BEIRUT: THREE DIMENSIONAL MODELLING OF THE CITY

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ABSTRACT: Beirut is undergoing transformation from the legacy of civil war in Lebanon. Teams of multi-national, multi-discipline professionals are collaborating to bring the city back to life. Solidere, a Lebanese joint-stock company, was created by government decree in 1994 to reconstruct Beirut city-centre. The company, a form of public-private partnership, has a majority share holding of former owners and tenants of city-centre property. Several projects are underway, including the redevelopment of Place des Martyrs, once the bustling heart of Beirut but badly damaged during the war. An international competition is being launched by Solidere to invite leading architects to submit design proposals for this historic area. This paper describes the development of a 3D computer model to visually describe the spatial characteristics of Martyrs Square and its context. The study examines the process and end results of the visualisation and raises issues of technology and knowledge transfer in a global marketplace.

Keywords – Beirut, Computer Modelling, Planning, Visualisation

1. BACKGROUND

Beirut, capital of Lebanon, is a city situated on the eastern coast of the Mediterranean Sea. It has a rich and fascinating history. Beirut is situated at a crossroads between east and west, north and south, and, as such, has a strategically important role to play in today's world. It is currently recovering from a long and tragic period of civil war which ended in 1990. Many players, local and international, are working together with common aims - to rebuild a city and its infrastructure and to help Beirut regain its former position as a commercial and financial centre in the region.

1.1 The Masterplan

The vision for the reconstruction of Beirut resulted in the formation, in 1994, of a private sector real estate company called Solidere (Société Libanaise pour le Développement et la Reconstruction du Centre-Ville de Beyrouth). Solidere is a joint stock company and its main objective is to develop the entire city centre of Beirut, an area of 1.9 million square metres. An extensive and ambitious Master Plan has been developed to form a framework for the restoration of the city. 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).

2. THE NEED FOR A NEW REPRESENTATION

Beirut has been visually represented in many forms throughout history. Its geographical position, lying between sea and mountains, makes it a rich subject for artists. Snow-

capped mountains sweeping down to the Mediterranean form breathtaking views. Representations have ranged from simple pencil sketches to magnificent perspective paintings. Photography has played its part, and has been used to document the history, and now the progress, of this developing city (Trawi, 2002).

2.1 Existing Representations

Solidere have used a variety of techniques for the representation of ideas, including two-dimensional plans, sections and elevations, watercolour perspectives and three-dimensional physical scale models. The latter has proved very appropriate when groups of interested parties, often from overseas, have needed to assimilate current developments, plans and future proposals.

The need to prescribe maximum building heights to protect the scale of buildings adjacent to the historic centre resulted in the creation of a three-dimensional computer model of the Master Plan. This model is able to show the topography, retained buildings, roads and open spaces as well as the maximum *building envelopes* of new designs. The Master Plan uses *streetwall controls* to form traditional streets and provide streetscape elevation controls. The roof plane is also considered important as many roofs will be overlooked. Solidere developed this three-dimensional computer 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).

2.2 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, and preparing for 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. Martyr's Square has historically been Lebanon's most important public space, a popular meeting place for locals and visitors alike. 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.

Plans for the city prior to civil war had considered opening up an axis from the Bourj to the sea.

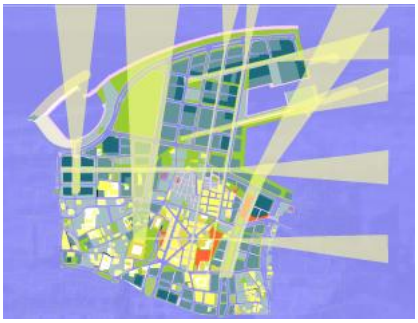

Fig. 1. View Corridors in the Master Plan for Beirut

Respect for this idea, and a concern to introduce 'view corridors' in the Master Plan resulted in an axis being designed to run from Martyr's Square across the first basin of Beirut port, to the 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.

2.3 International Competition

An international competition is being launched by Solidere to invite 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.

3. THE PROCESS

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 incorporates 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. Their 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.

