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Urban Modelling

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This project was an investigation into the application of Urban Information Systems [UIS] based on 3-Dimensional computer models. The research centred on a collaboration between the Architecture and Buildings Aids Computer Unit, Strathclyde [ABACUS] and the Edinburgh Old Town Renewal Trust [EOTRT] to develop a detailed computer model of Edinburgh's old town. The area of particular interest is the development of an interface to a database of property related information. This provides a means of analysing the multi-layered and multi-dimensional spatial data which is characteristic of urban environments. The research also investigated how, by using multi media technology as a data integration tool , urban models could be used to improve decision making in the framework of urban management.

Introduction

The primary objective of the research project was to develop a tool which would help the Trust in the task of assessing the visual impact of new developments on the urban fabric. However, previous experience in developing a similar model of the city of Glasgow proved that a three-dimensional urban computer model could be utilised in a variety of ways. Thus, it was apparent that this type of model had the technical ability to be used in a wider context. Recognising potential applications for the model has since become an integral part of the research project.

Within the field of rural land management, Geographical Information Systems [GIS] have been implemented to automate a diverse range of processes from simple mapping functions to complex land-use analysis, site selection and network modelling requirements. A GIS functions as a resource which, by allowing data to be more effectively and efficiently handled, improves the quality of planning and decision making processes. Within the urban setting GIS are of limited use. There was therefore a need for an Urban Information System [UIS] which would allow information to be assembled and applied in new ways and would account for the essentially three-dimensional nature of urban infra-structure. A UIS would enable the management of large and diverse spatial databases and provide effective tools for the collation, manipulation, analysis and display of urban information.

If such a system is based on a geometrically oriented model, instead of a map, certain advantages accrue. First, the city is fully represented in three dimensional form which provides an intuitive method for communicating proposed development policies and physical outcomes to both lay people and the associated professionals. Second, most urban information can be ‘geo referenced’, i.e. referenced to a specific geographic location. This provides a basis for the comparison of otherwise disparate data sets. Finally, a three-dimensional model provides a more direct method of accessing information within a database than is presently offered by current 2-D cartography. A predominant aim of the research was to illustrate that through the efficient and effective utilisation of a UIS in conjunction with current and pertinent information, then significant benefits can be realised for the planning and policy making processes within local government, which in turn will have a direct bearing on society as a whole.

In developing a tool to assist the Trust, the objective was to identify, and then prototype an information system relevant to the urban environment. The UIS would enable a variety of evaluations and representations to be

made concerning the built environment in terms of visual appearance, as well as reference other kinds of data, such as land use patterns or social statistics. Ultimately the UIS would provide a city with a common up-datable information base relating to the associated professions of architecture, civil engineering and the management of city utilities and would present these disciplines with a global view of the city. A priority of the research was to develop a system which would be applicable to any urban situation but which would also be able to account for the dynamic nature and individual physical and political characteristics of each different city.

The theme of urban modelling is one which ABACUS has developed over a number of years. In general it has been found that the progression of the research centres on three serial stages, as described below.

