Autonomous Spatial Redistribution for Cities

Jon Moorhouse and Gary Brown

The paper investigates an automated methodology for the appropriate redistribution of usable space in distressed areas of inner cities. This is achieved by categorising activity space and making these spaces morphologically mobile in relation to the topography within a representative artificial space. The educational module has been influenced by theories from the natural environment, which possess patterns that have inherent evolutionary programmes in which the constituents are recyclable, Information is strategically related to the environment to produce forms of growth and behaviour. Artificial landscape patterns fail to evolve, the inhabited landscape needs a means of starting from simplicity and building into the most complex of systems that are capable of re-permutation over time.

The paper then describes the latest methodological development in terms of a shift from the use of the computer as a tool for data manipulation to embracing the computer as a design partner. The use of GDL in particular is investigated as a facilitator for such generation within a global, vectorial environment.

Keywords*; Animated, Urban, Programme, Education, Visual Database.*

Introduction

This paper has emerged from a four year developmental module designed to introduce Architectural students to the complexities of urban design within materially distressed cities. Early investigations of the urban matrix based on a version of Kevin Lynches ‘Image of the city’ revealed that ‘activity uses’ as events were as important as the visual image of the city. These ‘activity uses’ were more flexible within the urban landscape forming a constantly amending symbiosis with the city’s fabric image. This realisation created yet another set of information layers and a consequent complexity that could only be handled as a series of extrapolated information layers within the computer, forming a simulated artifice of the city. We are in an age were simulated communicable realities as temporal, mental physicality now affects the aspirations of international cultures and how they reciprocally view the real, “Simulation has displaced production and the map precedes the territory.” (Huyssen 1989) Simulated worlds are therefore an appropriate platform within which to test “Nth mightly hoods” (Hatton 1985) of what the city can become. “The envisioning potential of the computer, and of Virtual Reality in particular, seems to offer a representational nirvana.” (Diamond 1999)

The educational module initiates with information gathering from the existing city under three main themes: Immutable image, mutable activity uses and desirability—producing 15 subsets of interrelated information within which there are further sub sets. These information sets are interpreted as visual patterns in layers within the artificial space of the computer which have a direct reference to the existing city. This utilisation of patterns relies on the fact that pattern recognition and pattern creation are inherent to our comprehension and manipulation of the environment, enabling us to successfully project and intervene in the environmental patterns for our benefit, thus taking advantage of our natural visual abilities of distinction and association. Overlaying the information of these visual patterns is another set of information acting as behavioural programmes, these programmes consisting of the behavioural strategies of that particular pattern of 'activity use'.

Programmes of Existence

This imbuing of behavioural programmes is associated with a theoretical change in the way that we view the universal order of the environment, from a linear mechanical model' towards a non-linear organic model. In this new order there are a multitude of space times and objects 'the being of things' is somehow indivisible from the whole—they are inextricably entangled with other objects and space time as environment. The figure can in itself be the medium for other entities and systems of figures such as flocks of sheep or blades of grass can be said to form a context. There is a relationship between the being and the medium, the figure and the field where the 'being of things' should be seen more as emerging from the medium rather than distinct from the medium because its existence is interdependent with that of the medium. Entities no longer exist as singularities, the 'being of things' consisting of open systems which are de-localised and are interdependent with other open systems where their interactions are characterised paradoxically by order and chaos. Temporal stability emerges from a 'being's' ability to store and utilise the incoming flow of energy into their open systems, enabling them to remain stable over periods of time to yield "reproducing, regenerative life-cycles" (Mae-Wan Ho 1997). These programmes of existence have a perpetual tendency to push themselves towards the edges and extremes of the system in order to optimise gain, interacting with all other environmental criteria and eventually amending the environment, producing the constant flow of environmental change. 'Being' in this new order of things is then a temporal state, it can be considered as in a superpositioned state that has more than one point of equilibrium as a response to the interactions of environment. Programmes of existence unify the diverse elements of 'being' whilst respecting the identity of each. These programmes of existence are locally imbued and are more important than any singular form of the spatial matrix within a frozen point of time because it is these generative programmatic relationships which create the changing forms and patterns of the environment through time.

