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ADOPTING A COMPUTATIONAL APPROACH TO IDENTIFYING AND MODELLING FUTURE DEVELOPMENT INITIATIVES WITHIN THE URBAN CONTEXT

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Abstract
In 2002 the State Government of Victoria, in partnership with the City of Greater Geelong and Deakin University, initiated an urban design framework to explore development opportunities of a series of redundant industrial sites adjacent to Geelong’s central activities area (CAA). One of the objectives of the framework was to explore a range of initiatives based on the expansion of the Deakin University Waterfront campus from 700 students to an expected cohort of 5000 students. Working with a set of predefined constructs for different types of city-based user groups, such as net floor space requirements and time/travel distances between facilities, the following paper presents a simple computational approach to assist in identifying, mapping, and spatially exploring different development scenarios.

Keywords
Urban design, computational, mapping

INTRODUCTION

Based on case study research into the proposed expansion of the Deakin University Waterfront campus at Geelong, from a present cohort of 700 students to a planned cohort of 5000 students, the following paper explores a simple computational approach to assist in exploring future development initiatives. By generating and context mapping a diverse range of development scenarios, based on net floor space requirements and time/travel distances, the approach attempts to enhance conventional brainstorming and workshop practices by inhibiting ‘convergent thinking’ (Guilford 1967) and ‘design fixation’ (Jansson and Smith, 1991; Purcell et al. 1994) during the early stages of the planning process. Both of these conditions often give rise to limited or unresolved development options, which invariably fall short of providing a balanced response to the expectations and needs of different stakeholder groups. The purpose of the approach is not to resolve an optimal or ideal solution, but rather to generate an array of different outcomes that extend the range of potential development scenarios beyond the limits of an ad-hoc approach.
WORKSHOPPING THE UNIVERSITY CITY

Deakin University currently has five main teaching facilities. Two of these, the Waurn Ponds campus and the recently established Waterfront campus are located at Geelong, Victoria's largest regional centre servicing a population of 250,000 people. Built in the mid to late 1970s at 9km south of Geelong's central activities area (CAA), it was expected that the Waurn Ponds facility would eventually become the epicentre of Geelong's greater metropolitan area. However this anticipated growth pattern did not eventuate and the campus, which currently accommodates 5000 undergraduate students, has by and large remained remote from the city, being accessible mainly via car and limited public transport. By comparison, the overwhelming popularity of the Waterfront campus (opened in 1996) and the economic, social and cultural benefits which it has attracted to the CAA through its city-based student cohort, has provided the catalyst for the university to seriously consider expanding its waterfront facility in order to relocate and accommodate all undergraduate courses currently being delivered at the Waurn Ponds campus.

In October 2001 the Victorian State Government's Department of Infrastructure, in partnership with the City of Greater Geelong, and Deakin University (identified as a primary stakeholder) embarked on an 18 month strategic planning process referred to as the "Western Wedge". While the objective of the project was to produce an urban design framework (UDF) for identifying opportunities and constraints relating to the development of Geelong's old industrial sites located adjacent to the CAA (Figure 1), a significant part of the process was aimed at establishing a range of design options to enable the university to meet its desired cohort of 5000 students. While the amount of work generated through the use of conventional brainstorming methods, in a workshop referred to as 'Allomorph 2', was considerable, attempting to canvas a range of divergent ideas which could be measured and evaluated against a set of tangible design criteria were nonetheless limited.

'Allomorph 2' was conducted over two days. Comprising five student-based design teams lead by key figures from the architectural profession, the workshop was directed specifically to exploring new campus options (Figure 2). While essential data relating to operational structures and net floor space requirements formed a key component of the workshop briefing session, teams preferred to follow a 'blue-sky' approach with minimum constraints. In departing from these essential briefing issues, this 'open' or 'free' approach to workshopping appears to have yielded little tangible material and surprisingly resulted in a range of generically convergent design ideas. Most teams appeared to demonstrate little understanding of the impact or scale of their proposed development and held little regard for either the urban context or the built space and floor area requirements of the client design brief.
Operating as an independent research team, which had been involved in preparing the context analysis for the Western Wedge UDF, and the campus expansion briefing data, the authors of the paper decided to follow a very different scoping process to that of 'Allomorphae 2'. Based on their context analysis, the team realised quite early in their research that by generating scenarios which explored both multi-campus and single purpose built facilities, an extension of Deakin's higher education presence within the 'Western Wedge' precinct could present significant opportunities and implications for other stakeholder groups within the CAA.

By critically appraising the 'Allomorphae 2' workshop, the team concluded that while brainstorming techniques had their merits, the ad hoc nature of the 'blue-sky' environment often presented limitations when attempting to evaluate outcomes. In addition, when designing from a highly informed analytical basis many of the designers who had been involved in data collection and assessment, and therefore had extensive association and exposure with the study area, often experienced 'design fixation' early in the process. Drawing on the deficiencies of the arbitrary 'what if?', the research team decided to introduce a degree of rigour into the design process by identifying and methodically controlling a series of simple urban design variables in relation to real projected growth estimates. While the team acknowledged that some of the concepts generated by a computational approach would be of little use, they also believed that a range of ideas would emerge, which were not previously apparent, but would nonetheless yield a rich core of divergent generic directions.
THE COMPUTATIONAL PROCESS

Sir Leslie Martin in his essay “The Grid as Generator”, attempted to “provide a strong theoretical basis for urban design”, by demonstrating how changes in the relationship between built form and space can affect the city as a whole.