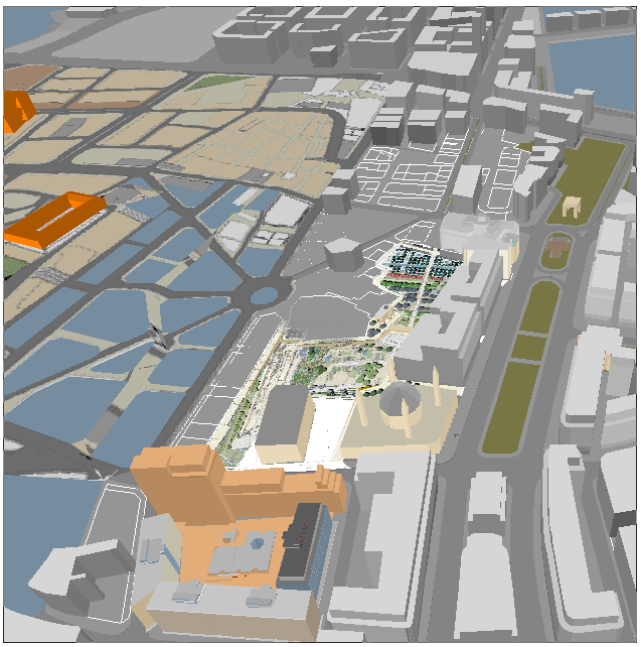

Fig. 2. Area of Martyr's Square Axis

3.1 Data Capture

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 modeled 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 to create an initially simple, interactive model. Coordinates of building footprints were accurately 'knit' to those of the terrain.

Details of the street wall sections, street furniture and landscaping were also provided. 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 2 shows a representation of work in progress of the building envelopes, incorporated in the Master Plan to aid the massing of new developments. The building envelopes were modeled to appear transparent, yet provide a sense of scale relating to the possibility of future developments.

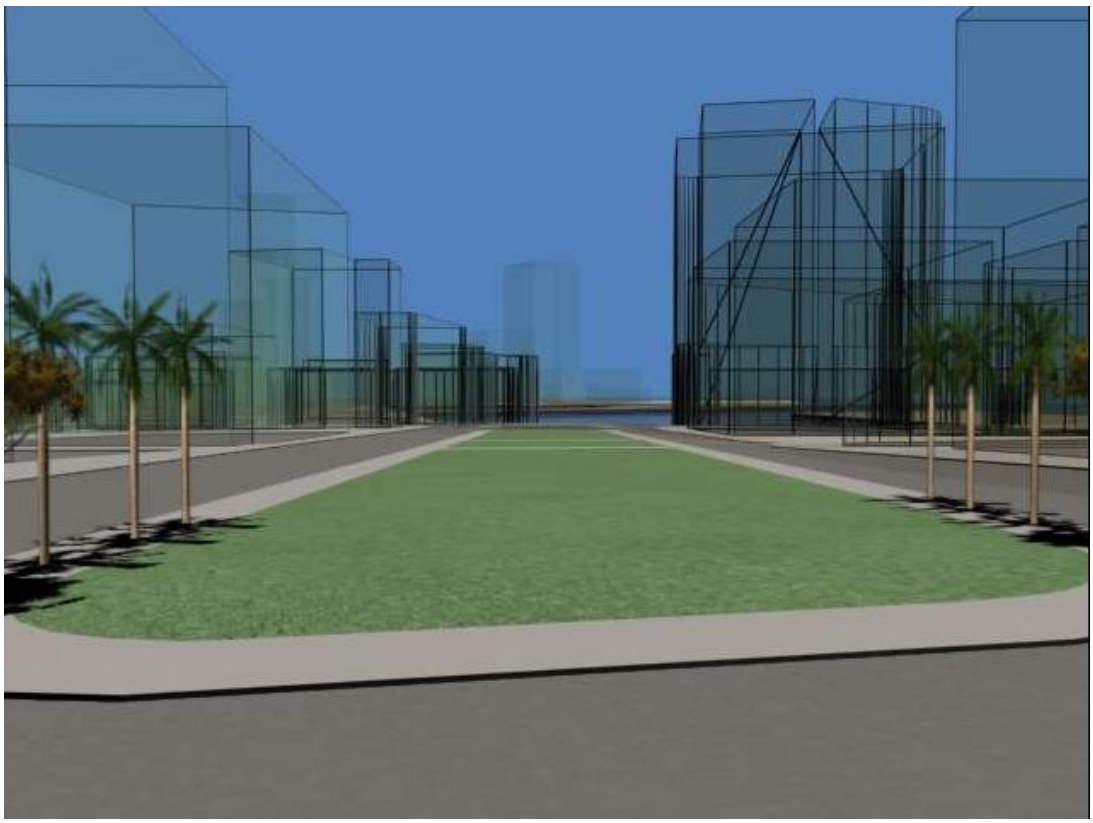

Fig.3. Martyr's Square Axis – work in progress - view towards the sea

3.2 Monitoring and Review

The Superscape model was valuable during the initial stages in meetings with the client to ensure that the geometry was correctly positioned and to discuss the required positioning of the final fly-through. 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.