Our mapping and classification of being tends to set up categories in stasis (frozen patterns) when in reality, as change is the only permanence, both entity and mediums are in perpetual motion The way we map and record initiates and perpetuates this stasis. We map that which is a moment in time in Euclidean space rather than mapping the forces which shape that moment in time and move between the Euclidean dimensions. In effect a new form of mapping is required in order to recognise the dynamics of the environment by realising that entity and medium are an interactive system and that there are only field to field or open system relationships. There is a stasis to architecture, "it is static rather than stable". (Lynn 1997) Architecture needs to adopt intents which makes it gravitationally appropriate within other urban systems. Inhabitation as landscape has become an accretive pattern reflecting our 'own' natural cycle, that endeavours to prevail over the cycle of nature. Today's cities can be termed artifices, but have failed to evolve relative to the dynamics of our own nature such that past patterns, in their majority retain an influence on our nature. "Natural patterns are generative, the constituents recyclable" (Frazer 1995). Our patterns fail to evolve and are deserted rather than recycled. They become patterns in the dust. The city should be considered, as having emerged from the topography in response to local forces (emanating from the holistic matrix) as a strategic material redistribution of the earth, similar to 'Gottfried Semper's mound', that reflects the local milieus programmatic requirements laid down and adjusted over time.

The Educational Module and the role of the computer

The aim of the educational module was to start with simplicity and develop towards the most complex of systems that are capable of re-permutating over time. Creating a series of 'base blocks' which have adaptive programs and strategies imbued locally that can be appropriately applied to our own environmental context. "By comprehending architecture and urbanity as a series of events related to programmes it is possible to envisage a more dynamic state where architectural elements can respond amending local conditions and overall strategies. Or where groups of architectural elements can create new strategies within the existing urban programme. "(Allen 1997) The 'base blocks' within this educational module are termed sprites: They constitute a small package of spatial information derived from a measured analysis of existing morphologies of each of the activity-uses. (Accommodation, Administration, Communication, Education, Entertainment, Production, Service, Storage, Retail) This spatial information is that indivisible formulation that generates the overall envelope of the building through its multiplication. In some cases this is based on the singular human space necessary to carry out a specific task related to that use e.g. administration, in other cases it relates to a constructional format, e.g. production, or the dimensions of a machine e.g. transportation.

These sprites are then imbued with two sets of interrelated behavioural programmes associated with parameters that tend to generate their envelope form (Megalope Pattern) and that tend to place them at particular locations within the city topography. These sets of behavioural programmes are termed 'accretive' for a sprite's tendency to generate morphological forms of the Megalope patterns and 'topographic' for

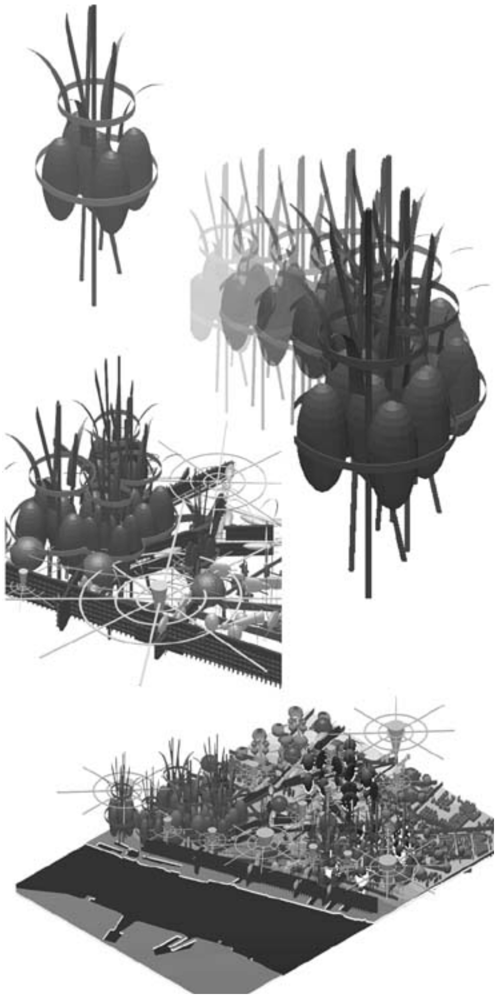

Figure 1 (left).

their tendency to locate at particular locations within the virtual city. Behavioural programmes are then interrelated, acting together to create a particular form at a particular location in the virtual city. To date students have formed and located these 'Megalope' morphological patterns by hand, utilising the programmatic reasoning that they accrue as a synopsis from studying the morphologies of the existing city and the 'sprite' precedent studies. The aim is to automate one part of the programme such that the computer does part of the work..

