has remained consistently definitive on the three-dimensional criteria for proposed building designs. Maximum building heights, building lines and façade controls on all main streets are some of the criteria viewed as essential constraints to ensure a good urban design for Beirut (Gavin 1996).

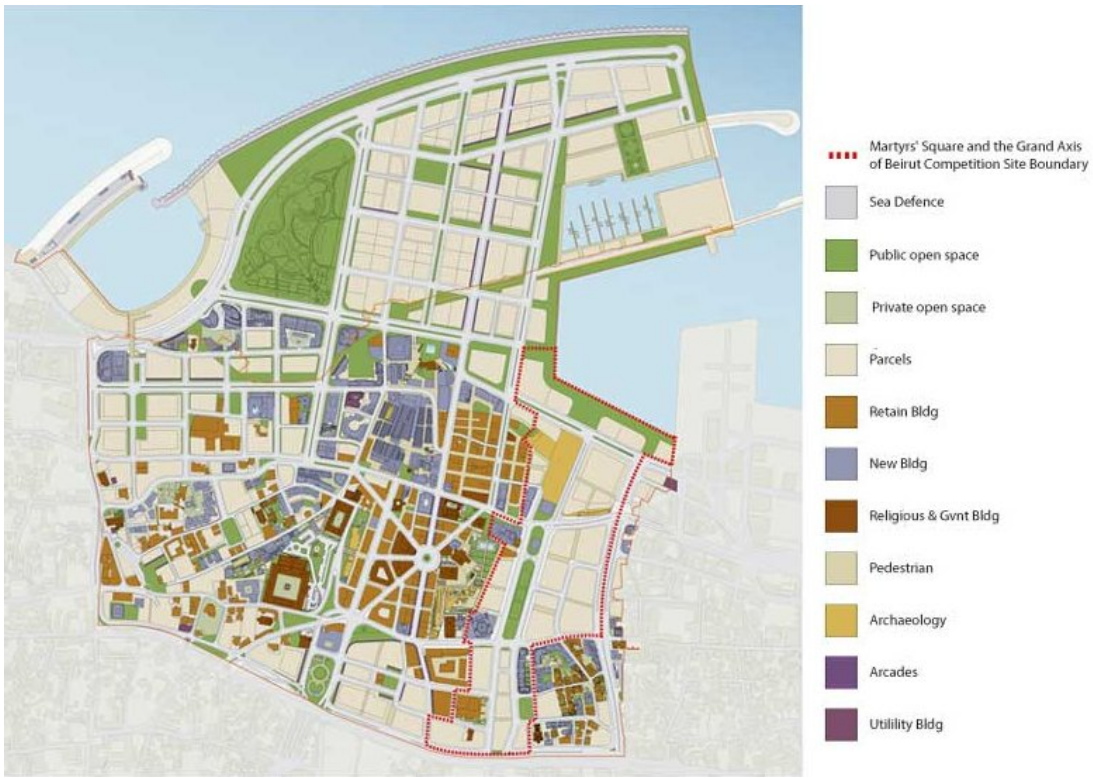

Figure 1 Master Plan of Beirut Central District

2 THE NEED FOR A COMPUTER MODEL

Beirut, like most cities throughout the world, has been visually represented using a variety of techniques. Two-dimensional plans, sections and elevations, watercolour perspectives and three-dimensional physical scale models have been used by Solidere for the representation of urban design ideas. A large physical scale model has proved a very appropriate means of representation when groups of interested parties, often from overseas, need to assimilate current developments, plans and future proposals.

However the emphasis of the Master Plan on the physical, three-dimensional aspects of development resulted in the creation, in 1996, of a computer model to assist urban designers to study layout and massing options. Solidere required this model to be used as an interactive urban design tool which could be used to consider building footprint and massing options, as well as maintaining a record of floor space and proposed land use by parcel, block and sector (Gavin 1996). The three- dimensional urban design tool was necessary to visualise the prescribed maximum building heights of proposed development in order to protect the scale of buildings adjacent to the historic centre and existing residential areas. The computer model needed to show the topography, retained buildings, roads and open spaces as well as the maximum *building envelopes* of new designs. In addition the model was required to visualise the *streetwall controls,* used to form traditional streets and provide streetscape elevation controls, and also roof planes, considered extremely important, as many roofs will be overlooked.