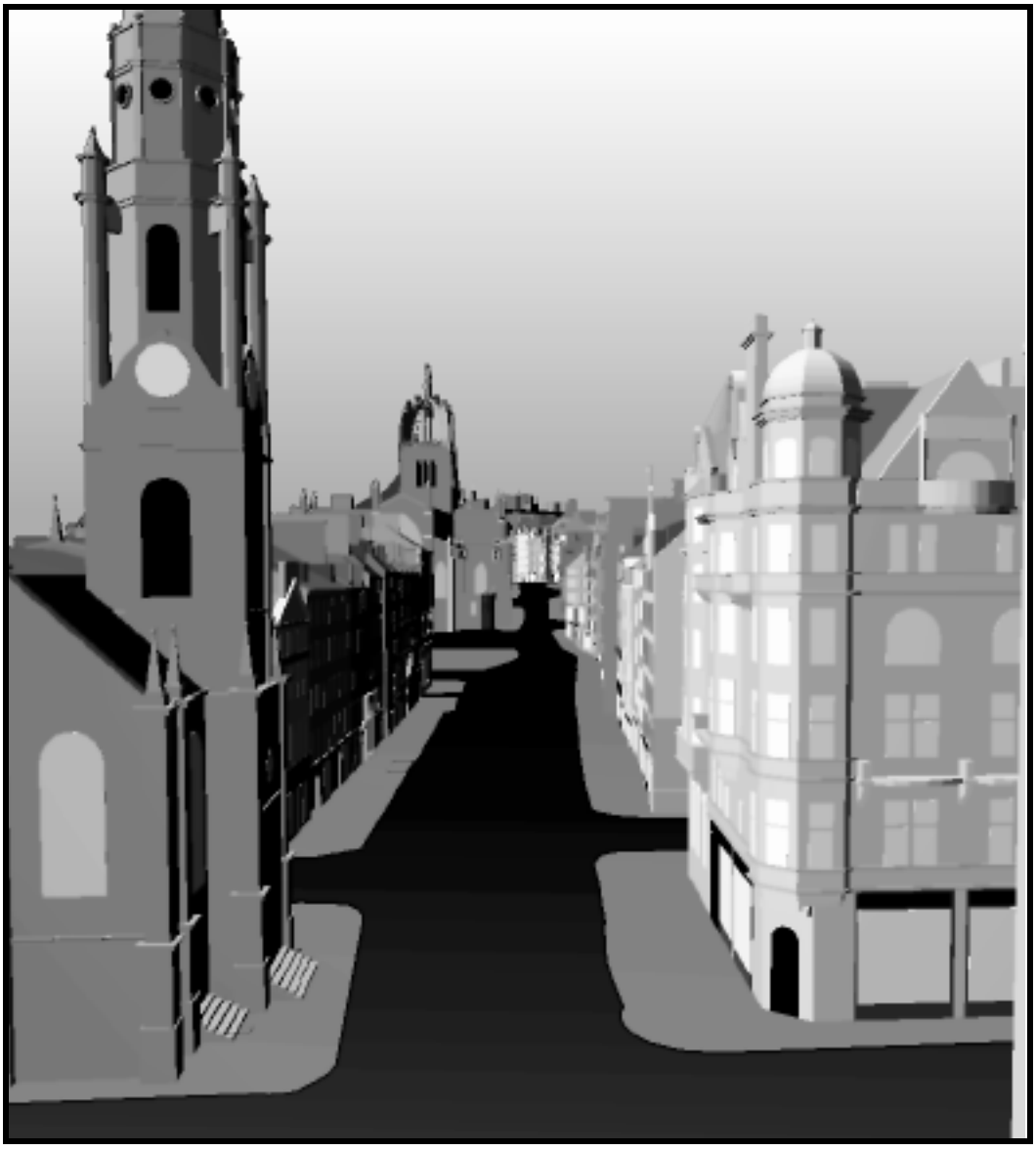

Figure 1. The Royal Mile, Edinburgh Old Town

A Geometrical Model

Firstly, in order to progress, it must be possible to construct urban geometrical datasets in an efficient manner. This requires that the essential data cap[ture can be performed in a manner that is both economical and timely. The key to this phase of the endeavour has proven to be a collaboration with the Ordnance Survey [OS] (the body who provide the standard cartographic function within the UK). The OS maps are currently available in a digital format and it has

proven to be a logical and efficient route to filter the 2-D data into a 3-D format thus providing an accurate and low cost initial approximation to the urban fabric. This basic model description can then be attributed with sufficient geometrical detail to form a recognisable and representative model of the urban environment (fig 1.) The Edinburgh Model in this stage of development is still a valuable tool for visual impact analysis and as such the EOTRT has introduced the system into its working practice. EOTRT operate the CAD package SPIRIT. Files can be transferred into a form readable by SPIRIT by using custom filter software written by ABACUS. Thus, the original objective has been met and the Trust has been provided with a tool which enables them to communicate proposals and co-ordinate planning strategies. The urban visualisation software provides a means of modelling and manipulating the spatial data about the buildings and the urban infrastructure. This allows the display of the massing of the urban fabric, the nature of the skyline and the detailed appearance of the urban spaces.