Martin’s presentation drew upon the spatial qualities of the city and composed them into purely mathematical arrangements, or groupings, that could be manipulated, depending on density and grain, to reveal the possibilities available to urban planners, architects, developers and engineers. Adopting the concept of the ‘Fresnel Square Diagram’, Martin studied the relationship between distance and built form, in the development of medium density and terrace housing models, to counter argue the generation of the high rise apartment block in lower socio-economic neighbourhoods.

Following the idea presented by Leslie Martin and Lionel March during their urban form studies at the Centre for Land Use and Built Form Studies during the late 1960’s, the method presented in this paper uses a base grid and two key parameters: dispersion distances and floor area requirements. While the approach appears to resemble a cellular-based formalism (White and Engelen, 1993), the parameters utilised are finite and their manipulation, at this early stage of the research, are moving more towards an application of the haptic shape relationships and spatial manipulations associated with Shape Grammar theory (Stiny 1975, Knight 1994).

The University City

Working with the 'University City' paradigm (see Figure 3) as a construct to anchor the investigation, the team conducted a precedent study of different inner city structures which accommodate higher education institutions. These institutions were assessed and analysed in terms of their student populations, estimated gross floor area, and dispersion distances between facilities. The building footprints were subsequently mapped over a same scale base
plan of the Geelong CAA and 'Western Wedge' precincts. The institutions and city structures analysed included: Cambridge and Oxford universities, minus their residential college components, and the facilities of the Royal Melbourne Institute of Technology University’s Melbourne city campus.

Figure 3: Same scale figure-ground comparison between three inner city urban campuses.
Dispersion Distances and the grid
The grid, illustrated in Figure 4, is based on research into walking distances established by the West Australian State Government. Their recommendations conclude that a 'comfortable' walking distance in an urban area consists of approximately 400 metres in a timeframe of 5 minutes. It is assumed that people using the new university would expect buildings to be based around this walking distance and timeframe. Distances beyond this threshold may be perceived as requiring the provision of other modes of travel such as bicycles or the extension and coordination of public transport infrastructure. The grid therefore begins as a 400 by 400 metre arrangement – measuring 560 metres on the diagonal (7 minutes walking distance). The dispersion distances between the university buildings are in turn structured in a sequence of 100 metre increments (or half a city block). This is further broken down into a sub-grid of 25 by 25 metre cells in order to conform to the floor area requirements and modular increments of the building plate sizes of the university.

![Diagrams showing grid generation](image)

**Figure 4:** Generating the base grid and cell size

Floor Area Requirements
The floor area requirements for the new campus facilities were based on the current and projected needs for both teaching and associated university spaces. The data provided by Deakin University, Buildings and Grounds Division, involved the relocation and accommodation of five faculties (Business and Law; Education; Koorie Education; Health and Behavioural Sciences; and Science and Technology) commanding a net floor area of almost 16,000 m². This total net floor area was divided into 25 by 25 metre cells. Methodically manipulated to generate different sizes of building units, variations of campus building stock were produced, which, together with different dispersion distances, established the basis for describing a range of campus footprints:
(1) Total Net Floor Area / Number of required Floor Levels = Net Building Footprint.
(2) Net Building Footprint / Number of Buildings = Nominal (n level) Building units.
(3) Nominal (n level) Building Units X Required Distance radius = Level of Dispersion.

Model Generation and Context Mapping
Manipulating cells by the addition of incremental 25x25m units in both vertical and horizontal stacks, and the dispersion of the stacks with respect to time and distance, facilitates a range of abstract models on a wire-frame grid. These models have no reference to any urban context and exist purely as spatial arrangements of building density on an imaginary plane. However when they are overlayed as a seeding plan on a same scale plot boundary map, with either a pre-determined fixed or floating point of origin (in this instance, correlating with the location of the existing waterfront campus facilities), their application and mapping to context forms the basis on which a range of associations, ideas and design drivers can be cultivated.

Figures 5a-e demonstrate the iteration of the process through a progression on a radially enhanced theme. The first slide references the base unit of the grid (25m x 25m) and indicates the built form volume if the total net floor area was stacked on 625m² footprint. The result indicates a single 26-storey tower structure. On the other hand if the required net floor space was developed within a single storey structure, the generic footprint would cover a total area of 1,625m², measuring approximately 128m x 128m. (Figure 5b). Working on a simple progression of dividing the single storey structure into smaller units of equal size, Figure 5c indicates two separate units of building mass measuring 128m x 64m while Figure 5d shows the generation of 26 separate single storied units (each 25m x 25m) placed 50m apart.

