Introduction

In the study of the cities, especially in urban and traffic studies for planning, the most popular approaches are modelling and comparative studies (Sue Batty at lecture), or theories and practices. However, modelling contains some issues to address before planners study because a subtle error may result in a totally different conclusion. Comparative studies are more useful if, and only if, it is done properly, This should be emphasised that the current studies of traffic amounts contain some common problems.

Travel behaviour is very complex. It is not possible to describe even one person. Researchers, as will be discussed in this essay, have made the models to statistically forecast the pattern and the models to fit people in. However, people do not actually move as the models imply, and do not follow the models planners and architects hope. Prigogine and Stengers (1984) explained:

> To take the classic example cited by Waddington, a programme of slum clearance results in a situation worse than before. New buildings attract a large number of people into the area, but if there are not enough jobs for them, they remain poor, and their dwellings become even more overcrowded. We are trained to think in terms of linear casualty, but we need new 'tools of thought': one of the greatest benefits of models is precisely to help us discover these tools and learn how to use them. (p. 203)

In searching new tools, we have to be aware that linear modelling is such a delicate method, which many researchers have ignored, that a small error can cause a significant difference. This kind of phenomena is called 'chaos'. By model, we discuss both simulation models like SimCity and analytical models. Cartwright (1991) explains this kind of models:

> Gathering more information or constructing more elaborate models about chaotic systems can become pointless. In fact 'research' can even be counter-productive, if it creates a false sense of security about planning and what it can do. Our ability to predict the behaviour of chaotic systems is inherently limited. Looking for more accurate models of housing demand or traffic flow

is potentially a fool's errand if these phenomena are indeed chaotic. (p.53)

The chapter then sees comparative study a better solution to this approach in planning but as a starting point to find out a 'new tool of thought' rather than a possible tool itself. Although the approach seems appropriate, many of the current comparative studies have one or both of two essential problems: some comparisons are academically and/or practically inappropriate. The chapter then seeks what a new tool of thought can be, by reviewing some of the well-known urban studies to identify the inherent problems of urban models and comparative studies.

Review of Urban Models

Since the early twentieth century, a number of urban models have been introduced and perhaps the same number of models have been criticised. In 1930s and 40s, the so-called 'central place theory' was developed and criticised its inability to “react to some change such as a modification of population density, or a transport innovation” (Allen 1997 p.29). The 1970s criticised the use of the systems approach due to their narrow conceptual base of the methods, inflexibility in the basic structure of the process, lack of any real theoretical development, and the fact that the models did not seem to be responsive to the changing demands of the city (Banister 1994). Large-scale models were criticised for its incapability to achieve the goals, which often had not been stated at the beginning of the study, and also for the fact that, for each objective offered as a reason for building a model, there was in many cases a better alternative (Lee, stated in Banister 1994).

The chapter reviews some of more recent models related to land-use and transport planning. The traffic need in the city, which is estimated by journey length or fuel consumption, is determined by a significant number of factors and thus multi-dimensional. One of the main purposes of modelling is to simplify the realities by removing the factors to reveal the relation of two elements. Here, three different urban models are reviewed which were supposed to give us, or at least imply, a solution to reduce the need to travel, but failed due to some inherent problems.

The first review is the simplest models. The Chicago School's urban model (Figure 3.1) clearly visualise the geography of the city, which categorises the rings along the radius in the city into several social classes. A more advanced modelling of this kind is Brotchie Triangle (see Hayashi and Roy 1996, Figure 3.2), which has been introduced to compare cities by their land-use efficiency and traffic demands.

