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Urban Challenges in Hong Kong: Future Directions for Design

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The high-density urban environment of Hong Kong is characterised by mixed land uses, population and housing diversity, an efficient mass transit system and cheap public transport, and easy access to most facilities, all typical of a compact city-state. It should be an ideal base for consolidating other desirable New Urbanism concepts such as more open spaces, better housing options, pedestrian friendly neighbourhoods or a cultural identity. However, shortage of buildable land in the urban areas, traffic congestion and environmental degradation have raised new challenges. Achieving physical planning goals has to be integrated with the urgent need to control pollution and waste, improve air quality, and seek a better balance with the ecosystem within and outside Hong Kong. This paper focuses on an energy-optimising model for Hong Kong, as a means of exploring strategies to improve the living environment. A conventional approach to urban design is unlikely to provide a satisfactory outcome. An emerging option for Hong Kong is to rebuild a part of the neighbourhood higher, so as to consolidate the mixed land use patterns in super rise buildings and generate land for community uses and open spaces. Broad design directions to achieve this are identified.

Keywords: high density housing; New Urbanism; Hong Kong; energy consumption

Study objective and methodology

New Urbanism (or neotraditional design) is an important effort to revitalise and integrate into a single location design concepts from the pre-automobile era that focus on comfortable living environment, promote convenient residential locations that minimise travel, provide access to a wide mix of facilities, and conserve energy, resources and heritage (Katz, 1991; Calthorpe, 1993). There are different approaches. Walt Disney's Celebration in Florida is perhaps its best illustration. The Transit Oriented Development (TOD) model incorporates a small *walkable mixed use community* that provides low-rise and medium-rise housing for different household types, with retail, civic, recreational and employment centres within a 2000 foot radius of a transit centre (Calthorpe, 1993). The New Towns and many of Hong Kong's modern housing estates embody many of the Traditional Neighbourhood Development (TND) concepts, while the TOD principles can be identified with the urban centres developed around the mass transit railway stations. There are three crucial differences: the local density is high, in the range of 500 to 3000 persons per hectare in urban locations; these locations are heavily built up with limited supply of new land; and third, the urban metabolic rate is one of the highest in the world which because of current technological limitations has resulted in massive environmental damage. However, the principles expounded in these approaches are important to Hong Kong, in order to restore ecological balance, reduce pollution, and to further enhance the overall living environment. Central to all these goals is the need to optimise energy use. While seeking an energy optimising development model, this paper explores potential directions for future urban design in Hong Kong.

There are four principal indicators of energy use or dissipation in an urban habitat. First, energy

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consumed in various human activities, which is directly measured, either as a primary source of energy or in final use (see Figure 1). Second, a significant volume of energy is absorbed into the land development and construction process, with the greater proportion of it used in the extraction and processing of raw material for, and in the production of building materials and components of, the built form. Third, society consumes a great deal of energy also in consumption of food, beverages, various other goods and services. Fourth, greater affluence and higher density are associated with greater wastage of energy and matter in various forms. In the end, all communities are striving to achieve higher levels of consumption of goods and services. It is pragmatic though to compare energy efficiency of two districts in terms of two measures only: measured energy parameters, and indicators of pollution and waste (Newcombe *et al.*, 1978). Examination of energy implications of different forms of habitat should not be limited solely to conventional measurements of energy uses that exclude pollution and wastage. A high density environment that minimises wastage and pollution may be an ideal form for Hong Kong. This study examines this hypothesis using available national statistics, a case study of energy utilisation patterns in two districts, and interviews with practicing professionals. Identifying future research needs is a secondary objective.