The utilisation of the computer within this educational module was a natural development from acetate layers of information to the utilisation of the computer as a visualisational data base whilst also utilising the module as a progressive pedagogical CAAD and teaching aid. Graphisoft's ArchiCAD was employed and the pedagogical intentions to develop the students' CAAD abilities were developed in tandem with the module. The 3D visual database of 'activity use' was constructed as follows:

A scanned city map covering 6 KM^2 was imported to form the base line from which a 3D contoured landscape was constructed, upon which the building footprints were overlaid. These footprints facilitated the extrusion of a scaled block model of buildings made up of 'Veneers' of each floorplate, artificially elongated on the Z axis for clarity and colour-coded according to their activity use. This visual database could then be explored from any angle, projection or layer and 'interrogated'. Following this, an additional layer of Veneers was added representing the desirability of land plots using criteria which produced a scale from 1 to 10. These were represented by shades of grey from light to dark. This was then extruded to a 3D representation producing a 'desirability landscape' of peaks and troughs. These veneer patterns were interpreted as 3D Megalope patterns through studies of existing precedents within the city and also the precedent 'Sprite' studies. These patterns encompass each of the activity uses, architectural and urban strategies and their perceived spatial relationships on a macro-urban scale. The 'Megalope' patterns were constructed and saved as Library Parts within ArchiCAD, meaning that they can be called up and placed within new Layers in the artificial city. In this way the Megalopes could be re-scaled as appropriate. Revision of the existing distressed artificial city was then set up as a series of specific aims to test various potential scenarios or the Nth Potential. Initially, this was based on references to the existing Megalope patterns and desirability map, together with investigations of other international urban concepts to generate a 7-point manifesto of what the city may become. The result, through insertion, deletion and intervention of new patterns to meet the manifesto aims, was the construction of a

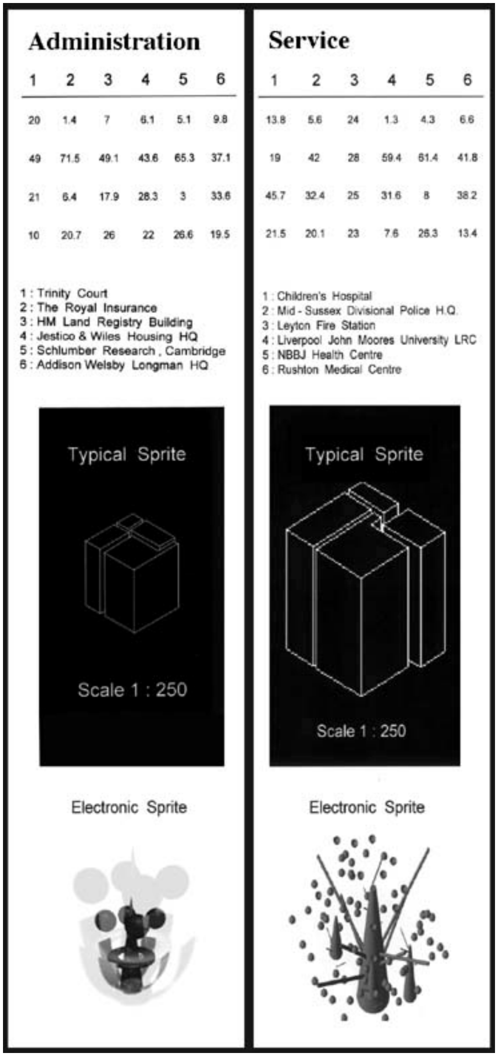

Figure 2 (right).

new arrangement of Megalope patterns that represented a new artificial city. These proposals for insertion and amendment could be tested in both combination and permutation during the design process by turning on and off Layers to see the resulting artificial landscape. The conclusive proposals were then presented using stills, flythroughs and animations of a city growing related to the specific manifesto aims of each group of students.