Review of Urban Models 1: Brotchie Triangle

The land use parameter represents the dispersal of employment relative to housing and give a between 0, when all jobs are at the centre, and 1, when one job is next to each house. The transport parameter is, on the other hand, the ratio of the average work trip length to that of

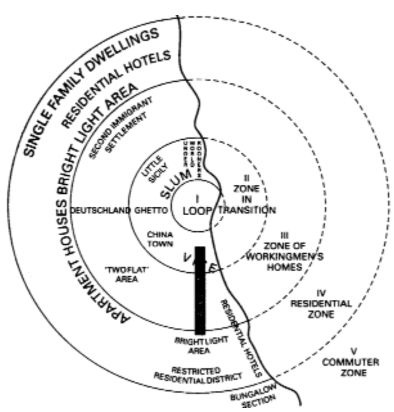


Figure 3.1: A Simple Urban Form
Source: Savage and Warde (1993)
Original: R. E. Parks, E. W. Burgess and R. D. McKenzie (eds.) (1967) *The City*, The University of Chicago Press.

the most efficient transport system at land use parameter 0. By modelling this way, a city is mapped on or within the Brotchie triangle (Figure 3.2).

Entropy ***S*** is, in Brotchie's triangle, a measurement of destination choice at a given land use parameter and is given by the logarithm of the number of possible commuting patterns. Diversity 1/***l*** is, on the other hand, the qualitative range of occupation choices. In the statistical mechanics or thermodynamics, they are related as:

$$U = R + S/l. \qquad (3.1)$$

The Triangle shows the city's potential and current efficiency of its settlement geography. It also shows that the efficiency varies significantly among different cities. Despite these characteristics, however, the Triangle contains four essential issues which are also found in other planning studies. The first two are involved in the Triangle itself, while the other two are the

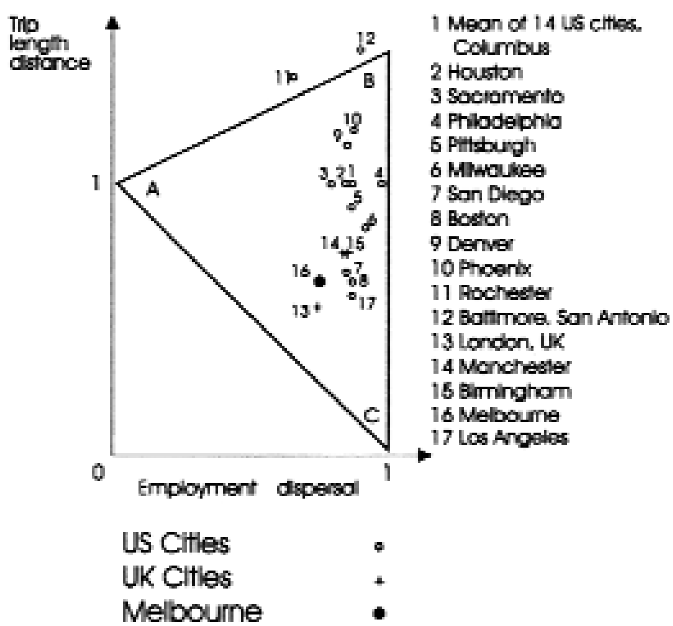


Figure 3.2 : Brotchie Model of Land-use and Transport Models
Source: Brotchie *et al.* (1996)

matter of comparison.

First, the procedure of modelling requires a significant amount of efforts. The measurement of land use and transport parameters are so hard that it can hardly be done frequently. Although the Triangle has some academic meaning, it is less practical in everyday planning.

The other issue of the model is more severe and critical. Entropy can, in fact, only be defined in an isolated system, yet the city is open, or more precisely 'dissipative structure' which entropy can not be defined. Capra (1982) has pointed out that:

> ..., although entropy is extremely useful as a variable for economic analyses, the framework of classical thermodynamics in which it originated is quite limited. Specifically, it is not adequate to describe living, self-organising systems - whether individual organisms, social systems, or ecosystems - for which Prigogine's theory provides a much more appropriate description. (p. 438)

This is a good example how planners misunderstand natural science. The failure is the assumption that the cities are at a static equilibrium. Intuitively, we know that any city is non-static but dynamic. Some urbanists even insist the dynamics as an essence of the cities. And it may not be surprising, but the cities are never at equilibrium, which is defined only in isolated systems. The systems like cities is called non-equilibrium or far-from-equilibrium systems. Statistical mechanics assumes that any system is at equilibrium, but human behaviours do not organise this kind of system as long as people are alive. The notion of entropy is, by definition, the randomness of a static isolated system, and thus can hardly represent the city.