Territory-wide concerns

The land area of Hong Kong is 1096 km^2 and only 176 km^2 is classified as developed land; the population of Hong Kong has been increasing at about 1.5% p.a. and per capita income in real terms grew at 3% p.a. during 1984–94 (see Fig. 1). The population density in the built up areas is close to 37 000 persons/km^2 or in the range of 500 to 3000 persons per hectare. High densities in this range result in mixed land uses, increased building density and a higher building material consumption ratio, a higher ratio of mobile population to residents, escalation in gross energy demand, transport congestion, high urban metabolic rates, and a heavy demand on eco-systems to support the dense population concentration. Glorifying high density development, on the one hand, is the massive economic benefits of concentrating highly skilled people within a small area, generating huge agglomeration benefits, increasing industrial competitiveness and raising the consumption levels of the people; on the other hand, are the devastating effects of waste and pollution, and arising from the growth in the material demand per unit area of occupied land, the large ecological area expropriated, e.g. by the Hong Kong model.

Traditional air pollutants like sulphur oxides, carbon monoxides, nitrogen oxides and particulates are also of major concern to urban designers in Hong Kong. On September 12, 1999, the roadside air pollution index was 93 in Causeway Bay, in Central Hong Kong; when it reaches 100, it is recommended that the young, old and the sick stay inside their homes. Activities which contribute to concentration of particulates, such as vehicular emissions, refuse incineration, movement of heavy vehicles, intensive construction activities, dumping of solid waste matter and their open burning, are very common in Hong Kong (see Fig. 1 for increase in pollution related complaints). Air pollutants are being readily transferred between air, water and land, rapidly degrading the overall environment as in other large cities (Haughton and Hunter, 1994, pp. 125–126). Pollution consists of substances, heat and noise; resulting changes to the microclimate from heat discharges is also suspected to be a critical issue in Hong Kong. Many city residents already fear the local impact of global warming. External noise levels exceeding 55 dBA are considered unacceptable. In urban Hong Kong, trucks, buses, motorcycles and construction work contribute to unacceptably high levels of noise during certain times of the day. Hong Kong is already home to a visible, large and smoggy dust dorm. Water pollution from industrial waste, and discharge of human sewage and animal wastes, is a considerable problem in Hong Kong. Tracts of marine areas and coastal waters are often visibly polluted.

What appears to be a balanced pattern of land development at the territorial scale is adversely distorted in high-density urban areas with transport claiming over 40%, huge volumes of building and little allocation for open spaces. On the other hand, there is a good deal of mixing of social groups, leading to economic benefits of high concentration of population and positive impact upon per capita measured energy consumption. In the medium term, the population and the residential density are likely to grow because