Figure 2 Initial (1996) Computer Model of Beirut Central District

3 REQUIREMENT FOR ANIMATION

3.1 Visualisation of Martyr's Square

A requirement to incorporate animation into the three-dimensional computer model came about when considering the development of Martyr's Square, a place of significant historical importance in Beirut. Martyr's Square has historically been Lebanon's most important public space, a popular meeting place for locals and visitors alike, but had been extensively damaged during the period of civil war. First called 'Al Bourj' after the medieval watchtower which stood at the SE corner of the Square, it became known as Canons Square after Russian a large artillery piece was placed in the Square during the Russian occupation of Beirut in 1773. It was named Martyr's Square in commemoration of the Martyr's of the Lebanese Independence, who were executed there in 1918.

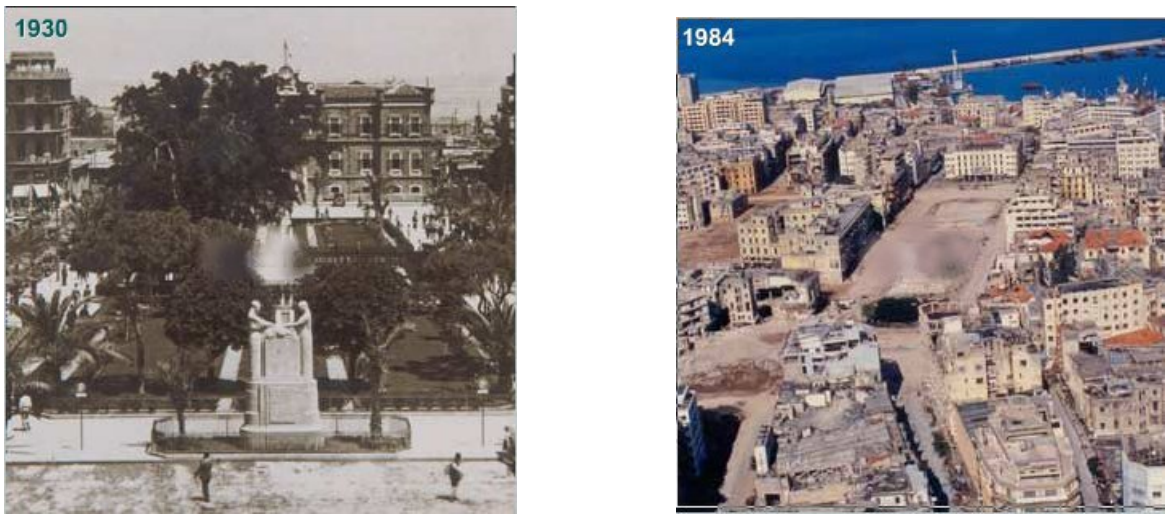

Figure 3 Martyr's Square in 1930 and 1984

3.2 International Design Competition

In order to identify design ideas for Martyr's Square, Solidere launched a major international urban design competition for the Square, the zone around it and its new extension to the sea, forming the Grand Axis of Beirut. Plans for the city prior to civil war had considered opening up an axis from the Bourj to the sea, and respect for this idea has resulted in a development corridor which opens up views from the square to the Mediterranean Sea. As the Master Plan evolved a number of additional view corridors were defined to maximize views of the Mediterranean as well as the mountain backdrop to the city seen across the bay. Two view corridors looking eastwards to the mountains intersect the main view corridor from Martyr's Square to the sea.