While the seeding plans could, in themselves, be interpreted as real built form, providing indicative projections of the relationship of built space to open public/private space, they are designed more to be interpreted as location points on a Cartesian framework. Hence one of the benefits of this approach is the way in which simple constructs can assist reflective thinking regarding the spatial relationships between sites of use and the urban context. Facilitating discourse they compel designers to compare the analytical criteria that describe the current framework of the city and a projection of how the criteria may change if subject to a particular seeding plan.

Figure 6 shows the process of transforming a 16 unit radial pattern from an abstract Cartesian model, through a mapping application on the city base plan, to its subsequent adjustment with respect to the urban context. The scheme comprises 8 single storey and 8 double storey building elements, spaced at 50m intervals. This process of adjusting the abstract model to its context is further driven by ‘built form’, ‘land use’ and ‘movement’ urban design parameters, which in turn assist in facilitating the transformation of a strategy from an abstract construct to its realisation as an urban campus (see Figure 7).
Figures 5a-e: Demonstration of the iteration of the model through a progression on a radially enhanced theme.
Step 1: Generation of abstract model on grid

Step 2: Generation of abstract model on grid

Step 3: Adjustment to the context with application of Indicators and Benchmarks

Figure 6: Illustration of the process of one of the radial abstract models from grid definition to its same scale context mapping and the adjustment to context
When considering opportunities and implications for the wider stakeholder group, the advantages of this type of scenario mapping, with respect to current and future land use, movement, and built form issues, appear to be more evident. For example, opportunities for the retail and service sectors of Geelong would appear to benefit more from a university structure that was distributed throughout the city - in a network of new and refurbished two and three storey buildings - as opposed to having the bulk of the 5000+ student cohort located away from the CAA in a single purpose built development adjacent to the railway station.
Figure 8 presents an example of four pattern schema based on different types of urban form (Lynch 1960 and 1981): (a) radial, (b) linear, (c) staggered, and (d) radial network (or cluster). While the development of constructs to structure the design process is an important aspect of all formal design procedures, it is intended that increasing rigour, via a rule based methodology, will be developed as the research progresses. However in the context of this paper the designs should be interpreted as simple first stage investigations.

**Radial**

The square radial schema is a generic model that examines the effects of change in density over a 400-metre dispersion distance. The exploration of the different dispersion levels allowed for the generation of two extremes, the tower and the edge university. The radial pattern is the most closely related to those generated by Martin at the Centre for Land Use and Built Form Studies and demonstrates how the same floor space, stacked in a single high-rise structure, can be distributed in a series of low rise developments over different dispersion distances (see Figure 9c for an example of context adjustment).

**Linear**

The arrangement of buildings strictly according to the organisational structure of the university’s faculty system, was another method of generating campus structures. The linear nature of the university allowed for the investigation of possible direct paths within the city itself, leading to enhanced opportunities at street level (see Figure 9b for an example of context adjustment).

**Staggered**

The staggered model investigated the effects of locating a directional growth plume over the city with a start and an end point. In the lower dispersion levels, the arrangement of the buildings established implied university ‘districts’. This may have a positive effect in adding value to existing building stock and real-estate levels in areas which may have been depressed relative to other inner city precincts (see Figure 9a for an example of context adjustment).

**Radial network**

The radial network model adopts the qualities of the ‘radial’ and ‘linear’ models to produce an interesting hybrid pattern that works on two levels of dispersion. This two-tiered construct allows for buildings to form ‘precincts’ that expand as the dispersion level increases. This is the only scheme used for the study that does not rely on the base grid. It does however still rely on the pre-determined 400-metre walking distance.
Figure 8: Important to the design process are the boundaries placed on the distribution patterns of urban form.
CONCLUSION

Working with a set of predefined constructs for different types of city based user groups - such as net floor space requirements and time/travel distances between facilities - the paper presents a simple computational approach to assist in identifying and spatially exploring various development scenarios. By experimenting with different arrangements of building stock early in the design process, our intention is not to provide a finite or optimum solution to a problem, but rather, to expand the horizon of potential design outcomes beyond the limits of an ad hoc approach. It is anticipated that this process will assist design teams in furthering
their understanding of the infrastructure, movement systems, and land use patterns of a city precinct, as it is progressively re-shaped through different mapping scenarios.

Emersed in the process of urban design is the collection, processing and communication of analytical data, and the mechanism by which opportunities and ideas are synthesised and evaluated. While the approach outlined above should not replace the core workhorses of analysis and conventional workshopping techniques, we believe that it can play a significant contribution if it is applied as a front end abstraction process in promoting effective workshopping procedures. In addition, with further research and development, we also believe that integrating such a model with the outcomes produced by planners specialising in economic development, may have significant benefits when attempting to translate their research into the design and upgrading of major activity centres.

REFERENCES


END NOTES

(1) Disclaimer. The research presented in this paper is the informed opinions of the authors and should not be interpreted as representing the opinions of the professional practices referred to in the text.