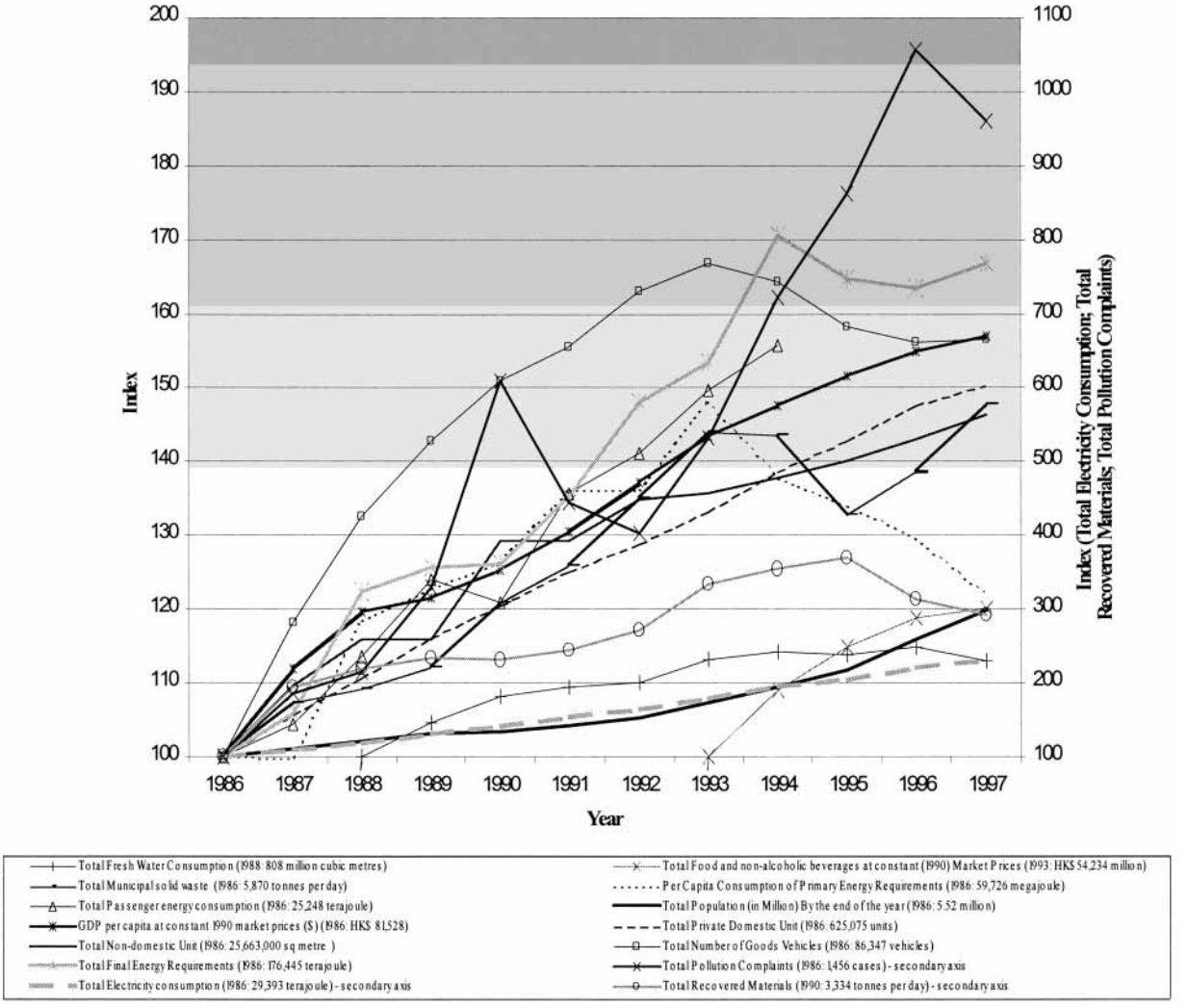

Figure 1. Fourteen urban habitat indicators, Hong Kong. Sources of data: Census and Statistics Department, (1999); Transport Bureau, (1999); Environmental Protection Department, (1999); Urban Services Department, (1998); Electrical and Mechanical Services Department, (1999b); Regional Council, 1999.

Hong Kong is a Special Administrative Region of China. The high population density in Hong Kong can induce energy efficiency if the social costs to the community are minimised at the same time, and the environment is properly managed.

Shorter trips and greater use of non-auto modes in the high-density areas should produce greater net energy savings than in the low-density areas (Keyes, 1982, pp. 218–225). Small and compactly developed or multi-nucleated locations with a large proportion of its population living in high-density neighbourhoods and a relatively uniform distribution of jobs and residences should reduce travel and therefore induce energy efficiency. Hong Kong should simulate this condition to some degree. However, measured per capita consumption of petroleum products in Hong Kong, and the use of energy (petroleum products and electricity) in passenger transport have been increasing approximately at a rate of 6% p.a. during the same period; the number of goods vehicles including containers increased by 6%. The number of passenger journeys grew from 7.03 million in 1980 to 10.86 million in 1997. In Hong Kong, 90% of the population rely on public transport. However, the road capacity is already overloaded with about 273 vehicles per km (Census and Statistics Department, Hong Kong). In 1997, a total of 1831 km of roads carried 500 228 licensed vehicles; 318 350 licensed private

cars (63.3% of all vehicles) and 118 279 (23.6%) goods vehicles overburdened the transport system (Transport Bureau, Hong Kong). The internal freight movement is dominated by road freight although marine transport has emerged as the dominant transport mode for cargo (Ng and Wang, 1993, p. 208). Freight transport uses diesel that generates more pollution than unleaded petrol. The share of rail transport increased from 7.2% in 1980 to 30.3% in 1997.