One of the remarkable features of the city is that its each individual element is able to construct the city. This kind of systems in this sense are called self-organising system (Prigogine and Stengers 1984). This phenomenon is quite common as all the living creatures are self-organising. A machine is not self-organising because they do not construct themselves. Here is the gap between the reality and the modernists' beliefs that 'housing is the machine of living in'. The city is able to maintain a certain form or even able to grow on their own, but only at far from equilibrium because the city maintains itself with continuous inflow and consumption of people, information, goods and energy and their mutual interactions. According to Prigogine (Prigogine and Stenger 1984), this kind of systems is called dissipative structure. As this example shows, planners are not expert in science and thus often make a wrong discussion in applying natural science to urban study. As a machine can not be dissipative, housing should not be 'the machine of living in' against Le Corbusier insisted.

Other mistakes found in the Triangle are from comparative view points. The first issue is a simple failure how to compare the parameters among several cities. When you make a comparison, in academic sense, you have to select comparable samples, which are identical with only limited exceptions. When you compare men and women, people would assume they are all both human, not dog male and human female. Even within the same race, you may make comparison such as scientists and artists, but in this case they must be, for example, both European scientists and artists, not European scientists and Chinese artists unless there is a reason. Jacobs (1961) have already given us a great insight of what comparative study should be, by referring four initially identical squares in Philadelphia:

> ... What has become of these four, all the same age, the same size, the same original use, and as nearly the same in presumed advantages of location as they could be made?
>
> Their fates are wildly different. ... (p.120)

One of them is now Philadelphia's great asset, two of them still ordinary squares and one has been slum-cleared. These squares do not only illustrate the volatile behaviour that is characteristic of city parks, but also what comparative study should be. For example, in preparation of the development plan for a growing city with 100,000 population, planners should compare the current cities with those of population 200,000 to identify the best development pattern. None the less, planners compare very different cities such as American cities and

Asian cities without examining other factors. In the worst cases, they justify their study as the samples are collected all over the world even though they are incomparable. Consequently, the study is scientifically unreliable.

Urban study is supposed to contribute to urban planning. The other issues is the samples themselves in this sense. In Brotchie Triangle, the issue is that there is little variation in land use parameters among the sample cities. Although it does show us how far the city has the potential to reduce the traffic demand at the condition, the study does not show us what to do. This issue will be reviewed in the later part of the essay.

Review of Urban Models 2: Cellular Automaton model

Cellular Automata (CA) is a new class of the computer models of how a small number of cells form a strange patterns, by giving us the opportunity to simulate existing urban form and to provide for the design of optimal forms (Batty 1997). The concept is, the city is complex, so are the CA models, thus the city might be expressed as a cellular automata model. Since a CA system seems to consist of agents and a limited number of rules, the analysis of the rules may help understand the changing of cities.

CA are models in which contiguous or adjacent cells, such as those that might comprise a rectangular grid, change their states - their attributes or characteristics - through the repetitive application of simple rules. The current urban models based on CA are usually two-dimensional whose rules for transition are quite simple (Batty 1997). The rules for transition from one cell state to another can be interpreted as the generators of growth or decline, such as the change from an undeveloped to a developed cell or *vice versa*. This change acts as a function of what is going on in the neighbourhood of the cell, and the changes in the neighbourhood trigger the change of the cell state.

This approach seems appropriate when it is linked with common and understandable rules (Semboloni 1997) and the analytical approach which draws on established studies in urban morphogenesis and economic, social and cultural phenomena (Erickson and Lloyd-Jones 1997). The current researches are, due to the performance of the computers, still stuck in very basic models with a few rules, reacting only to the cell's small neighbourhood. In addition, the rules should be expanded to the internal emergence mechanism of the cell and external factors of the system to express urban and regional models as the urban system is self-organising as well as 'dissipative'. It is therefore impossible to explain the emergence of New Towns, for example. Another example is that a person (an agent) invented a mass production system of private vehicle (a rule) in the city or elsewhere, which, through a significant effort of marketing research, will rule the transport system. This subsequently affect the people's (agents') life styles (rules) and the environment itself.

