# 7 Conclusion: New Urban Morphology

## Summary

For more than a century our duty has been to improve the urban environment. Throughout the last century, as we have removed the problems out of the cities, they have been gradually spreading outside the urban areas. By adopting intensification of particular land uses through zoning and suburbanisation, moreover, our cities now largely depend on mass transportation, even in this information era. Subsequently, urban problems have not been merely delivered outside the urban area, but its scale has changed from local to regional and global.

In our current life style, A significant number of us live in a suburb of a medium or large city, commute every morning and evening from Monday to Friday and go to regional hypermarket on Saturdays or Sundays. As the suburbs have grown, people's commuting time has increased as much as two hours per day in many cities. Because so many people move in the same way, the transportation system, be it roads or public transport, are intensively used in certain areas at certain times. Because of people's movement pattern, many of the current proposals of new transport systems are not adequate. In London, where the public transport is already saturated, the proposed approach of modal shift from cars to public transport will simply end in further congestion. More important is to reform this travel pattern so that people need to travel less, by bringing the workplaces as close to where they live as possible. By receiving these reports, the European and British governments have adopted the concept of 'compact city' and 'Urban Villages' respectively without enough verification (CEC 1992; DoE 1994).

The urban morphology is not a new study. However, it is only recently that we have studied it in relation with transport efficiency and demands. Density and population have been stud-

ied since late 1960s or early 1970s, yet the two-dimensional analysis of land uses and transport network is still at its infancy. The approaches taken are mostly simulation of model cities, the same idealistic approach as Howard and Le Corbusier did, and would fail for the same reason as they have failed, as the ideal city is modified when developed or is difficult to develop. In addition, this top down approach is not favourable because, unlike Howard and Le Corbusier's era, we planners have neither political or financial backgrounds.

Taking account of them, I have discussed a new approach by introducing an urban transport network dimension as a parameter in the same way as standard deviation or variance in statistics. I set a parameter that reflects the ratio of suburban road density to urban road density, which takes a value between 1 and 2. This parameter is called fractal dimension and can be obtained both for actual cities and model cities; can be compared with self-sufficiency, density, population and so on; and can be estimated as long as ten minutes with any GIS application. Therefore, I will discuss fractal and fractal dimension in relation to planning practice in this conclusive chapter. Fractal is a new concept in town planning, and can be misunderstood easily, and thus is explained again. Then, the influence of road network dimension is compared with that of self-sufficiency, density and population. In the last section, I will discuss the future possibility of this new concept.

## Fractal Means Accessible

We have postulated the hypothesis that a more efficient road network has higher fractal dimension, but not necessarily vice versa. We have examined it by estimating ten comparable cities/towns of England that have similar population size and high self-sufficiency to avoid these effects. The estimated fractal dimensions have high linear correlation with average journey length with correlation coefficient 0.658.

In theory, there are several benefits of fractal transport system. First, fractal form covers the

whole area. To understand this, imagine a simple urban model with a ring in the centre with several spines (Figure 6.3). As you move from the city centre to suburb, you will find the gap between the spines growing larger. People living in that area, thus have to travel to the near-by spine, go back to the city centre and go along the next spine, even though the destination is close. In this city, to accommodate this unneccessary traffic, roads have to be widened and, consequently, the total road area will be expanded. As the roads occupy more space, the density of other uses decrease and you have to travel more. In the city with efficient transport network, on the other hand, you are supplied with more opportunities so that you are likely to have shorter ways. This is true because people commute less in the cities with higher fractal dimension as discussed in Chapter 6.

In order to design a local settlement, we have discussed a concept of neighbourhood in Chapter 5. Of importance is to think from the local. It should be stressed that the higher fractal dimension does not always bring fruits of the efficiency to the road network. Logically, the thesis verified that efficient netoworks tend to have higher dimensions, but not vice versa. It is not straightforward to show a model of the efficient road network by simply giving higher dimensional layout but is necessary to construct design theories that match the finding of the thesis. In Chapter 5, for example, we have discussed a concept of neighbourhood, or how to think neighbourhood. In the conventional planning, neighbourhoods are separated parts of the city. In reality, however, the administrative boundaries of neighbourhoods are not the same as residents'. For the residents, any point in the city should have an adequately self-sufficient neighbourhood, rather than every nighbourhood is self-sufficient, so that the traffic demand will reduce significantly. Such neighbourhoods often share their boundaries with adjacent neighbourhoods (Figure 5.8, p.63) where "[r]esidents may define different neighbourhoods depending on their personal location and associations" (Barton 2000 p.139). Similar comments are found in Murrain (1993) and Haywards and McGlynn (1993). Bill Hillier (1996) takes a different approach that leads to a consistent conslusion as our findings. His