The urban metabolic rate and the appropriation of ecological areas are predicted to grow faster than the population. Because of the high density of buildings, and the propensity to accept short life for buildings, arising from sky-rocketing land values, construction and demolition (C&D) waste generation is an unusually serious problem in HK. In 1992, 8600 kg of materials was consumed on a per capita basis; construction materials and fossil fuel accounted for 42% and 31% respectively; approximately 30% or 2600 kg per capita was generated as waste (Faber *et al.*, 1995; Koenig, 1997). In 1990, for example, 1100 km^2 of ecological area was expropriated for each sq. km of urban land in Hong Kong (Koenig, 1997). More recent calculations indicate an even higher figure (Barron and Steinbrecher, 1999, p. 169). Land consumption for waste disposal could rise to over a quarter of all new land uses in the next two decades in Hong Kong (Koenig, 1997).

The above trends portray the characteristics of recent *urban expansion* in Hong Kong, which have led to possibly the highest energy, material and waste turnover rates in the World (Koenig, 1997). The above trends are intertwined with current urban morphology in Hong Kong. Hong Kong cries out for a new urban form, in order to project land productivity beyond the current limits. New urban design programmes have achieved only limited progress in reversing these trends in high-density urban areas, because their impact is localised, and when the impact is projected onto a larger urban scale, new designs are virtually reduced to extensions of the current urban form, especially in terms of functions and with little impact on the overall environment.

Urban structure and employment trends, land use

The spatial and energy structure of urban areas is influenced by the size and shape of settlements, structure of land uses and provision of open spaces, the nature of the communications network, density, interspersion of activities and various siting factors, the importance of each depending on the scale which is being considered (Burchell, 1982, pp. 19, 148; Downs, 1982, p. 148; Mandelker, 1982; Owen, 1985, p. 35). At the intra-urban scale, on the other hand, both compact nucleated structures and linear grid patterns become more effective (Owen, 1985, p. 35).

Hong Kong's current urban structure is best described as providing a balance between urban concentration and decentralisation of population (see Figure 2, Hong Kong 1999). The process of suburbanisation or new town developments would in practice save energy only if the satellite cities succeed in being balanced and self-contained communities.

The New Towns in Hong Kong have generated more home to work travel because of lower than planned employment to household ratios. In 1996, 44.9% of the population lived in the New Territories, but over 70% of them travelled far to work (Department of Census and Statistics, 1997). There was increased commuting between the CBD and the New Towns. Further, total employment numbers in the Mass Transit Railway (MTR) service area increased at a rate of 17% p.a. from 1981 to 91. The proportion of jobs in the MTR service area increased from 10% of all jobs in the Metro area to 41% during this period. Numerically the largest increases were in wholesale retail, import and export, and then almost equal increases in manufacturing, and finance, insurance and real estate (Wang, 1998). Population also increased in the Metro area but at a slower rate (Cook and Wang, 1996). Equally important for energy planners is the unplanned differential in the growth rates in employment and residences between 1981 and 1991. The increase in jobs in the trade, retail and restaurant services would have been associated with a heavy increase in goods traffic. It is likely that a large number of *new establishments* set up in these sectors contributed to travel congestion and pollution. Only limited information is available on travel habits in Hong Kong (MVA, 1993). A study for the Planning Department (RBA, 1998) raises the question whether there is an oversupply of retailing facilities in HK.