Decisions had to be made throughout the process on the level of detail accurately represented on the building facades and when to use geometry or apply photographic techniques. Issues of data size need to be addressed when modeling urban environments as the volume of data can make the model unwieldy and the animation slow. It was necessary to simplify much of the CAD data that had been supplied, removing unnecessary polygons, in order to produce an acceptable end result. A combination of detailed geometry and photographic techniques were used in this model. Adobe Photoshop was used to create the custom texture maps required.

Figure 4 shows how the model evolved to incorporate streetwall controls and outline of potential buildings within the transparent building envelopes.

Fig.4. Martyr's Square Axis

3.3 Knowledge transfer

As commercially available software was being used by both parties this provided a common platform for dialogue and understanding. Mutual respect and cooperation are essential ingredients if such international projects are to succeed. Whilst development of this model was done in the UK, much collaboration was necessary in the process in order to achieve the desired end results. However the number of actual visits was minimized and was necessary only to establish the client's needs and to obtain a real understanding of the city and location to be modeled. Gathering the photographic data required for the simulation served to increase knowledge about the city and surrounding geography.

A key factor contributing to the success of this collaboration was the multi-lingual skills of the Lebanese. Email communication between the two countries provided a fast

and efficient way to ensure the client's needs were being met as the project progressed. The client, by outsourcing this project to a UK practice, 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, skills are required within the client's organization in order to collaborate with the model-building company and to have some internal understanding of the underlying technologies and consider further applications in their use.

As the modeling process progressed the client began to further appreciate the benefits that a computer model can offer to urban areas that require constant reappraisal. The 3D model of the Martyr's Square axis could be re-used on other projects at different stages of development. It could also be extended to other parts of the city centre. Architects, both local and international, could be asked to display their design intentions within an accurate urban context. Investors and businesses could use the model to identify preferred situations within the city. Realistic representations can also help citizens understand and be more involved in the development of their capital. Recent research into the utilization of digital city models suggests that urban VR models can be considered as falling within three main categories: design and planning, education and general research, commercial and entertainment (Bourdakis, 1998).