"spatial laws are the 'first filter' between the boundless morphological possibility for such aggregates and the properties of the vanishingly small subset we call cities" (p. 339). One of the most important findings in his study is that more crimes occur at the streets of low hierarchy because they are less accessible and thus few ‘streetwatchers’ that maintains the society at the most basic level.

Politically, minimising the need to travel requires a discussion in a more broader sense. In order to alleviate the air pollution caused from transport, the most efficient measure is the modal shift from private to public transport, or ultimately, to walking and cycling. The study of journey length is still quite useful because the relation of journey length and transport mode is apparent (Figure 2.5). Alternatively, the pollutions generated from transport and energy consumption in transport and other means are to be studied. Apart from the discussions of sustainability, fractal dimensions may be used to estimate the transport cost.

The analysis taken in the thesis is of using average journey length to work, and therefore ignores other transport purposes such as for shopping, social, entertainment, within work and freight, which are less likely to correlate with urban form. On the contrary to work travels, these journeys do not tend to move between city centre and suburbs but have very different patterns. For example, journey for social purpose include meeting their friends and family who might live close or very far. Unlike work travel, the destination is not fixed, and travel is less frequent so that people do not pay much attention to accessibility. I, myself as a Japanese living in Britain for example, go back to Japan once a year however long the journey is. On the contrary, I would not go back home more than a few times even if I lived much closer. Similar pattern is applied to entertainment journey. Shopping journey is more similar to work journey although it tends to be smaller. Travels related to business and freight have less relevance with urban form because much of them is interurban, regional or inter-

national.

## Urban Form and The Need to Travel

We have examined the physical factors of the city: self sufficiency, size, density and the fractal dimension of road network. As reviewed in chapter 3, there has been few attempt to compare them. Policy makers therefore have to prioritise one over the others based on their instinction, rather than research. Theoretically, they all affect the need to travel in the city, but how much each factor does may differ and is not obvious. It is not difficult to compare these factors, if research is done consistently. One approach is to compare the correlation coefficient values (Table 7.1). It clearly shows how a factor is related to the traffic need over the other. The result extracts the importance of road network, Independence Ratio (***IR***) in the countryside, Density (ρ), and ***S/R*** in the countryside. In urban areas, therefore, road network and density have the highest correlation.

Yet, it is too early to conclude that they are actually dominant factors of the need to travel. In figure 4.6, as the density varies from 1196 persons/sq km to 3541, ***AJL*** ranges only from 4.93 to 9.83. It is politically and financially the least practical approach to triple the density of already established towns, particularly in the current context of sustainable development. On the contrary, although less practical within a short period, changing road network towards higher fractal dimension does not seem to require much political opposition, as the practices reviewed in chapter 2 are welcomed in many practices.

The conventional measurements of urban form, population and density in demography and total road length and road density in transport, have no implication of two- or more dimensional aspect of urban form such as land use patterns. As Jacobs (1961) discussed, this is the reason planners have been confused with density and congestion. Indeed, high density and congestion are the sign of successful cities. Imagine, for example, two identical shops

Table 7.1: Correlation Coefficients

| Urban Factors | Correlation Coefficient | | |
|---|---|---|---|
| *IR* | 0.128 | 0.006 | 0.529 |
| *W/R* | 0.079 | 0.006 | 0.245 |
| *S/W* | 0.103 | 0.048 | 0.422 |
| *S/R* | 0.397 | 0.030 | 0.470 |
| Area | Not Available | | |
| Population | Not Available | | |
| Density | | 0.493 | |
| Road Network *D* | | | |
| | | 0.658 | |

located nearby to each other, but one full of customers and the other with little. The successful shop needs to design a good shopping environment for the customers, not to reduce the number of customers, by aligning the items, the casher, information so that the customers have enough space. In the city, where variety is highly prioritised than the average and in which departure and destination can be anywhere, it is of importance not to assert that any mean density or any particular form has a dominance. Using the concept of fractal gives a measure to combine a missing dimension of space, which gives two-dimensional implications to population or density, and gives one-dimensional value to urban form by measuring the deviation of the distribution.