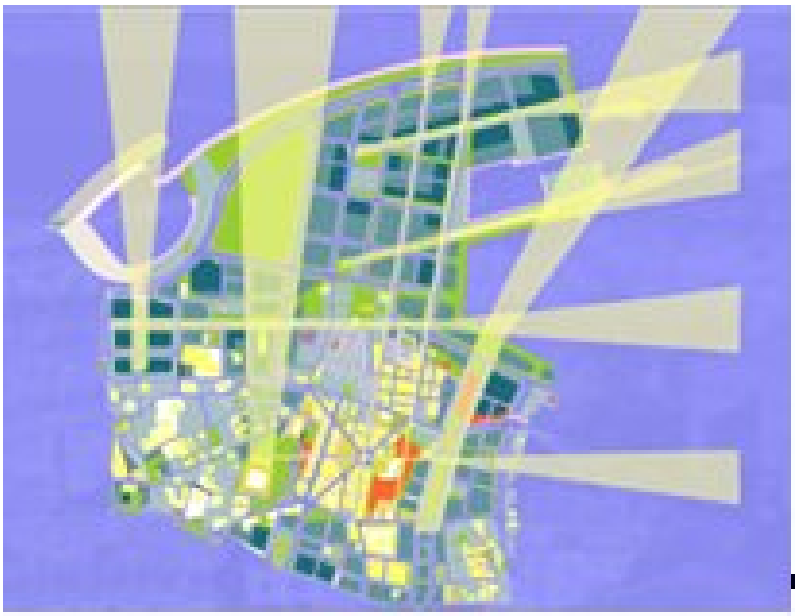

Figure 4 View Corridors in the Master Plan for Beirut

The international competition is currently inviting leading architects to submit design proposals for this historic area. Solidere felt that an animated three-dimensional model of the axis would help designers quickly gain an awareness of spatial characteristics, massing plans, design constraints and context of this significant place. A representation was required to enable specific views from points of interest and to understand how new development proposals would interact with the existing environment.

4 PROCESS OF VISUALISATION

The initial three-dimensional computer model for the Master Plan had been produced in-house using local expertise and commercially available software. In order to implement a representation of Martyr's Square which incorporated animation and interactivity it was decided to engage the use of specialists in this field. A UK company of landscape architects and environmental consultants were commissioned to work with Solidere to produce the required end result. This company, Insite Environments, has worked with leading clients in the UK on a wide range of environmental projects and had the necessary experience to undertake a project of such importance. Whilst visualisation techniques are becoming more user-friendly the techniques of landscape visualisation remain highly expert-oriented (MacFarlane R. *et al* 2004). The company's brief was to produce a computer representation which would provide a massing study of the Martyr's Square axis and an animated fly-over to contextualize the axis within its surroundings. The representation was required to be output on both CD and via the WWW.

A systematic process of data capture, monitoring and review was undertaken to produce the required end results. To construct the model, data was required for the terrain, road and pavement networks and buildings. Existing 2D city plans provided a source of data and part of the area had been previously modelled in AutoCAD. This

geometric data, supplied by the client in both 2D and 3D format, was sent to the UK as email attachments or CD. The widely used, commercially available software platform of AutoCAD aided compatibility. Data was refined to provide the appropriate level of detail and imported into Superscape VRT to create an initially simple, interactive model. Coordinates of building footprints were accurately 'knit' to those of the terrain. The model was exported into Autodesk Architectural Desktop for further detailing.

Details of the street wall sections, street furniture and landscaping were also provided, often via paper drawings from Solidere. It was agreed that textures, materials, finishes and colours of existing buildings would be gathered via a photographic survey conducted by the UK team during a visit to Beirut. Also, as the representation was a massing study, some technique was necessary to distinguish existing buildings from the maximum *building envelopes* of new designs.

Figure 5 shows the wireframe representation of the geometry of the model.

Figure 5 Wireframe Model of Martyr's Square and Surrounding Area

Throughout the process of constructing the geometry the interactivity of the Superscape model was valuable in discussions with the client to ensure that the geometry was correctly positioned and to agree the routes of the final animations. For interim feedback certain parts of the model were imported into 3D Studio and still images were produced and emailed to the client. A continuous process of review

and feedback followed in order to ensure the accuracy and appropriateness of the final end result.

Figure 6 Interactive Model of Martyr's Square

5 END RESULTS

Figure 7 shows how the model evolved to incorporate streetwall controls and the outline of potential buildings within the transparent building envelopes. The building envelopes were modelled to appear transparent, yet provide a sense of scale relating to the possibility of future developments.

Figure 7 Simulation of Streetwall Controls and Building Envelopes

The model developed to incorporate the simulation of street furniture and landscaping. Even statues of important historical significance, damaged during the war but now restored, were included in the representation.

Fig. 8. Place de Martyr's – Streetscape including Statue

The paths of the animation were carefully designed to emphasise the importance of the view corridors and to provide designers with the spatial characteristics of the intersections of these.