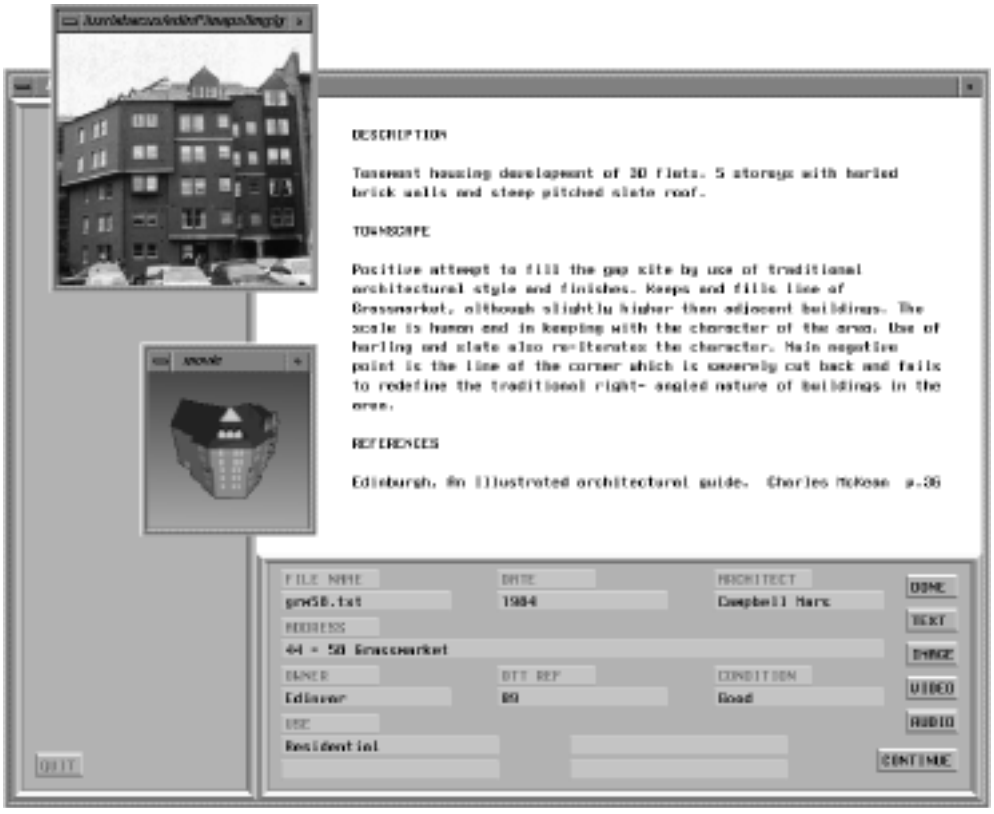

Figure 2. The Data-base Interface

The Urban Data-base

Secondly, the geometrical data can find increased functionality through the attribution of the buildings with ancillary data describing their relationship to the city. It is at this stage of the project development that the possible potential of transforming the model into a useful information system becomes apparent. An ideal UIS would be an open system containing disparate yet standardised databases linked to what is essentially 3-dimensional cartography. Unique spatial co-ordinates would provide a means of linking and cross referencing an indefinite number of databases relating to the same urban environment. Value would be added to each piece of data through the spatial manipulations allowed and their inter-relationship with other relevant data sets. Each database could be maintained by the principle user but the important factor would be that during any particular query, data from disparate sources relating to the same geographical location could be accessed and merged Taken to its logical conclusion this vision of an urban database has a number of advantages Resources may be saved if data is collected and stored without duplication, 'data redundancy' is thus avoided, similarly, the data may be used more effectively and efficiently than if it were stored separately. If data is stored at several locations by various bodies, then excessive time and effort may be required to gain access to it. The

data is likely to contain fewer errors. In particular, inconsistencies in the data are less likely to occur. The task of keeping data current is made easier and as a result, the updating of information is more likely to be carried out. To put this into practice it was decided to implement a section of the EOTRT data base as a test case for the project. The Trust had previously commissioned a survey of the building stock within the conservation area, the objective being to establish a set of data sheets relating to each building and related site. The outcome was manifest as a file for each building containing a textual description as well as photographic records and building plans.