Review of Urban Models 3: Six Settlement Patterns

Another approach of models is to create several settlement patterns to compare. Rickaby (1987) reasonably demonstrated the relationship of urban form and energy consumption by creating six settlement patterns of English towns of population about 100,000. He concluded that the development for this size of cities should, in order to save the fuel consumption and the cost of fuel savings, be one of two types: concentrated-nucleated configuration or dispersed-nucleated (villages) configuration (Rickaby 1987, Figure 3).

His interest was moved to investigate the impact of various incremental development strategies on archetypal English towns (Rickaby 1991). A single model was created based on twenty English towns with populations about 100,000 with the settlement diameters ranging

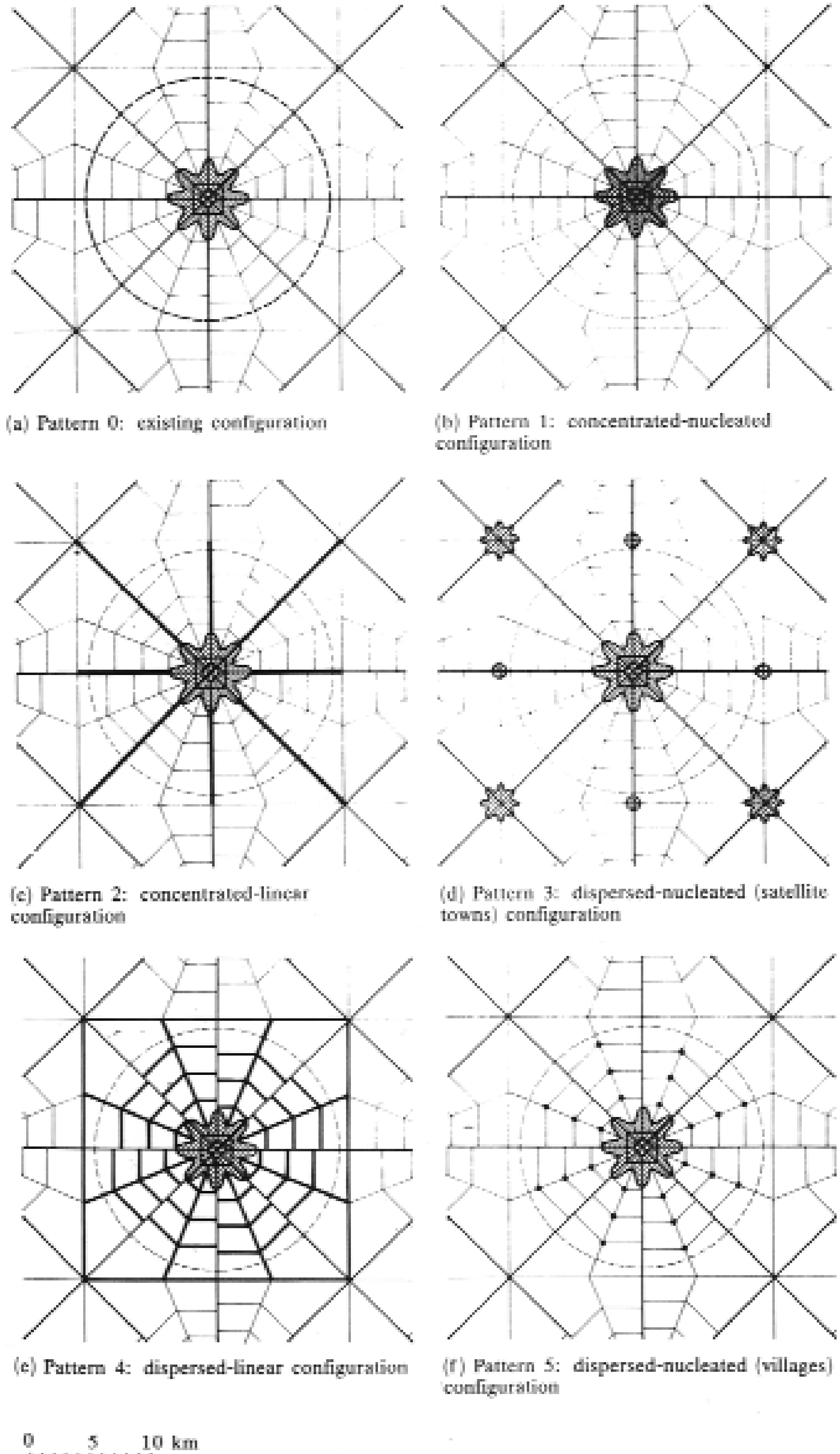


Figure 3.3 : Six Settlement Models

Source: Rickaby (1987)

between 5 and 10 km. According to Banister *et al.* (1994), these sizes are within the ideal settlement size for walking or cycling. Rickaby (1991) concluded that there was little evidence in the energy impacts of a variety of development strategies as far as the development was within the boundary.

Although Rickaby's models are reasonable, there addressed an issue. It is often indescribable to which settlement pattern a town belongs. The current tools of planning, in many countries including UK, development control, takes a bottom up approach such as development control (Roberts and Lloyd-Jones 1997). The model-based planning seems to require a top-down approach such as government intervention. Now that planning has lost its political and financial power and confidence (Hall 1996), it is unlikely that the town can be developed towards a certain model at large scale.

Review of Comparative Studies

Review of Comparative Studies1: Gasoline Consumption and Density

Many comparative studies have one or both of two failures found in the Brotchie's Triangle case. That is, which cities to compare and in what way. Even the most influential researches such as Newman and Kenworthy (1989) contain these problems, which has led most planners to believe in the relation of density and car traffic. Dangerously, even policy makers, such as CEC, have adopted this view without enough verification (Breheny 1992b). In fact, since 1970s, there have been a significant number of contradictory evidences (see Owens 1986).

