SUSTAINABLE DEVELOPMENT AND BUILDING DESIGN

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Introduction

Sustainable development, the current theme of much of the environment debate, applies pressure on buildings in two respects. Most of the papers in this publication address pressures defining the interior form of buildings. This is very much the private world of the building occupant. But a building is also located in landscape, or townscape. This paper discusses those issues which may define its future value through its location and the functions it can perform.

Sustainable development

Let me first define sustainable development. It is a term widely used in the global environment debate. For most countries in the Third World the emphasis is on 'development'. Development is an aspiration whose legitimacy is hard to deny. The issue for many of these countries is whether the path of development that they have chosen is sustainable in the long run. This of course is no less an issue for a developed country like the UK. The most common definition of sustainable development is that given by the World Commission on Environment and Development - the Brundtland Report:

'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'

This definition is often brought to bear on the construction industry in terms of restrictions on the building design in order to ensure a sustainable use of natural resources. For example, we might consider that in order to obtain a sustainable level of greenhouse gas emissions, our buildings will need to be much more energy efficient. The use of air conditioning refrigerants other than CFCs is another example of an external sustainability constraint borne by the construction sector.

Renewable and non-renewable resources

The sustainable development debate is often presented as devising a strategy of moving from non-renewable to renewable resources. At the end of the 20th century this represents something of a paradox. The resources that are most under threat are not the non-renewable resources at all, but the renewable resources. Fish stocks, we are told, are perilously low in many parts of the world. The world's biodiversity is falling at an alarming rate. The world's forests are being cleared in vast areas. The world's construction industry is a large player in this latter process.

In contrast, our sources of non-renewable materials show no sign of decline. The US Geological Survey publishes estimates of known reserves of important metals. Despite the world's consumption of these materials, its revisions show largely the same level of reserves over the last twenty years. These estimates are supported by world market prices which have continued to decline over the same period. It is never wise to scoff at market prices, often excellent warnings of shortages. While the prices of copper and oil may have declined, the price of rhino horn has escalated.

The role of innovation

What has brought about this remarkable situation? The problems for renewable resources are clearly institutional failure in their management. The 'miracle' of non-renewable resources is clearly innovation. Some of this innovation is in extraction technology. When the UK first tentatively sought to extract oil and gas from the North Sea, this was very much a marginal technology. Now of course we are exploring depths and distances from shore quite unthought of twenty years ago. Some innovation is in end use. After all, if we could increase energy efficiency by 3% per annum, then each year a thirty year reserve of fossil fuel reserve would have been re-extended to thirty years.

Innovations diffuse through a marketplace. What we discover today in the North Sea oil fields will gradually diffuse to other markets with a time history described by that famous logistic S-curve. This means that the impacts of some innovations are often easier to anticipate at least quantatively than we might first imagine. Innovation also occurs through learning. A relationship between cost of production and *total accumulative* production - called the 'learning curve' - is often found in the manufacturing sector. Roughly speaking we obtain the same percentage drop in cost for the same percentage increase in total accumulative production. Here the accumulative production reflects our accumulated knowledge as to how to produce. We may be less conscious of this relationship in the construction industry because of our habit of making every building a novelty. However, the relationship implies that once an innovation has evolved we should expect its costs to drop and its availability to increase.

Buildings as assets for a sustainable future

Let me sum up so far. Buildings do have an impact on the sustainability of development through the resources they consume. The issues involved are

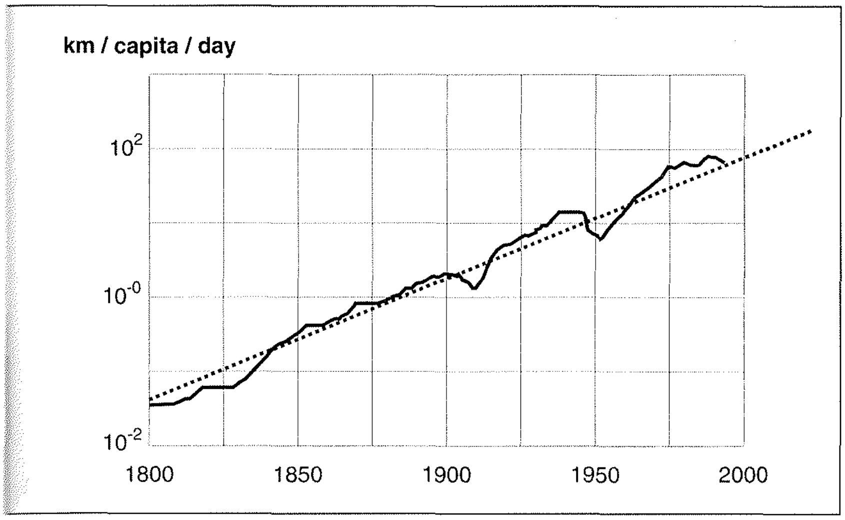

Figure 1 Growth of transport with new technology.