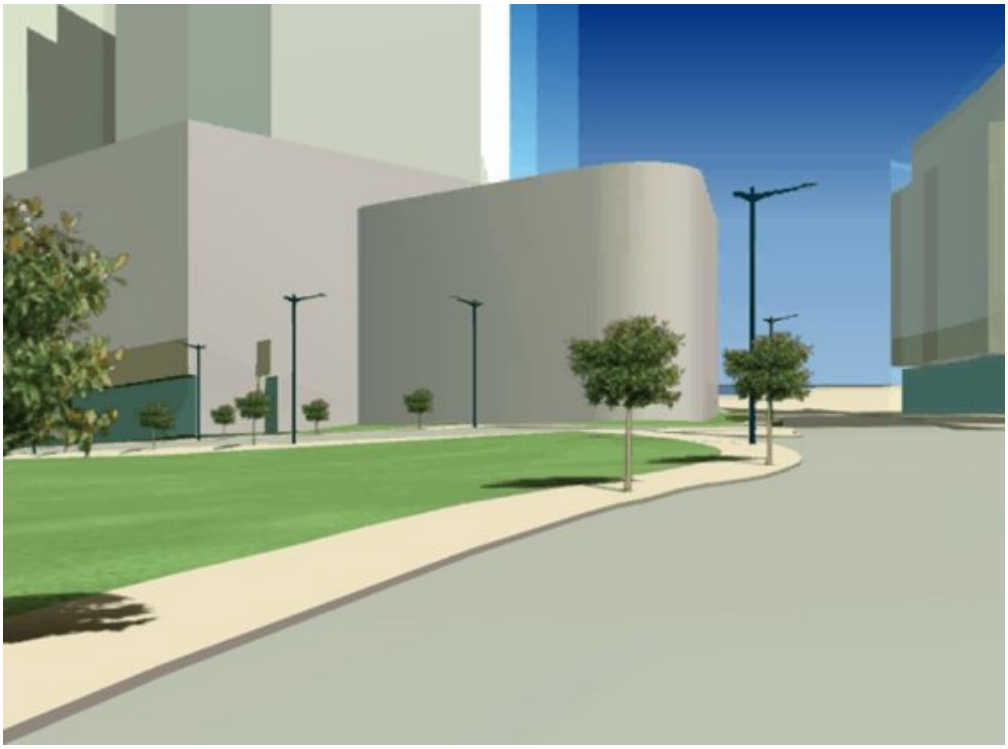

Fig.9. Intersecting View Corridors

Figure 10 shows an image from the final fly-through Martyr's Square. The final animation involved the rendering of over 7000 frames in 3D Studio in TGA format which were then compiled into two AVI animations. The rendering for the animations was done across a number of PCs and took 1015 hours to complete. The final model had a file size of approximately 50 megabyte.

Figure 10 Aerial View over Martyr's Square

The detailed geometric modelling in this project was done using Autodesk Architectural Desktop, on a personal computer typical of those used in architectural offices throughout the world. The media of computing proved very appropriate when modelling a constantly evolving Master Plan. Seeing the plan in 3D often resulted in observations that had not been made from 2D forms of representation. Challenges for the client included collecting and providing all of the relevant data and also working with a specialist UK practice. However, by outsourcing this project to a UK practice, the client was able to assess the benefits of the technologies with minimum risk. Outsourcing increases flexibility, enabling a company to move to different solutions faster as it is not locked into a particular set of technologies due to staff competencies (Whyte 2002). However outsourcing does require appropriate skills within the client's organization in order to collaborate with the model-building company.

The complete project, including models, maps, still images and animations was sent to Beirut on five 700mb CDs. The medium of CD, chosen for its conciseness and portability, also enabled the end result to be circulated efficiently to competition

entrants. A smaller file-size version was produced for the client's competition web site.

Figure 11 Aerial Views on Competition Web Site

The competition was launched in two stages. As stage two is currently underway the process of gathering feedback from the users is ongoing. Initial feedback however has been positive in regard to the effectiveness of the simulation as an aid in assessing the spatial characteristics, design constraints and visual context of Martyr's Square. The simulation of scale and proportion of the buildings and open spaces have aided understanding of the importance of the visual impact and challenges of new development in a place of such historic importance.

Competitors who were successful in reaching stage two of the process were provided with a CD containing the two animations of Martyr's Square and the Grand Axis. The web site was designed with access control so that only selected competitors could gain a right to use this area.

Whilst the initial purpose of model was to enable the creation of a multimedia presentation of appropriate file size for the purposes of distribution to competition entrants via the WWW and CD, the users of the model have perceived the usefulness of having access to the model data so that they can display their design intentions within an accurate urban context. There have been requests by some architects to have access to this data, rather than just the final animation and still images. The fact that the commercially available software had been used for this model will aid interoperability between interested parties, and the availability of data will increase confidence in using the model for design decision making.