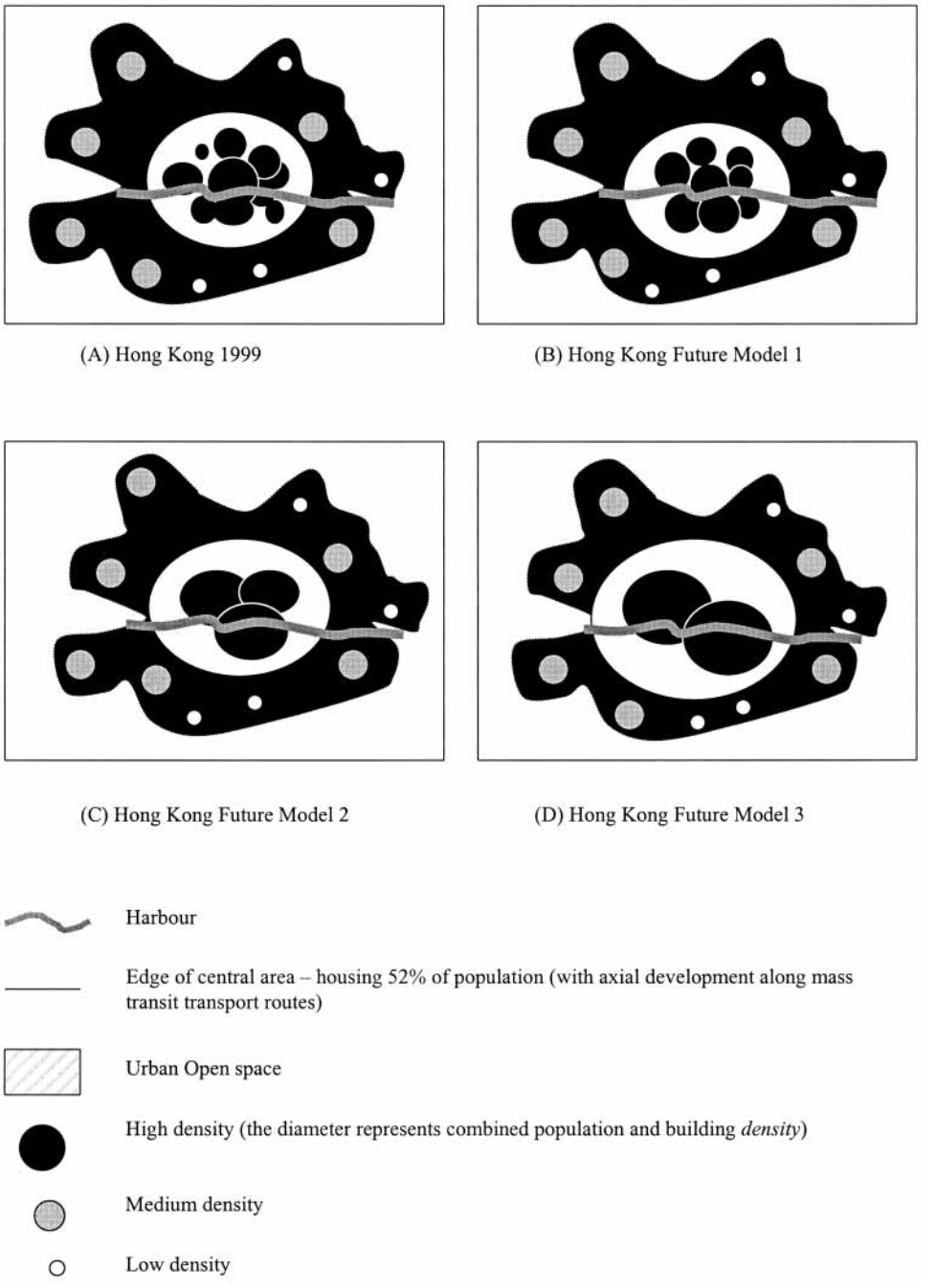

Figure 2. Urban structures for Hong Kong. (A) Hong Kong 1999. (B) Hong Kong Future Model 1. (C) Hong Kong Future Model 2. (D) Hong Kong Future Model 3.

Land use planning to minimise energy demand in Hong Kong should target those activities within the residential and non-residential sectors that currently have the greatest shares in *overall energy absorbed, including waste and pollution*. These are identified below (Ganesan *et al.*, 1999), and further research is necessary before they can be prioritised:

(a) Space heating and/or cooling within and outside buildings;
(b) Home to work travel;
(c) Travel for social, cultural and recreational activities;
(d) Transport of goods for household consumption (freight transport uses diesel that generates more pollution);

(e) Location decisions affecting households and businesses;
(f) Waste reduction and recycling for resources.

