THE CREATION OF URBAN FORM

A normative approach to modelling

Kalliopi Maravelea, M.Grant

Abstract. The aim of this research project is to develop a methodological process that allows the designer to assemble and create various scenarios representing an urban environment through the utilization of economical computer based methods. During the last decade different techniques have been developed to address the needs of visualisation of urban areas many being based on photographic and photogrammetric systems. The demand for 3-D urban models continues to grow and although new technologies have undoubtedly reduced the time needed for the construction of a 3D model, there are still some remaining problems related to data quality and the level of the dimensional accuracy. On the basis that these problems are primarily related to software and hardware constraints and in conjunction with the fact that the richness and complexity of an urban space is difficult to represent in a 3D context, there is a growing interest in the modelling of the urban fabric which is not dependant on heavily capitalised technology for its data. The core principle of the current research project is summarised in the process of deploying a mechanism, which will allow the visualisation of urban form without loosing its quality and architectural characterisation. This technique suggests that a selection of various building types can be collected and described by their architectural elements, textures, scale and dimensions. From each group of buildings a library of fragmented architectural components can be then derived. The accomplishment of this methodology is the formulation of a 'grammar' comprised of a characteristic ‘syntax’ and its associated ‘vocabulary’. Therefore the expected outcome of this research is an approach that would allow the designer to create easily and quickly not only any desired building but additionally any imaginary cityscape.

Keywords: urban form, urban modelling, visualisation techniques

1. Introduction

The three-dimensional visualisation of a city has become an interesting area of research in the field of architecture and urban design especially in the last two decades (Bourdakis, 1998). The need to model and visualise a city is important not only for architects and planners within the design process but also for clients who might require an overview of the spatial and aesthetic consequences of proposals. This demand for the creation of 3D models of urban environments has given rise to the development of various rendering and construction techniques, including the

3D GIS, aerial photogrammetry and laser scanning, which allow the creation of realistic city models with greater possible use in the area of urban planning and architecture.

1.2 RELATED PROBLEMS IN THE CONSTRUCTION OF 3D URBAN MODELS

In the general area of the construction of 3D city models there are three main elements which, if not taken into consideration may lead to unsuccessful three dimensional models. These are :(i) data sources, (ii) level of detail, (iii) level of realism (Shiode, 2001). The source of data used for the production of 3D city models is an important factor because it affects the speed of construction of the model and ultimately its final usefulness. The amount of information used in a modelling process is usually linked to the level of detail. Therefore if the minimum level of detail is inputted, that would mean that a level of abstraction of the real city would be obtained which might not give a realistic rendition of the represented space. On the other hand if the maximum level of detail is inputted, then the time required to both construct and process the model will be uneconomical and the level of ease in use will be diminished. As a result, the key to the success of a good computer model is "*the process of providing the maximum characterisation of the subject for the minimum of input data*" (Grant, 2002). Therefore, from all the above there is a prime need to reduce the required input of a model to its minimum but still achieve its maximum output.

2 Focal area and scope of proposed technique

This paper presents the development of a technique that can be adopted for the creation of 3D urban environments which is not based only on the representation of *existing* buildings and spaces, as has happened so far, but on the creation of *imaginary* scenarios, ranging from a façade, an individual building or an entire urban space up to large-scale city models. Such models can be used to test specific spatial urban scenarios prior to construction as well as being able to represent or analyze a specific situation under consideration.

2.1 CONCEPT OF TECHNIQUE

The work that lies behind this study has been concentrated on the following concept in that; *many individual buildings, if extracted from their context are superficially similar to each other*. This can mean that many buildings, if carefully observed, share similar characteristics in relation to their architectural elements and which are articulated in a similar way perhaps according to their function or type. Therefore if similar types of buildings, which share the same gross features, are grouped together, they can be represented through a *singular* representation.

This analysis leads to the fragmentation of each chosen building type to its compositional elements including doors, windows, materials and other architectural features. The same principle of decomposing single buildings can be applied to the urban environment, which consists of elements such as street material, street furniture, trees, people, cars, and all other common details. The selection of all these elements can then be modelled and stored within an archive as a set of *archetypes.*

The nature of this process delivers control to the model designer. The selection of the range and complexity of the chosen archetypes is derived through observation, a process within which the designer can chose the level of granularity of detail. At one extreme many grossly similar buildings or other urban artifacts may be represented by a single archetype while equally the designer might chose to widen the scope of representation by modelling a greater variety of forms. This approach is sympathetic to the strengths of computer modeling, allowing the designer and subsequent users to dictate and balance both the level of realism and the effort required to capture and manipulate the final model.

Given that each archetype is formed and stored as a composite entity, this approach offers a great deal of flexibility in that the substitution of elements, (the 'vocabulary') while ordered by the same rule set (the 'syntax') ultimately offering a wide range of possibilities in the rendition of the final object.

2.1.1. Statement of current technique

The core of the system is the archive within which each element of architectural vocabulary is standardized, stored and categorized each being described through the use of a specific terminology, proclaiming their style, design layout, use, or even relationship with the building which they might compose. For instance, for the description of an element like *column,* three specific categories might be used; *Ionic, Doric,* or *Corinthian,* each of which indicate their style and period. Then when a more specific description is given then the column becomes '*an Ionic order with an attic base and a fluted shaft'.* As (Edwards, 1926:19) describes *"the greatest part of the vocabulary of architecture is expressional".* Ultimately, it is obvious that this description could not be expressed unless there was a certain structured grammar to give coherence and sense. Therefore for the above example '*an Ionic order with an attic base and a fluted shaft',* the grammar is used to analyse the construction into a representation which show its underlying structure, which in this particular example is composed of three main parts; *the base*, *the shaft* and *the capital.*

However, when a more complex description is required i.e. of a building or a synthesis of an entire streetscape then the 'grammar' can be ordered by a superset of rules derived from known 'good practice' and existing design guidelines many of which have been formed by experimental approaches and trials. Therefore in this approach the 'grammar' is represented by the author as the structure of the imaginary building or the urban scenario and the 'syntax' is the way each archetype is used to compose a building and in sequence an urban space.