6 CONCLUSIONS

This case study has shown how three-dimensional computer modelling has contributed, as a means of representation, to the historic city of Beirut. It has illustrated the following:

- Commercially available CAD software can be used to create virtual environments of efficient file size and interoperable with other architectural models being produced. To incorporate animation requires simplification of the geometry in order to provide the interactivity or movement required. Clients, who often provide the underlying data for a model, need to be aware of this data simplification process.
- Urban models have much potential if based on accurate data. Communication can be improved between interested parties who cannot visit the site as long as there is confidence in the technical abilities of the landscape visualiser and accuracy of the digital terrain model and data capture techniques used in identifying the position of the buildings.
- A smaller, specific area within an urban model can be animated to illustrate the benefits of being able to walk-through or fly-through a scene. This can act as a pilot study with which to assess the potential of currently available animation / VR software and techniques. If the urban model subsequently develops into one of a larger scale then issues of structuring and management of large urban databases need to be addressed.
- There is potential for digital city models to be used for a variety of purposes. The database of geometrical information can be developed to one containing other urban attributes, including historical information. Urban models in the UK have proven to be genuinely useful to a wide range of users (Ennis G. *et al*, 1999). In the US a VR model of Los Angeles has effected ongoing research investigations into the diverse applications of computer based urban models, including education and cultural tourism (Jepson W. *et al*, 1998).

7 THE FUTURE

Urban Planners in Beirut say that a 3D computer model is now an essential tool when considering complex townscapes and planning issues. Solidere is currently considering further 3D modelling of the city-centre to produce an urban design tool that can be updated in-house. Such a model is essential:

- to generate 3D massing diagrams, set in the urban context, for individual parcel development briefs
- for submissions made to the Higher Council for Urban Planning to show the urban context for any future large project and phased construction.
- for submissions made to the Higher Council for Urban Planning to show the urban context for any project seeking a Master Plan Amendment
- to show progressive growth of street landscaping and public space planting, within the urban context, in five-year increments

They seek to develop a rational layering system that will be appropriate for the way urban designers and town planners need to work. Bourdakis advocates the development of custom tools for urban scale simulations, which perhaps will meet some of the requirements of urban planners (Bourdakis 2001).

As software and hardware capabilities are developed to meet the needs of urban analysis we should see the development of more cost effective solutions which will further enable remote communication. However 80% of drawings are still done in 2D and there will need to be a change in mindset in order to increase the use of 3D tools (CIRIA 2005). The cost and time taken to develop 3D models is still perceived as too high by many urban planners. Researchers are forecasting that the introduction of new object-oriented 3D modeling systems will hopefully change this (Roupé 2004) and enable designers to adopt 3D design tools earlier in the design process.

Nonetheless the number of cities that have been modeled is increasing and important lessons are being learned. Studies are showing (CASA 2005) that 3D city models tend to be derived from three techniques:

- Traditional 3D computer aided architectural design
- The engineering approach based on photogrammetric analysis and surveying
- Geographic information systems

Techniques will be selected on the basis of their appropriateness for the task in hand. This case study has been offered to illustrate the importance of

- Interoperability – there are advantages if models are interoperable with other architectural models being developed.
- Accuracy – major consideration for urban analysis
- Access – who has access to the model and how is this controlled?

Consideration is now being given to extending the use of the model for a public consultation process; no doubt the first of many alternative uses as Virtual Beirut emerges.

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REFERENCES

Bourdakis, V. (2001) On Developing Standards for the Creation of VR City Models, **19th ECAADE Conference**, Helsinki, Finland, 2001

Ennis, G., Lindsay, M., Grant, M. (1999) VRML Possibilities: The Evolution of the Glasgow Model, **VSMM '99**, Dundee, Scotland

Gavin, A., Maluf, R., 1996, **Beirut Reborn**, Academy Editions.

Jepson, W., Friedman, S. (1998) Virtual L.A., Urban Simulation in Los Angeles, Planning Magazine**, The Journal of the American Planning Association**, July 1998

MacFarlane, R., Stagg, H., Turner, K., Lievesley, M. (2004) Peering through the smoke? Tensions in landscape visualisation, **Computers, Environments and Urban Systems**, 29 (2005) 341-359

Virtual Reality and 4D Modelling in Construction (2005) **CIRIA**, Construction Productivity Network, Members Report E5114

Roupé M. and Johansson M. (2004) From CAD to VR – Focusing on Urban Planning and Building Design. **AVR III Conference and Workshop,** Chalmers, Gothenburg, Sweden, 27-28 May 2004.

3D Cities Review (2005) http://www.casa.ucl.ac.uk/research/3dcities.htm (accessed April 2005) **CASA**, London

Whyte J. (2002) **Virtual Reality and the Built Environment,** Architectural Press, 131-132