The commercial land use in Hong Kong consumes a higher proportion of conventionally *measured energy* than other users, mainly for *space heating and cooling*. In 1997, the commercial users took up 59% of total electricity consumption. The domestic users consumed 25% and the industrial users 16%. The decision to locate businesses has major implications for other energy demands. However, location is often determined for them on account of land use zoning restrictions and the built in financial implications.

Case study: Mong Kok and Sai Kung districts

To understand energy use and efficiency in different habitats from an urban designers standpoint, we should examine the following areas: population density, urban structure, land use and employment locations; building density and land values; socio-economic groups and consumption patterns; transportation; waste and pollution; urban services; and technological changes. As part of this study, two areas were compared in terms on these issues: Mong Kok within the Yau Tsim Mong (YTM) district in urban Kowloon and Sai Kung in suburban Kowloon. The population of Mong Kok is 159 287 and 197 876 in Sai Kung. The Yau Tsim Mong (YTM) district that includes Mong Kok has a uniform population density of 38 044 persons per sq. km while Sai Kung district has only 1533 persons per sq. km. In the Mong Kok area, the dominant land use category is 'major road' (40.12% of total land) and the second is 'residential area' (27.56%), whereas in Sai Kung, the two dominant land categories are conservation area and Green Belt which are 40.1% and 20.4% respectively (Planning Department, Hong Kong).

Significant differences are identified below. Employment *available* (within the district) to household ratio is projected to be 0.59 for Mong Kok and 0.33 for Sai Kung. Sai Kung has families with a marginally higher income and better car ownership, but Mong Kok is associated with more substantial space heating and cooling, and greater wastage and pollution. In city centres, the permitted plot ratio for commercial/office buildings is 15. The residential plot ratio is 5–7 in Sai Kung, and up to 7.5 in Mong Kok. In Mong Kok, with more than half the land held back by the public sector for transport and other uses, intense competition among residential, commercial, office and industrial uses has led to much higher land prices. In high density Mong Kok, a quarter of all public transport journeys are on the electrically operated trains (electricity is mostly imported from the Mainland). Passenger travel in Sai Kung is based on petroleum-based vehicles. However, the peak time average car journey speed in Hong Kong Island/Kowloon/Mong Kok is only 24.8 km per hour. In both districts, freight transport is a dominant road user (Transport Bureau, Hong Kong).

In Mong Kok vehicles for public transport and freight of essential goods for businesses form a major proportion of all vehicular traffic during the congestion hours, this means that even when private cars are reduced in numbers, the congestion is unlikely to ease during peak travel times unless restrictions are placed on other types of vehicles as well. The amount of domestic solid wastes in Yau Tsim Mong district is 2.12 kg per (resident) person per day in 1997, far in excess of 0.91 in Sai Kung. It is noteworthy that there are more visitors and tourists seen in Mong Kok who increase waste collected. Sai Kung has a higher proportion of commercial and industrial waste because of new development projects (4.63 kg per employee per day *vs*. 0.52 in 1997). The existing practice is to dispose of domestic waste unsegregated. Mong Kok is among the most polluted areas in Hong Kong while rural Sai Kung is endowed with scenic spots and is known as the 'Back Garden of Hong Kong'.

Considering both resident and mobile populations, the study indicates that per capita *measured* energy utilisation is currently less in YTM, especially since cleaner electric power is used by the MTR and YTM is expected to benefit from economies of scale in utilisation of power required for most uses. However, when wastage and pollution are considered, the energy efficiency differential is really indeterminate (Ganesan *et al.*, 1999). This case study confirms that wastage and pollution must be considered in evaluation of energy efficiency in any location.