already well covered in standard texts. Perversely the most pressing issues globally are not non-renewable resources but renewable resources that we hold in common. Innovation has been the key to keeping the problem of non-renewable resources at bay. Yet the inevitable diffusion of innovation presents a quite different problem to buildings - the prospect of their obsolescence. This is the second aspect of buildings and sustainable development that I would like to address. Buildings ought to be one asset that we pass on to next generations which are at least as valuable as they were when we inherited them. If we insist on using long life refractory materials for construction, then we owe it to the future to ensure that they are passed on as assets not mausoleums. As the London tour guides will remind you, 2 Marsham Street will be demolished next year. Even if we recycle the rubble, it is hardly a monument to this second perspective of sustainable development.

Thus, although each building affects the sustainability of development through resource consumption, the stock as a whole has an asset value which is passed on to succeeding generations. Consider the area of sheltered space in the UK. Add to that for each household its share of shop, factory, office, school and warehouse. I suspect we find ourselves with an average floor area per household that would do a Roman Villa proud. Why do we consume so much sheltered space and why is it found where it is? What forces of innovation might make that built form in that location obsolete?

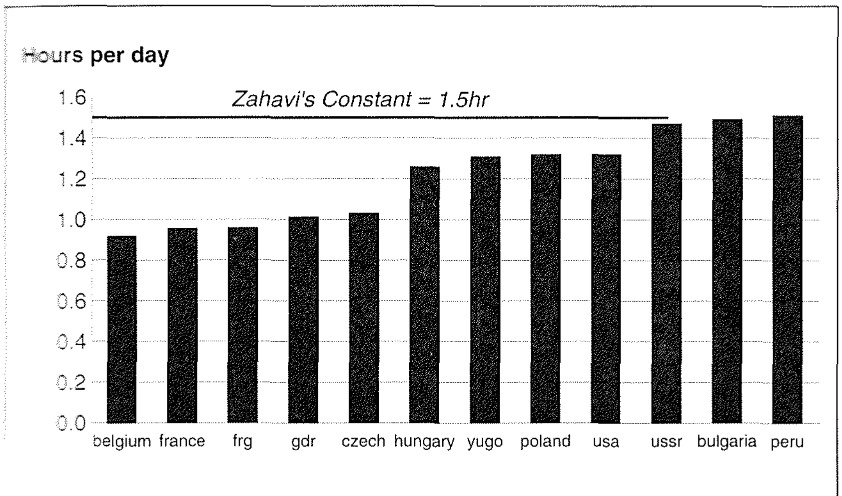

Figure 2 Approximate constancy of travel time.

The Rural Paradigms

To illustrate my point, I would like to begin with an example remote from the normal discussion of built form - the rural building. Figure 1 is arguably the single most significant curve in the rural environment. It records data first collected by order of Napoleon on the average distance travelled per day by Frenchmen. It is a record of the growth of transport technology, as each S-shaped diffusion curve of new technology spreads through France. It begins with foot and horse. Then follow canals and railways, and the motor car. The final spurt is the Train à Grande Vitesse (TGV). This is hardly the end of the story however. In France, as in Britain, the fastest growing passenger kilometres are in air transport. You may recall that in Paul Theroux's novel of the future, *O-Zone*, personal air transport was common-place, so there may be more to come.

The lesson for the rural community is that each step in technology leads us closer towards a world market for food. Once cities relied on their surrounding countryside for food. Now cities rely on the world. For the rural community two extreme scenarios unfold.

The first might be called the Euro Disney/Thomas Hardy experience. Farms in this scenario cannot compete in the world market. They diversify through tourism, vernacular - but centrally heated - residences, with agriculture as a part-time pastoral backdrop. The second scenario is quite the reverse. Here farms are a high technology, capital intensive enterprise, world competitive and using the most advanced technology. Like any other industry, it will be keen to reduce its wastes, and keen to satisfy the requirements of the environmental protection regulator. Unlike other industrial enterprises, located some way from other services, it will be keen to recycle its by-products. The buildings that this enterprise will require are quite different from the rural paradise.

There is arguably a further scenario, where the farming enterprise has moved away towards new non-food crops for pharmaceuticals or fuels. It would be hard to imagine a farm that was producing biofuels that was not using them for its own use. At last then - the autarchic dwelling, about which the Cambridge School of Architecture dreamed in the 1970s! This exercise shows how innovations in transport may be the largest factor in defining the right type of building at a specific location.