Adding Interactivity

At this stage the computer's role had been solely as a data-management, 3D modelling and visualisation tool. The next stage was to design in a level of interactivity. The rationale behind this was two-fold. Firstly, the students interpretations were potentially prone to whim. This was not necessarily counter-productive but in some cases unjustifiable. Secondly, the process of location within the artificial city in the computer was time consuming, meaning that proposed cities were often singular. One way of achieving this seemed to be to allow the computer to suggest solutions using a set of conditions which can be variably weighted by the students these conditions becoming the behavioural programme strategies of the activity uses in terms of their desire to locate at various points in the city. This necessitates programming representational forms within the artificial city and consequently finding the most suitable software environment through which to achieve it, without loosing the pedagogical CAAD teaching aims. Initial investigations were made into game technology, particularly simulations. Certain similarities were drawn between what we were trying to achieve and Maxis' Sim City, which is an urban planning simulation game in which cities are constructed by defining zones and providing amenities in order to attract simulated citizens. This is achieved through sophisticated algorithms. This inspired an approach through which we provide a general set of algorithms affecting the Sprites and Megalopes (Library Parts) which facilitate the simple development

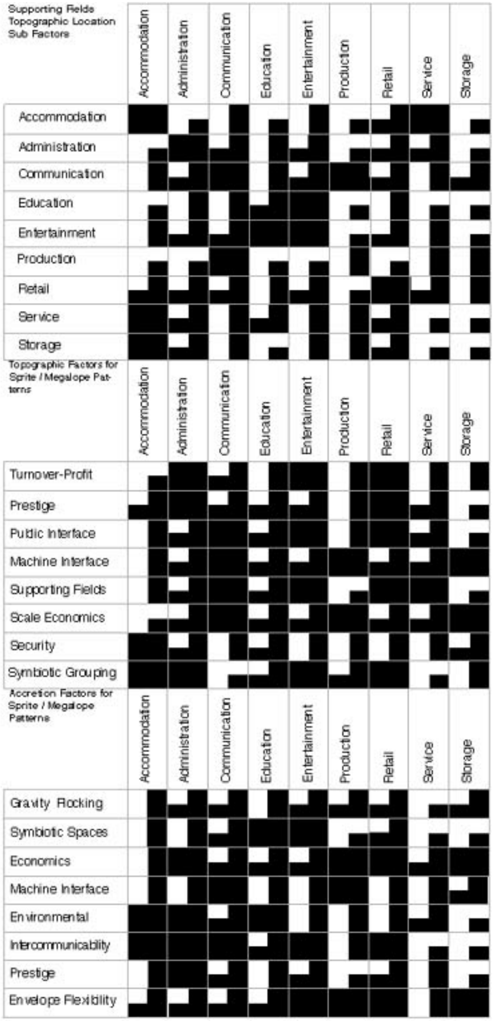

Figure 3 (left).

of conditional rules by the students.

From previous experience, an examination of Macromedia Director and Apple's HyperCard as potential multimedia programming environments was made. The necessity to remain in a 3D, Vector-based environment through which the Sprites and Megalopes could be informed by— and subsequently inform—the CAAD model directed us towards the use of VRML or ArchiCAD's own GDL and consequently full circle. This would provide a continued ease of use by students and retain a pedagogical desire to remain within specific CAAD directions. GDL is ArchiCAD's parametric programming language, it exists in the background of any ArchiCAD model and is, in a sense, generated through the normal use of tools from the software's tool palette as well as through direct scripting of the Library Parts. In brief, entire projects generated within ArchiCAD can be saved as Library Parts or, as with our visual database, Library Parts can be placed within a project.