Discussion and conclusions

1. Hong Kong cannot be reinvented; but she can be rebuilt. Reducing overall energy consumption emerges as a major task. The most important goals facing urban designers in this task are to achieve a more balanced land use and built form in the high density districts, reduce impact of environmental pollution on human groups, reduce waste disposed, create more open spaces, seek reduction in energy for space heating and cooling, build more residential space and realise greater harmony with the ecosystem.
2. Radical restructuring of land uses in urban Hong Kong to emulate the great ideals of garden cities is not feasible physically. The glorified garden city concept has been trampled in the urban areas by historical circumstances of Hong Kong. However, Hong Kong has evolved its own pattern of development dictated by the historical, geographical and political past. It is a highly functional organic urban form. Many aspects need improvement. It cannot be altered into an eco-city or a green city overnight. Future urban design will need to choose among two alternatives. The first option is to look for expansion of the network of nucleated city centres built around the Mass Transit Railway (MTR) stations and implement reforms in land use, transport facilities and pollution control as outlined in this paper. There will be a gradual increase in building heights and residential density. This is a virtual continuation of the historical pattern of development with renewed emphasis on cleaning up the environment and providing open spaces within the localities (see Figure 2, Future Model 1). Small communities in mixed-use surroundings need to be identified, and protected from exposure to traffic and pollution. For longer-term benefits, urban designers should seek population concentrations through land use restructuring, in order to support financially the expansion of the MTR. Travel demand should be determined by policies (MacCready, 1999). The findings from this survey also militate against further reclamation in the Victoria harbour.
3. The alternative is to seek a local model of the megastructure compact city concept with buildings as tall as 500 to 1000 metres, linked by three-dimensional connectors for transport of men and materials (Hyper Building Research Committee, 1997). The emphasis is on self-containment at high population concentration and energy efficiency. A part of the structures will be below the ground level to increase building strength and minimise energy for transport. The needs for social acceptability and assured returns for private investment will dictate a slower growth of building height in this model. It will take several decades for Hong Kong to realise such a concept. Designers will seek to double plot ratios to perhaps 30, and reduce site coverage to no more than 20%, over one or two decades. Such a gradual development will not impose a dramatic change in urban morphology, rather a gradual acceptance of a modified version of the ideas of Buckminster Fuller, Paulo Solieri, and indeed Frank Lloyd Wright. The Hyper Building Research Committee of the Building Centre of Japan in Tokyo suggests designing a Mini-Hyper Building 300 Metres in height initially (Figure 2, Future Model 2) to incorporate the technologies that would, with appropriate modifications, support a 1000-metre mega structure several decades later (Figure 2, Future Model 3). Hong Kong has considerable experience already in erecting structures over 300 metres. The ultimate form promises a high density, pollution free, friendly neighbourhood with more open spaces, all within an energy efficient system. Guidelines for planning of a hyper building system for Hong Kong with particular reference to size, mix of functions, limits to investment per unit area, total investment return, and the form, including shape, height, volume, etc, should be developed (Yeang, 1997). The new form should aim to achieve higher energy efficiency with respect to items (a) to (f) identified earlier. Researchers at Waseda University, Tokyo are researching into these issues but the requirement to provide a minimum level of jobs within the megastructure faces economic challenges. There is also no concrete data on how overall energy consumption per sq. metre of usable space will vary in the proposed hyper building designs. The hyper building compact city form is the logical extension to the high density urban

form of contemporarily cities. The perceived energy efficiency of these high density forms has been thwarted by the energy embodied in and additional energy spent on reducing waste and pollution. Our case study could not establish that a high density form in Hong Kong was more energy efficient, compared to a low density situation. Unless research reveals that a hyper building form is relatively energy efficient, it will not be the preferred form of the future.