The City

Let me now turn to the city of the future, where the effect of transport technology must be at least as great. My analysis here begins with an observation from transport theory that, rich or poor, we tend on average to spend about 10% of our waking time travelling. (Figure 2) The proposition that this fraction will be maintained in the future is reasonable. The richer we get, the longer we can afford to travel, but the higher the opportunity cost in time that it incurs. This constancy should put us on our guard in assuming that information technology will solve our problems. It may enable many to work from home, and so free up time previously spent commuting. However, that may mean these workers will simply locate themselves even further from work than before, travelling to town for the occasional critical meeting.

This constancy and the expected advance in transport technology, lead us to an explanation of the growth in city size. Arguably a pedestrian city could hardly manage a radius of much more than 5-6 miles. A dense urban city with slow transportation might manage 10 miles. A low density city with free flowing freeways could manage 20 miles. Thus as transport innovations spread through the populous, so existing cities grow, rather than new cities emerge. This is easily illustrated by the growth of London. As transport technologies were taken on board, it was able to spread and lower its density. If Paul Theroux's personal air transport really were to become a reality, finding where one city began and another stopped might prove hard.

City Density and Environment

The low density city is not without its own problems. A classic study in urban geography (Figure 3) shows that the gasoline consumption *per capita* in low density cities is significantly higher than in high density cities. This is despite the low average speed of traffic in the denser city. As a consequence, it is worse to be downwind of a low density city than a high density city of comparable size. This may be why most of the pioneering innovations on abating vehicle emissions have been applied first in the low density environment. However, the high density city is not without its problems. The same data shows that the gasoline consumption per unit area is no better, probably worse, in the high density city (Figure 4). We would thus expect local pollution in the form of noise and short-lived emissions to be higher.

Expectations are that motor vehicles, like other manufactured goods will, through the leaning curve, become cheaper compared with average wage rates. We have also seen that, at least in the medium term, raw material inputs will not be a limitation. So the traffic in the high density city will if anything become denser. Cities might then follow one of a number of possible scenarios.

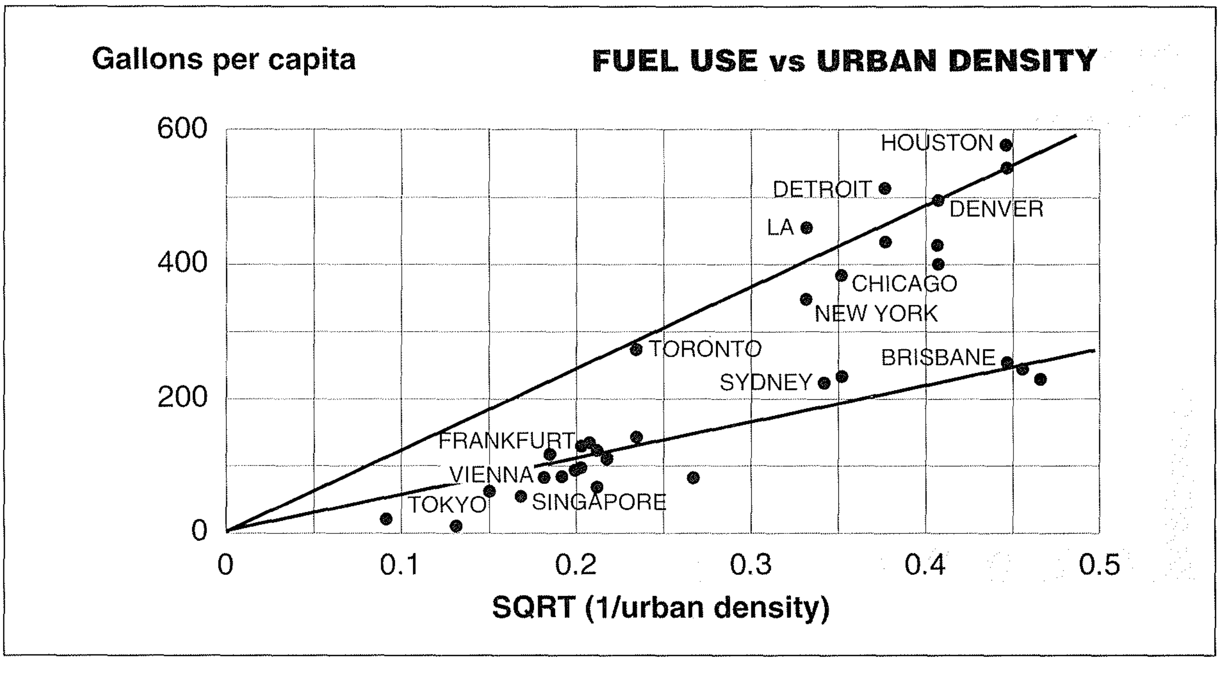

Figure 3 Fuel use in high and low density cities.