The most impressive and influential result is the exponential relation of density and fuel consumption, derived from about thirty cities in America, Australia, Europe and Asia. The higher is the density, the less fuel is consumed in the city. If you remember the argument of the Brotchie Triangle, however, you can view the graph in a different way. First, it does not take a full account of other factors which affect the fuel consumption. Fuel consumption is, in fact, largely influenced by economic, social and environmental conditions. The efficiency may vary significantly, for example, between cities in cold regions and in warm regions. Also, the size of sample cities, varied from Zurich (the population of 370,000) to New York (the population of 7,070,000; Greater New York 16,180,000) or Tokyo (Greater Tokyo more than 30,000,000), may affect the fuel consumption.

It is more reasonable, therefore, to take the sample cities into several categories: American, Australian, European and Asian cities because, within the category, the conditions of the cities are closer although it is still incomplete (Figure 3.4). The result is clear in Europe. There is little correlation between density and fuel consumption, if any. The density of Copenhagen is as half as that of Frankfurt or Brussels, for example, yet the fuel consumption is also lower than them. The effects of density on fuel consumption still cannot be denied, but only when other factors are properly taken into consideration.

The other issue is how to interpret the meaning of the result, which is not the failure of the discussion but rather of planners. That is, although the effect of density is significant at lower density, so is not at medium and high density. To reduce the fuel consumption to half may require another 10% of density in US, 100% in Europe and 1000% in HongKong and Tokyo, as the figure implies. It is, however, the least practical to raise density by 100% of the existing towns. In Europe and Asia, therefore, it is inevitable that this higher density scheme will fail.