4. Because the Hyperbuilding alternative can only be a gradual development due to financial and social constraints generated by an already built-up high density area, it will not preclude further decentralisation of especially business and jobs. We noted that the highest job growth in recent times has been in the MTR area. As Hong Kong's population exceeds the seven million mark in 2000, and moves inexorably towards the ten million count, Hong Kong's planners should seriously consider the development of a second, self-contained business district, not just further extensions of the current CBD which encompasses parts of the Hong Kong island and Kowloon. Lantau hosts the new airport and the Disney complex, and with its rapid transport connections emerges as a prime location to attract new high tech businesses and government facilities that can be relocated. The massive move of the manufacturing sector into South China in the last two decades amply demonstrates that profit-hungry businesses in Hong Kong will respond to fiscal incentives and land – related concessions. These incentives have to be substantial though since Hong Kong does not have a cheap pool of labour.
5. In order to develop detailed planning and design guidelines to achieve the above improvements, five areas emerge as most promising for further research and development. These are: office buildings and HVAC systems; restructuring current urban land use to reduce movement *at the local level* of retail goods, home to work travel and non work travel; location of residential estates to improve air quality; reduction in construction waste; and hyper building technologies appropriate for Hong Kong. The first four issues are concerned with the most extensive energy uses in the Territory, that together account for a major portion of Hong Kong's ecological footprint in China when integrated within a 3-D form advanced technology for building, energy conservation, waste reduction and recycling which may lead to a pollution-free green environment (Faber *et al.*, 1995).
6. There is considerable potential in Hong Kong to improve office productivity, using solar energy systems, energy efficient HVAC and Information Technology (IT) systems in buildings, within broader urban design goals (Lam and Hui, 1996; Hui, 1997; EMSD 1999a; EMSD 1999b; Hui, 1999). Consultants report that up to 32% savings can be realised using water as a cooler in office buildings. Use of solar energy for heating and cooling in all buildings should attract fiscal incentives. Only a small portion of commercial space in Hong Kong, probably less than a twentieth, is likely to be considered as intelligent by advanced international standards developed elsewhere (Ivanovich and Gustavson, May 1999, p. 74). There should be concurrent efforts to improve air quality within buildings and the urban environment outside in Hong Kong (Wise, May 1999).
7. Nearly 45% of the Territory's residents have to travel several kilometres to work daily. Location and land use decisions should seek to minimise this percentage in conjunction with fiscal measures and land pricing strategies. Targets for employment (within a district) to household ratio should be set up. These would likely vary from 0.35 to over 1.25 depending on land and population size. The hierarchy of shopping facilities, available to a locality like the Mong Kok district, including the network of shopping centres accessed by the residents of Mong Kok at the Metropolitan, regional district and local levels, and secondly, the distribution of shopping facilities at the local level should be restructured to minimise non-work travel.
8. Urban design should aim for lower levels of pollution, especially for the residential locations. There are several approaches to achieve this: reduce traffic flow that depend on petroleum products; increase cleaner forms of transport such as electrically operated mass transit systems; and separate residential districts as far from heavy traffic as possible. Planning in Hong Kong should provide for separation between residential

locations and trunk roads; guidelines should provide a healthy balance between open spaces, trunk roads and housing allocations, such as to improve air quality in housing estates.

9. About 77% of the total C&D waste is used as fill material for reclamation in Hong Kong. If the balance is recycled, then landfill space now used for dumping could be reduced (Environmental Protection Department, 1999). In order to reduce waste, Ng and Wong (1997) have argued for modular designs, standardisation of building components, and specification of efficient and durable materials and favoured life cycle energy evaluation. Environmental assessment of building materials does not include the cost of waste disposal and benefits of recycling in the calculations of Hansen *et al.* (1994). We should consider all costs, including energy required for their production and expenses of waste disposal.
10. Urban design should promote recycling technologies, allocate land for their operations during design of new towns or urban development projects, and ensure that designs minimise waste creation, and also facilitate efficient collection and separation of waste for recycling purposes (Mallard *et al.*, 1982). For example, design of collection points for waste within projects and public space should provide for means to segregate waste. Kajima Kensetsu, Japan, has developed technology to generate power for households from waste. It is time to incorporate such systems in Hong Kong housing estates.
11. Urban designers along with other professionals are being called upon to work towards a lower urban metabolic rate for Hong Kong, and greater sensitivity to the ecosystems within and outside Hong Kong. This is a complex issue since Hong Kong is a part of Mainland China where our ecological footprint is most visible. However, the transfer of *renewable* resources as well as two-way trade that is sustainable in the long term may be regarded as benefiting the *economic and social needs* of both Hong Kong and the Mainland. Generally greater energy efficiency in our urban system should reduce the adverse impact of Hong Kong's ecological footprint, and this is the way forward.

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