Our overall approach for interactivity within the database, and hence between the database and the user, concerns the attraction (desirability) of topographical locations within the city model to the Library Parts (Megalopes) or vice-versa. This relationship is based upon the applied, weighted attractivity of point locations (Nodes) and the imbued (programmed) tendency of the Library Part to be attracted to them. This can be addressed in (at least) two ways from a programming point of view. Firstly, how the Megalope locates itself within the topographic model, termed here the 'Megalope Down' approach, or secondly, how Nodes within the model attract different Megalopes, termed here the 'Model-Up' method. The result is ostensibly the same, although each present different programming problems. Both approaches rely on identifiable Nodes within the topographic model having an attraction value and the Megalopes having a tendency to locate or be attracted. This necessitates a certain amount of programmed data for each, together with a dynamism within the overall system that allows this dynamism to occur from an initial static position. The major difficulty here is facilitating this dynamism within an apparently static CAAD environment.

The 'Megalope-Down' method addresses the problem of programming the Library Part that represents each Megalope with the ability to find a suitable location within the topographical model. In order to achieve this, several initial conditions must be met. Firstly, the model must be able to return data to the 'searching' Megalope. A useful feature of ArchiCAD which may be applied here is the Zone Stamp tool. Intended to help the designer zone buildings and inform the Quantities database, the Zone Stamp can be used to assign definable characteristics to an area, in this case a node, e.g. attractivity value, degree of importance, colour, etc. Data stored in a Zone Stamp is readable on request by a Library part and the Zone Stamp can be sized as desired in relation to a notional grid overlaid on the topographic model. The second condition is that the Megalope must be able to 'move', or at least test, a number of potential locations before deciding its optimum destination. This is not too difficult so long as the extent of the topographic model is known—which in this case it is. If we consider the model to be flat (i.e. consider in plan) and take the starting point to be the origin at the bottom left-hand corner of the topographical plan, we can instruct the script to probe nodes on a grid and interrogate these nodes for attractiveness, storing the results for future decision-making. This is accomplished through a FOR-NEXT loop, adding definable X and/or Y transformations each time and REQUESTing data to be stored in the internal buffer (or ignoring no data or existing positioned Megalopes with an IF THEN statement). The script can then select the optimum position on plan, return the Z height of the ground level and construct the Megalope in position from the 3D geometric script. The implications of this method are that the Megalopes are 'fired' at the topographic model in a user-defined order. Further, a degree of randomness can be programmed in at the position selection stage. Both of these implications can be used to increase the variety of outcomes.

The Model-up Method begins with the topographic model and its set of Nodes. It attempts to select the most appropriate available Megalope for each defined Node and locate it in place. The approach differs distinctly from the 'Megalope-Down' method from a programming point of view. If the topographic model is used as a starting point, the model must be able to take each node in turn and attract a viable Megalope. Nodes must be programmed (through sub-routines) to select Megalopes. ArchiCAD Library Parts can CALL upon other Library Parts as part of their script. If the model itself is considered as a Library Part with 1 Node this poses no problem. For more than 1 Node (i.e. in any realistic proposition) the model needs to be imbued with the capability to rebuild itself (at least) once for every node that exists. One way of doing this is to activate ArchiCAD's SPECIAL menu and activating the REBUILD BETWEEN FRAMES command as proposed by Nicholson-Cole (1998). This then requires a fly-through, or a series of Frames, to be generated in order for the Frames to come into existence. The script can detect the nearest Node to the current Camera position and call up the appropriate Megalope. The beauty of this method is that, programming aside, the way the inhabited artifice is constructed depends upon the choice of camera path. A number of different camera paths may produce a number of different outcomes. The most interesting side-effect of this process is that the fly-throughs generated in this process can trace the construction of the artifice.

Concluding Remarks

With these developments the envisioning potential of the computer as a teaching and design aid is utilised to maximum effect, whilst maintaining initial pedagogical CAAD teaching intentions and reducing the students workload. Students have the potential to learn the reasoning behind why buildings group to produce specific morphologies at specific locations within the existing city by enabling them to programme the characteristics of a set of building blocks, thence reciprocally enabling them to critically assess the conclusions of these programme changes through the visualisation of the artificial city constructed.

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