3. Development of methodology

In an experimental application of the methodology the Merchant City precinct in the City of Glasgow was chosen as a test case from which to assemble data. This choice was made due to the area displaying both diversity and complexity while still maintaining a limited but characteristic topology of building types and materiality. The selection of five building types according to their function was selected as being the most representative; *churches, tenements, warehouses* and *public buildings.*

3.1. THE PROCEDURE OF SURVEYING AND DATA CREATION

The collection of information on every individual building was surveyed in three steps; *observation, estimation* and *comparison.* Direct observation of every individual building and an approximate estimation of its characteristic dimensions (height or length) was performed by taking a standard of a known dimension (of block size for instance) or by comparing some of its features with a neighbouring building of a known dimension. Elevational photographs together with freehand sketches were obtained for all the buildings on each visible face. There then followed a process of transferring and modifying the photographic data into the appropriate software in order to achieve a set of orthogonal façade images, which finally had to be created as image maps ready to be imported to the 3D model. Each of the building's facades was then broken down to its main components including architectural elements like doors, windows, roofs, columns, details, textures and other ornamental features (Figure 1).

Figure 1: Creation of image map facades of individual building and disintegration of building to its elements

All these components were described by their own architectural vocabulary creating individual *archetypes*, each of which had been identified by an individual symbol, i.e. for doors (d1,d2,d3…), for windows (w1,w2,w3…) and so on. Therefore, every elevation of each building was descriptively analysed, acknowledging the style, rhythm and form of its architecture, according to the position of its individual symbols of *archetypes*. When the new façade was about to be formed, a set of new 'rules' were followed which dictated a different 'syntax' by the new position of the selected symbols, which in their turn synthesized the imaginary façade (Figure 2).

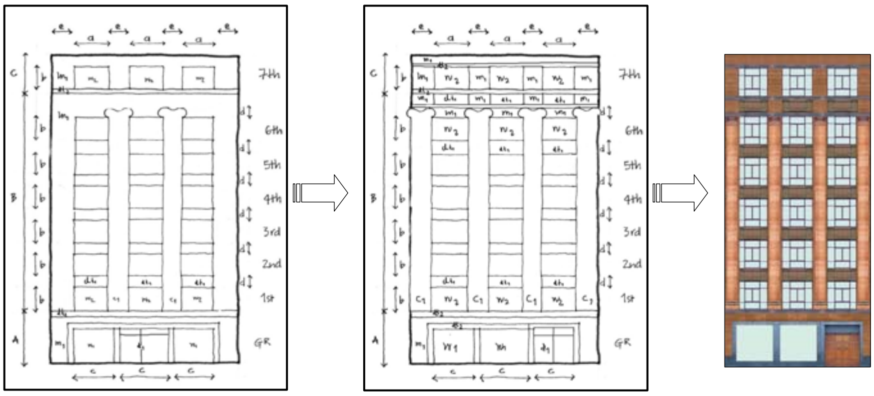

Figure 2: Architectural analysis of building's syntax and transformation into an imaginary façade

3.1.4. Syntheses of Street Facades

After reconstructing the individual buildings from their elements, the same principles can be applied for the creation of imaginary street scenarios. To perform this, a collage of all the required facades, which have been already been stored as *archetypes*, was produced using the appropriate software. One example of street façade composition is shown in Figure 3, in which all the buildings share the same *language* and a similar *syntax* by having repetitive elements on horizontal and vertical aggregation, which again makes their appearance in the whole synthesis more uniformed.

Figure 3: Creation of imaginary street façade

Figure 4: Creation of imaginary urban scenario

Therefore the formation of a syntax composed by a combination of all the created *archetypes* in a certain way, allow any 3D design scenario of possible
functional urban environments also to emerge. The additional factor here would be only the position of urban elements like cars, trees, people, as well as environmental effects like, streets, skies, etc. in order to make the settings realistic. Figure 4 illustrate such an environment.

4. Conclusion

The design and construction of 3D environments is a complex task, but technological advances in the last decade have helped in making this task less arduous and have increased the possibilities in this field. The advances in the field of urban modelling have challenged the author of this research, who came up with a mechanism of creating imaginary urban environments.

The fundamental idea behind this study was based on a set of *archetypes*, which included a variety of different components from individual buildings, environmental and spatial elements, allowing an iconic representation of *any* urban city form. The application of an architectural 'vocabulary' formulated in a syntactic articulation can lead to the creation of a singular building as well as aggregations of many buildings.

Most visualisation techniques have been concentrated on representational issues. In this study, the computer visualization technique developed is advantageous compared to the traditional methods since it provides a mechanism aimed at simplifying the geometry and the imagery of the dataset and eventually contributing to an efficient 2D as well as 3D method for modelling urban scenarios. By using the current technique for the creation of a new urban space, prime consideration should be given to the distribution of the elements, sizes, scale, dimensions and characteristics of the space. This would give the opportunity to the designer to study every step of creation and be more actively involved in the process of modelling.

A future extension of the technique might be to recognize that the process of deriving an architectural grammar from existing buildings also captures a number of characteristic dimensions, such as height, width, area, volume, solid and void, from which design metrics might be parsed. In this way it could be possible to interrogate models for additional geometrical criteria which might aid the designer in design decision making. In addition, the implementation of the archetypal data into a computer programme as described codes, could lead to the automatic creation of building types and urban forms.

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