Banister et al. (1994) surveyed five cities with variable sizes and structures: Liverpool (450,000), Leicester (270,000), Milton Keynes (170,000), Oxford (124,000) and Banbury (30,000). In the same paper, they assumed the relation between the size and the main transit mode, but they do not seem to have considered it in the latter chapter which discussed the relationship between energy consumption and urban form. What makes it worse is, they

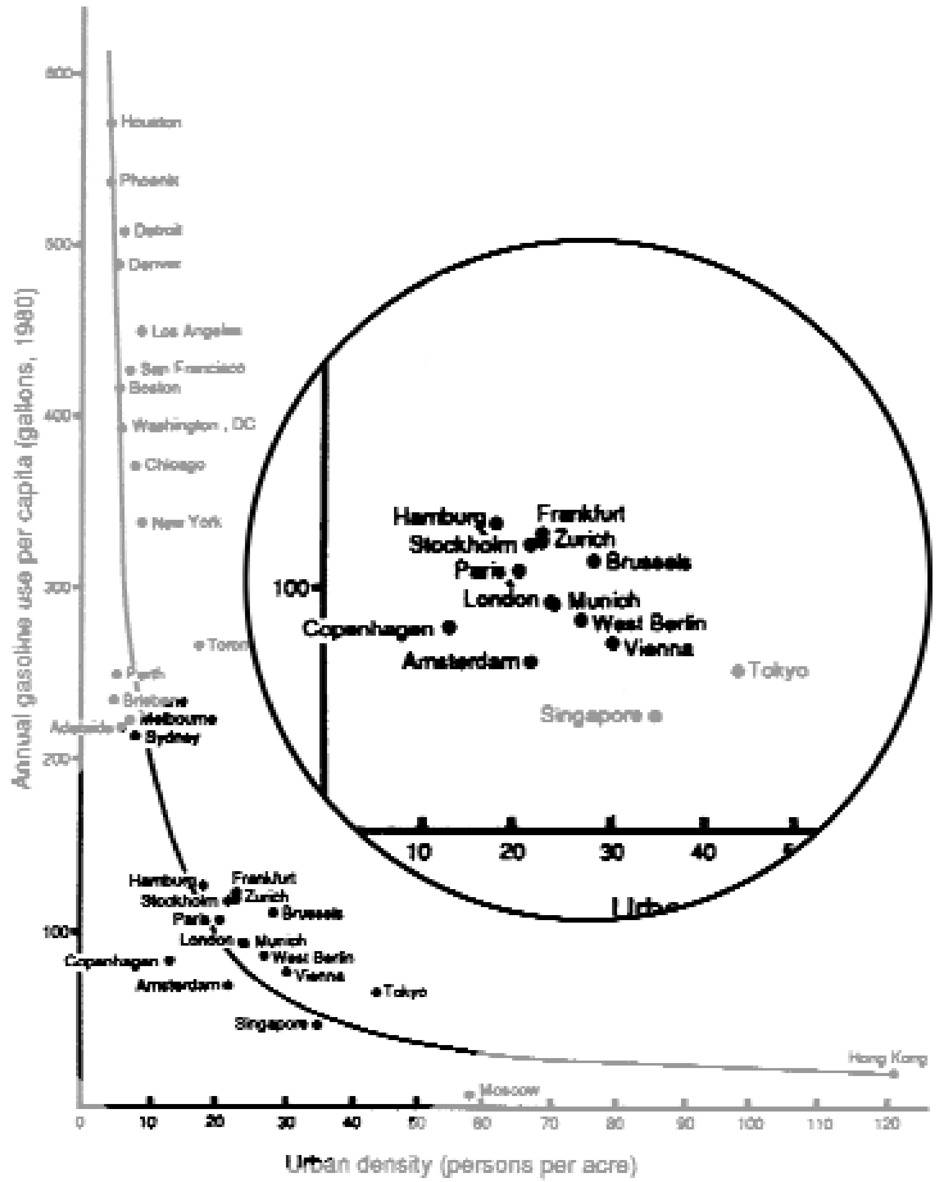


Figure 3.4: Density and Fuel Consumption in Europe
Source: Modified from Newman and Kenworthy (1989)

mentioned the difference of the transport policies in the beginning as a reason to compare these cities. The consequence is predictable: the results were so complicated and they had to compare the policies. They even mentioned “[p]hysical concepts such as density, size and shape are all important, but so are economic factors such as degree of self containment and local employment” (Banister et al. 1994: p. 8), which they ignored in the latter discussions.