4. END RESULTS

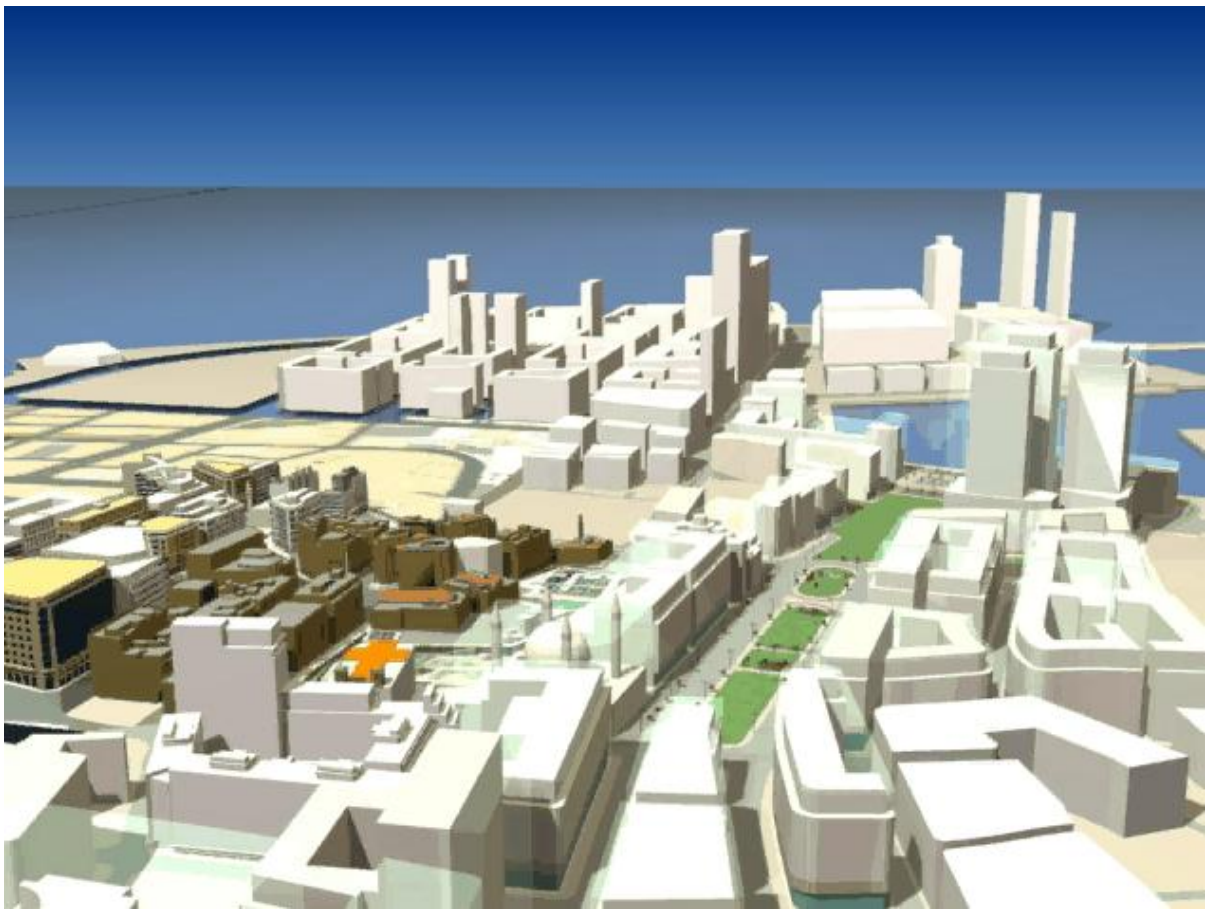

Fig.5. 3D Model of Martyr's Square axis – fly-through

Figure 5 shows an image from the final fly-through Martyr's Square. The final animation involved the rendering of 6000 frames in 3D Studio. In order to be used for important design strategies such a model must be credible. Confidence is essential in the accuracy of the digital terrain model and the data capture techniques used in identifying the positioning of the buildings. The effectiveness of this visualization, and reliability of the end results, was aided by outsourcing to a company who specialize in such model-building, and who employ built environment professionals who have an understanding of the planning process.

The 3D model is an acceptable representation of Martyr's Square, with sufficient details to communicate the spatial characteristics and context. The detailed geometric modeling in this project was done using Autodesk Architectural Desktop. The difficulty in any modeling work is knowing when to stop, as further details and geometry can always be added. Usual restraints of tight competition deadlines and business profitability emerge as influencing factors. It is important that the costs and effort in making an animated model support its purpose for the specific context in which it is to be used (Suneson, 2002).

The medium of CD, chosen for its conciseness and portability, 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. The end results also demonstrate what is possible to achieve with commercially available software and a hardware specification typical of that in many offices. The total time taken to complete the whole project was 1,015 hours.

Fig.6. 3D Model of Martyr's Square axis – walk through – intersecting view corridor

Fig.7. 3D Model of Martyr's Square axis – fly-through – roof plane

5. CONCLUSIONS

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

- Whilst commercially available CAD software can be used to build the geometry of a scene in great detail, this geometry will require refinement in the animation software 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. 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.
- 3D modeling and animation adds to, but does not replace other, more traditional, techniques of representation that are still required, and used appropriately, by the client in this study.
- 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 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 et al, 1998).

5.1 Future Work

As software and hardware capabilities are developed to meet the needs of the urban planner we should see more examples of the implementation of 3D modeling on a routine basis. Designers are beginning to adopt 3D design tools earlier in the design process, and commercially available building information modeling software, based on parametric database technologies, is emerging. Researchers are currently developing standards for the creation of VR city models (Bourdakis, 2001) and are advocating the development of custom tools for urban scale simulations. The number of cities that have been modeled is rapidly increasing and important lesson are being learned. Cities with a rich heritage can plan future developments with care, and can also use the technology to simulate what has happened in the past. For a city like Beirut, with many layers of civilization in its rich heritage, interactive 3D modelling could provide a means of learning about long-forgotten worlds.

It is interesting to observe how this latest form of representation is finding a role in urban design. Its importance is becoming more recognized and acknowledged. We question whether computer modeling is but an extension of traditional visualization techniques, rather than a replacement (Giddings, 2002). The use in Beirut of two-dimensional plans, perspective drawings, watercolor paintings, three-dimensional physical scaled models alongside three-dimensional computer models, is providing heterogeneity of techniques for the representation of a city with a rich heritage and exciting possibilities for the future.

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