## Designing Fractal City in Practice

The concept of fractal does not suggest any particular urban form. Instead, it gives us the measure to compare the forms. Theoretically, however, there is a good mathematical attempt to seek a sustainable urban form (Figure 5.5). There is little relation known of this non-linear spatial analysis and fractal geometry. The former suggests a star-like shape while the latter emphasises decentralisation. They do not seem identical at first glance, yet it is of academic interest to seek the fractal dimension of this efficient form.

The concept of fractal transport system can be applied in practice. One of the misunderstandings I have most received is that it suggests to build more roads. By definition used in

the thesis, fractal dimension is merely the distribution parameter of road density, and is independent from the total road length. In addition, although building roads in the suburbs surely increases the fractal dimension, we accept some assumptions that roads are always built reasonably. Therefore, it is emphasised that the hypothesis of the thesis as 'the more efficient the land uses tend to take higher fractal dimension of its transport network', rather than 'the higher fractal dimension always means better transport'.

In practice, roads are not built if there is no housing, offices, shops or factories. An example of developing new roads is to link two existing adjacent villages/towns. This may provide more employment opportunity in the neighbouring area than within the town, although it is not always true, by increasing the overall travel lengths. Another example is development of new settlements. As you build settlements, you are more likely to build roads. If located carefully, the development will reduce the fractal dimension of the whole city transport and will make the transport more efficient.

It is, therefore, suggested that the councils analyse the fractal dimension of their road systems, which would not take more than thirty minutes, to know its current condition. The county council collects this data, and can use a parameter in deciding the location of new settlements so that fractal dimension will be increased. By doing so, it is possible to reduce the need to travel with supplying new housing.

It should be noted that, in practice, transport is one of the considerations, so that it can be compared to other parameters, such as sustainability indicator of town centre studied at CASA (http://www.casa.ucl.ac.uk/sustain/), in which retail, services, crime, telecommunication and real estate are addressed. However, because fractal form is more accessble, it is likely that these approaches, especially those related to spatial accessibility, overlap the concept of fractal city. And again, as the analysis of fractal dimension is easier than any other

kind of spatial analysis, it can be used to estimate in advance of detailed analysis.

## Further Discussion

The hypothesis of the possible relation between road fractal dimension and journey length is tested to a very limited range of cities in a condition. It is of interests to further research for smaller and larger cities as well as in different conditions. Also, it should be attempted to mathematically discuss the relation of fractal dimension and optimisation of form to minimise the average distances. It should be noted that the hypothesis advocated and tested in this thesis requires more observations as well as theoretical background. It should include the application of scale methods which require more intensive efforts but surely the mainstream of fractal geometry. The area method is, indeed, able to accommodate only half the definition of fractal city, yet it does not guarantee the possibility that the city supplies adequate opportunity at lower and larger scales. Also of interest is the mathematical relation of non-linear analysis and fractal dimension. More elaboration is required to mathematically link the fractal to Shiode's (1995) analysis of locational optimisation.

The concept of fractal is quite useful in town planning, especially to understand the ambiguous concepts of good city form, such as 'fine grain', 'mixed-uses', 'permeability' and 'hierarchy'. It is, for example, possible to define the dimension of 'land-use mixedness' to measure how much the land uses are mixed in the city. Also implied is the relation with social and economic factors. Some measurable social and economic factors such as income variation may be discussed in much the same way as travel demand discussed in the thesis. The concept can be further applied, for example, to land-uses once its generator, and thus fractal dimension are defined. Transit Oriented Development, for example, is reviewed twice in the thesis as a possible generator of land-uses. Land-uses are two-dimensional and require more effort than perimeter or road length to estimate fractal dimension, yet it is quite practical if a

high resolution map is available. In either case, using fractal dimension is advantageous to help us understand the ambiguous planning concepts of social cohesion, economic variety, fine grain, semi-lattice and so on. Fractal dimension is as useful as standard deviation and variance in statistics, in the case fluctuation is more important than averages, such as town planning.