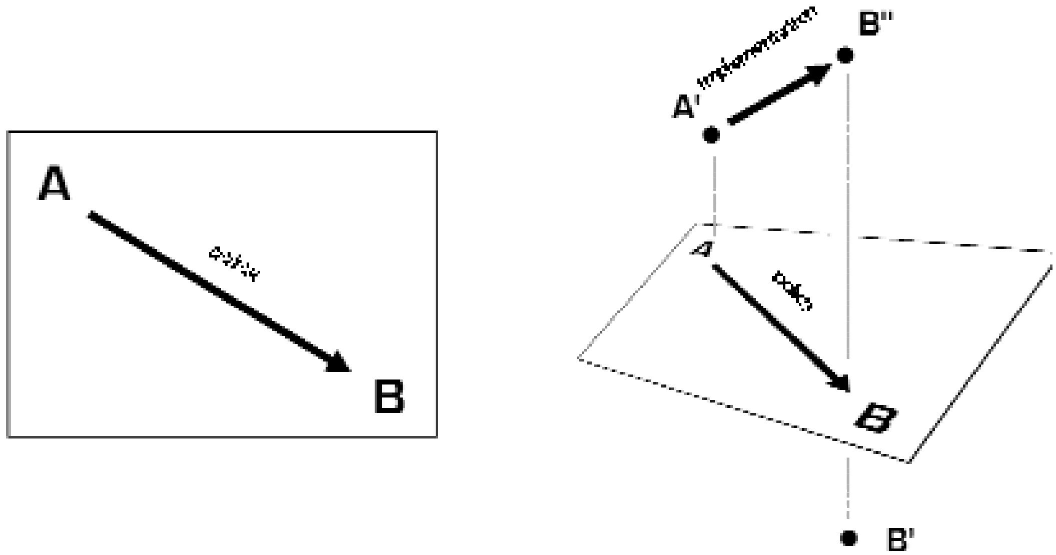
Lessons Re-learnt

These issues do not deny the possibility of a model that can describe a city. Yet, it can be concluded that it is practically impossible to describe a city with this kind of models reviewed here. By making a model, details are removed. However, as Jane Jacobs and Christopher Alexander discussed (see Chapter 5), details are one of the crucial factors which make the city livable and organic. None of these models is able to answer the questions addressed by Jacobs (1961): “why some slums stay slums and other slums regenerate themselves even against financial and official opposition[?]”' (p.5)

The real city is oo-dimensional, taking account of political, economic, social and historical effects. People develop a land not only because two objects interact each other, but various interested groups interact each other. The resulted equation is therefore multi-dimensional, yet the dimension of a model is always lower. Suppose that the current condition of city is A, in Figure 3.5a, which is mapped A on the model which has ideal condition in B. The policy from A towards B can be implemented in any way in reality as Figure 3.5b shows.

Allen (1997) modelled the city as self-organising to "show how the macroscopic pattern of settlement, the hierarchy of cities and towns, results from the aggregate effect of individual decisions, each of which is being made in pursuit of personal goals and limited information." (p.27) A possible solution to overcome these problems is to see the city as dissipative structure. Limited information, though, can be stored in a set of hard discs, which may be piled up to the moon (Klauss 1995).

Comparative studies, on the contrary, of similar cities but with varied traffic demand is worth considering. Given that the population in the urban areas is growing, it seems the most practical style of study to compare the cities with the same population, the same economic con-



(a) Model (b) Reality

The solution based on a lower-dimensional model (a), no matter how accurate in theory, may not function as intended in much higher-dimensional reality (b).
Figure 3.5 Model and Reality

dition, the same polices but varied traffic demand, when preparing the development plan for a smaller city. Or, in Jacobs' example above, planners should study the city that have solved the same problem in the same condition.

Hence the chapter title 'Lessons Re-learnt'. Again, we "came back full circle" (Hall 1996 P.421). The review here shows that planners have kept making the same mistake Jacobs pointed out forty years ago, and will they?