Interestingly the cost indicator, as shown in Table 20.4, appears to mirror the energy results.

Conclusion

Longevity is important. The Integer Concept Tower is the best performer over all the indicators in the 75-year life assessment. The presumption is that it will have this long life because of the intrinsic flexibility of its frame construction. Whether this same flexibility and thus extension of overall building life can also be achieved in reality by the other two standard blocks is outside the scope of this study. Moreover, redundancy is seldom caused by the basic constructional materials losing their functional integrity and nearly always to do with the economics of flexibility. As Hong Kong's gross domestic product (GDP) increases it is very likely that tenants, once content with space-standards that would be considered in many other countries to be small, may well demand greater habitable floor area. If this cannot be achieved by the refurbishment of buildings due to the inherent inflexibility of, say load bearing cross-wall type construction, then building design should be changed to facilitate flexibility. It is also worth mentioning that the demographics of Hong Kong are changing in a way similar to many first world countries. In Hong Kong a move towards smaller nuclear families is predicted. This, together with a reduction in couples having children and an overall population decrease, will result in a greater need for smaller housing units, (one or two person units) and this shift in demand is already affecting the Hong Kong Housing Authority (HKHA).

Clearly, both changing demographics and the growth in personal aspirations with rising GDP will lead to an assessment of how the existing housing stock can accommodate these increasing requirements. A judgement will have to be made whether adaptation and refurbishment, or demolition and rebuilding, is the correct course. The answer is likely to vary with the circumstances of each housing block or estate. However it is worth considering the following points that largely come down on the side of demolition and rebuilding:

- **The operational regime is significant for all the buildings and energy efficiency is clearly important. Strategies to reduce energy demand and supply with energy generated renewably should be examined. However, the application of insulation is perhaps the most cost-effective solution although this might be difficult to achieve on a number of the existing standard housing block designs**
- **The repair and maintenance regime is also significant. This indicates that improving building construction in order to minimize maintenance and running costs could considerably reduce the overall life-cycle impacts**
- **The inherent inflexibility of the traditional *in situ* cross-wall construction together with the standard H-plan form makes conversion and reconfiguration relatively difficult**

- **Recently after the severe acute respiratory syndrome (SARS) outbreak last year there has been increasing concern about the spreading of both pollutants and pathogens and that the spread of contagious diseases and poor air quality are exacerbated by the standard housing block plan form. It is possible that refurbishment could contribute to improving or eliminating this situation**

The question posed for the HKHA is, by using the modelling process, how can the choice between refurbishment and redevelopment be optimized in terms of environmental and economic impacts? This now requires a series of different refurbishment and redevelopment alternatives to be assessed using the model methodology outlined above. In this respect, the Integer Concept Tower is definitely worthy of further investigation as a possible new build alternative.

This should go hand in hand with the development of the model to extend to cover a substantial part of Hong Kong's building stock. The extent of relatively standard building archetypes in Hong Kong makes this process relatively straightforward and about 20 building archetypes have already been identified that represent over 90% of the building stock. A process of benchmarking the complete range of Hong Kong's building types should be undertaken so that best practice standards can become design targets.

The models described above can now be tested to review a whole series of design questions. For example, at what point would the inclusion of a photovoltaic façade cladding be cost effective or conversely, how much would the price of energy have to rise for its inclusion to be effectively paid for in say 10 years? A similar question could be posed for insulation. And, if the layout (plan form) of the buildings was rationalized, what would be the consequence? Perhaps the largest question to be raised in Hong Kong's construction sector at present relates to the extent and potential of the use of precast elements. Here a range of alternatives can be explored and the proposals optimized. This research has resulted in the development of models that can be already used, and further work is now underway to refine them.[5]

Notes

1. The Integer Hong Kong partners are: Gammonskanska, CLP Power, Swire Properties, the HKSAR Government, the UK Government, Integer UK, Hong Kong Housing Society and Hong Kong Housing Authority (HKHA). The patron is the HKJC Charities Trust, who have sponsored an exhibition and the construction of the Integer Pavilion, which over 20,000 school children have now visited. The construction of the Integer Pavilion and the mounting of the exhibition have also initiated a construction industry research and development group that focuses on construction-related sustainability issues. The group is composed of representatives from the Integer partners as well as leading university department involved in construction, interested in advancing sustainable construction.
2. 'Material mass' is the mass of any material expressed in kilograms or tonnes.
3. 'Churn rates', – the rate at which tenants vacate their flats, and are replaced with new tenants (e.g. every 5 years). The rate has a considerable impact on repair and refurbishment, which in turn affects the energy and material inputs in the model.