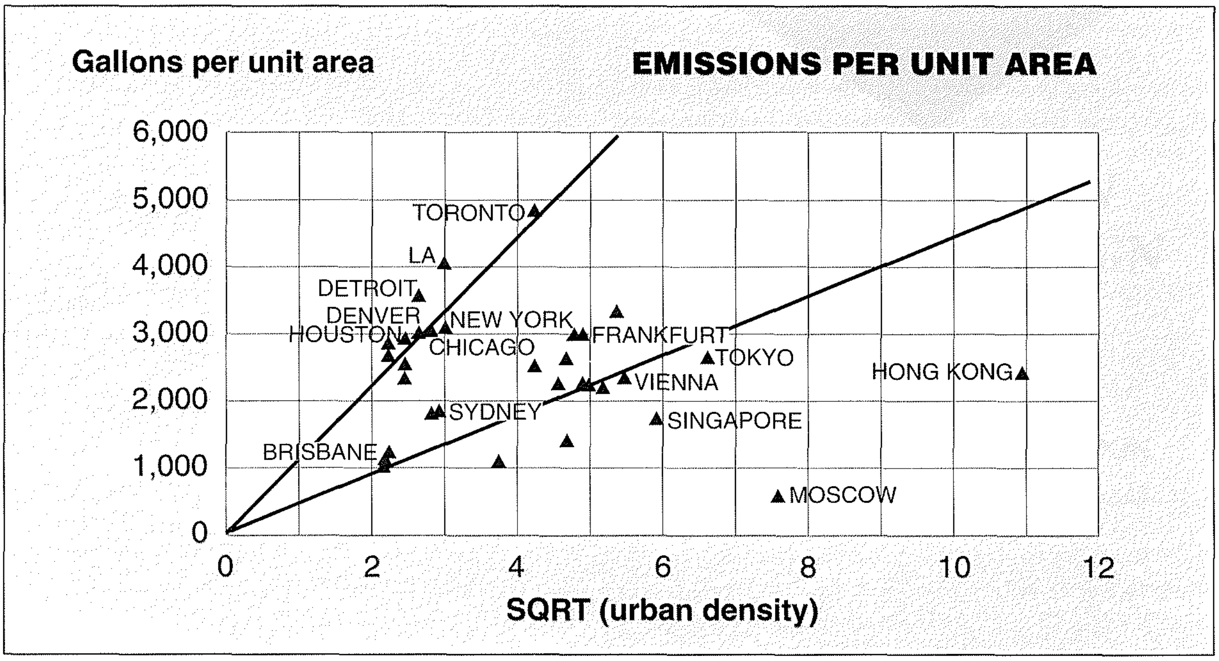

Figure 4 Fuel use per unit area for high and low density cities.

One scenario would be Euro Disney again. Already some European cities have an Old Town free of traffic, full of tourists, and full of museums and art galleries. These cities will ossify about some transport epoch. Venice perhaps is the classic example, locked in time at the great age of the canal. The real business would take place in the new low-density suburbs beyond the 12-lane Belt Way. But there may be a third scenario.

Conclusion

I have argued that buildings contribute to sustainable development in two ways. They are consumers of resources and they are assets to pass on to future generations. Innovation is playing a major role in tackling the first of these concerns. However, the course of innovation also means that transport, and hence the value and function of location, are likely to change over the lifetime of the building. The issue under most pressure is the future of the city centre.

As the scope of personal travel and of goods and services extends ever wider, we may be moving back towards the city state. Globalisation tends to induce regional specialisations and the urban centre sits at the hub of these global networks. That it may take only twice as long to fly from JFK to Heathrow as it took to get from New Jersey to JFK only serves to emphasise how the modern city becomes the regional gateway to the wider world. Not every city will wish to become a Disneyland town. Few cities will wish to become hollowed out cores, home only to the destitute. Instead, some will aim to be dynamic. Their areas of art, commerce and entertainment will need to expand and contract as opportunities and markets arise. They cannot afford ossification or decay. For a building in such a city it hardly then means much to say 'form follows function' when 'function' may vary so widely during a building's life. The function one seeks is then simply flexibility within the building shell. The idea of a design tightly optimised to first use, looks inconsistent with sustainable development in a rapidly changing world.

If these speculations are correct, it does not mean the end of building design appraisal, possibly the reverse. Rather than an automaton optimisation to a client brief, design becomes an assessment of the options to be left open, not the options to close.

The opinions expressed in this paper are those of the author alone.

Background Reading

A useful introduction to future scenarios for transport technology is to be found in *Mobility*, R RAINBOW (Shell, 1994). This was the source material for Figures 1-4.