The task was now to integrate this data within the existing geometrical model. This was achieved by creating an interface that allowed a user to move around the database and graphically browse the data using 2-D maps to select buildings and their associated records. Unlike a conventional database where each record points to a building, this implementation takes each building as a graphical pointer to a record containing further data. Also provide is a query interface that enables a limited "search" functionality. This enables a user to search for a record on the basis of context combined with a selection of Boolean, arithmetical or lexical operators. This will allow for a search pattern of, say, a mixture of use category, ownership, date, condition and location. The information content has proven to exist in a number of media formats, namely text, photographic images, large scale drawings and even video or voice recordings. Each media is capable of being contained within the structure of the database and although this type of system is commonly referred to as multi-media, its true worth is that once captured, all the data becomes homogeneous and exists in the same form, accessible through one interface and capable of dissemination in a similar format.

The Urban Design Tool

Currently the system does not provide for the evaluation of existing or proposed changes to the urban fabric or public spaces. To use the system as an instrument for evaluating the qualities and quantities of the building stock within the context of any city and as a support mechanism for resource management then it is necessary to attribute further values to the data. To utilise the existing geometrical data, the base level of detail can be used to allow the calculations of floor areas, volumes, densities and distances. As the underlying model is in an accurate, digital format it make sense to utilise this fact to gather data that would otherwise only be available from costly on-site surveys. Increasing the capacity of the system to perform more complex arithmetical calculations would enable the user to obtain the following evaluations of the urban form and structure.

Given this ability it would then become plausible to utilise the model in this new mode and allow the evaluation of, say, built density as a function of other parameters. Similarly the results of a design intervention could quickly be assessed by evaluating existing and/or potential floor areas to be used for new or re-development. The potential extends beyond the building stock since the ability to differentiate, and calculate, the fractions of hard and soft landscape as well as that proportion given over to transport networks will allow the evaluation of the road network structure. (including parking areas, individual and accumulative distances between specific points in the city) and even the ability to evaluate of the extent of infrastructure given to road networks. (Overall length of systems).

The categorisation of building usage e.g. housing, commercial, education, retail, car-parking, vehicular routes would enable complex evaluations of urban development projects on varying levels of scales: single buildings, whole blocks or within the overall context of the city. Such evaluations could review: the mixture of categories of use within a specified area showing the distribution of different building categories within an urban district. Similarly the same technique could be applied to the transportation densities in an area. Specifically the size of distribution networks and distances from supply points of goods to receiver points could be calculated, along with the individual, average or accumulative distances between places of residence and areas of work, retail and recreational areas and social and cultural points. This type of evaluation could immediately pinpoint potential problems in a proposed development such as the ability of the transport networks to meet expected demand, the availability of critical services (fire, police) within a designated area and even the trivial such as the relative proportion of car parking facilities to expected residents. The location and frequency of specific services such as public transport, police stations, fire stations and schools could be defined for a specific density of development with a particular use profile. This could be aided by applying simple planning rules.

Linking cost information to the building use categories would provide a means of evaluating the economic feasibility of proposed developments which in turn could provide an estimation of project costs and investment modelling. Similarly, the viability of transport networks can be evaluated by attributing cost information to different modes of transport. As a result it would be possible to assess: the accumulative distances between places of residence, areas of work and other targeted locations. Given this ability it would then be possible to test proposals against the optimum capacity of the system allied with the existing population density as a function of the desired frequency of the system and the cost per mile.

Conclusion

The urban environment is the product of innumerable people and their activities operating over a long period of time. The manifestation of urban decay in many cities in the United Kingdom and Europe over the last 30-40 years can be partially attributed to the failure of policy decision makers to predict with sufficient accuracy the future requirements of the people. Cities should be viewed as more than a collection of buildings. Technology can undoubtedly help in improving the infrastructure, yet technology itself does not provide the answers but it can provide a mechanism for obtaining solutions to social infrastructure and management problems in urban environments.

The potential of a IUS, as described here, is immense. The ability to collate, compute and communicate data at an urban level is undeniably powerful and it is clear that constraints on the future development of such systems are no longer technical but are issues that are mainly social and political in nature and the questions relating to the legal, ethical and economic constraints will have to be addressed before the full potential of the UIS in the field of urban management can be realised.