

Market Transformation, Innovations and cultural change initiatives for the construction and building industry – defining a holistic approach for sustainable architecture

Barriers to achieving sustainable architecture

The built and the natural environment are embedded in the social, the cultural, and the economic arena. These elements do not stand in isolation but interconnect and merge, they shape and are shaped by these environments. At the same time there is a great variety of actors which guide and bring life and dynamism to these environments. These actors make a wide spectrum ranging from national and local authorities, community leaders to professionals and scholars in a vast majority of disciplines as well as the people which stand as receivers but which also engage in molding their environments by exercising their agency. Different inputs are then given into the making of the world in which we live from the different actors and disciplines concerned. Despite the presence and interconnectivity of elements they have been often treated as single realities. Actors have also worked as single entities from policy makers to professionals failing to see the impact of their products and projects beyond their own disciplines. There has also been little emphasis on the way people perceive, experience and most importantly incorporating them and their insights actively into the construction of the world they live in. Lau, et al (2006)³ observed that there is a missing dialogue between designers and users in the perceived versus the assumed role and performance of window design for apartment homes. The lack of communication between the two groups indicated that there is a risk of mismatch of expectations from the designer and the users' perspective resulting in an unsatisfactory evaluation of the building in operation. This could have been avoided if a user survey or similar is built into the design process in the first place. The importance

of a collaborative design process is evident especially when there is a noticeable change of lifestyle and work style promulgated by the rapid transformation of societies due to economic growth and external influences such as globalization and information technology.

Global Challenge and current situation in Hong Kong

Despite the fact that the concept of sustainable building has been around since the late Nineteen Eighties if not earlier⁴, researchers and practitioners noted the slow growth in the number of sustainable buildings in the world market as a whole. This is true in the developing or developed cities including Hong Kong. Despite the availability of affordable technologies and practical solutions, the readiness and perhaps eagerness on the part of the designer, a reluctance to implement sustainable building exist today, probably due to a fear of increased investment, and unappreciated efforts on the part of the developers⁵ and users respectively. At the same time, there has not been enough effort into the understanding of the full social, economic and environmental impact single products have in the larger and long run picture. Greater understanding and greater awareness of the role of buildings could translate into willingness in the adoption and implementation of sustainable building.

Architecture, socio-economic and environmental motor

Today it should be underlined that a product, a building, not only stands as an entity lost in its mere purpose as housing or office. Products such as buildings are engaged in the production and reproduction of the social, the

economic and the environment. A building, for instance, can create a positive or a negative working environment which makes work not only a more or less pleasurable activity for the working people but it also can contribute or be detrimental to efficiency and productivity facilitating or inhibiting production, economic growth and development. Furthermore, this is part of a chain which makes efficient or deficient use of resources, pollutes or not pollutes. The latter highlights that the product, the building, constitutes an integral component for the social, the economical and the environment and it is in line with the interest of the people, entrepreneurs and governments. Bevege (2007) reported on his post-occupancy evaluation on a recently renovated office building in Australia whereby the occupants reacted favorably to the sustainable building as users. Bevege conducted interviews and task tests that revealed improved performance and a noticeable improvement of well-being, healthiness and productivity in the work force. As a result of the renovation, the senior management of the office decided to mandate that all future premises they chose to occupy should be a sustainable building.⁶ Bevege suggests that the future to promoting sustainable building lies in the education of the user (the demand side) whose preference would transform the behavior of the developer (supply side).

The meaning of holistic approach to a sustainable architecture

Recognizing the role of buildings in the social, economic and environmental arena calls for dialogue and cooperation. There is a need to bring together those directly engaged in the building industry with the people, the entrepreneur and the policy maker. It becomes

paramount to bring together people from different disciplines: the architect, the planner, the economist, the geographer, the sociologist, etc to achieve an improvement of performance of the building industry as a whole. The natural and the built environment constitutes people's living, leisure and working space enhancing or hampering their activities, it is then in all of us an interest to ensure the social, economic and environmental sustainability.

Time for market transformation, innovation and cultural change

In the past decades the world has witnessed a rising public concern for sustainability. The latter has been marked by phenomena such as global warming and its consequences which have become evident for the public. The environment has also received strong attention from the media which has contributed to disseminate public and global awareness on the need to achieve sustainability. These have been accompanied by the demand for green products which has been translated into the creation and expansion of these markets. They have been able to highlight the positive elements in their products and appeal to the people.

Sustainable or green building, as other green products, must appeal and enhance its market within the environmental discourse, actively being promoted to the user, developers and governments as a key in the achievement of sustainability. Furthermore, it becomes paramount to contextualize the green building beyond the environment, in the production and reproduction of the social and economic. A sustainable building must be perceived as an investment which creates well-being as well as a positive working environment, contributing

not only to energy but human efficiency and therefore productivity and lower costs.

Fostering and enriching demand calls for incorporating users, entrepreneurs and developer's insights to bridge the gap between supply and demand. Enriching demand with a holistic and incorporative approach aims at avoiding stagnation of the green building industry, stimulating R&D and guaranteeing there is a continuous flow of resources, ideas and innovation. A strong demand, dialogue and cooperation will enable the sustainable building to survive, regenerate and consolidate as our future habitat, a sustainable habitat.

Acknowledgement

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³ Lau, S.S.Y.; Baharuddin; et.al. (2006) Reconsidering Day-lighting Design Paradigms for Tall Buildings in a Densely Built City, Australia: Architectural Science Review, 49, 3, pp.285-294.

⁴ 1998 marked the first world conference on sustainable building, held in Vancouver, British Columbia.

⁵ This is especially true for a property market dominated by speculative developers instead of user clients.

⁶ Lindsay R. Bevege, Powerpoint presentation at the SB07 Workshop held at the Professional Green Building Council, Hong Kong, January 10, 2007.



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Supplementary photos to the article Partnership between the Government and the Architectural Profession in promoting sustainable development

<Photo 1 & 2> - Building Envelope with energy conservation functions in the Wetland Park Visitor Centre. (Source: Architectural Services Department)

<Photo 3> - Reuse of old bricks from Mainland and granite rock paving from the boundary wall of Wanchai Police Headquarters in the Wetland Park Visitor Centre. (Source: Architectural Services Department)

<Photo 4> - Material reuse - Gabion wall infill made from oyster shells from Lau Fau Shan in the Wetland Park Visitor Centre. (Source: Architectural Services Department)

<Photo 5> - Building design to abate road traffic noise - use of a combination of measures including setback, podium, barrier, architectural layout and extended fins. (Source: Environmental Protection Department)

<Photo 6> - Building design to abate road traffic noise - use of landscaped podium (Source: Environmental Protection Department)

Partnership between the Government and the Architectural Profession in Promoting Sustainable Development

The World Commission on Environment and Development defined, in its publication entitled “Our Common Future” in 1987, sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The concept called for joint efforts of the Government, the business sector, professional bodies, planners and all policy makers in deciding on and implementing development strategies. In the highly urbanized environment of Hong Kong, partnership between the Government and the architectural profession is one of the most effective means to promote sustainable development. Let me give some details as to what we have done and the progress so far.

Multi-pronged Approach in Promoting Sustainable Architecture

2. The Government has always attached great importance to the promotion of sustainable development in the design, building and subsequent operation of new facilities. To this end, we have adopted a multi-pronged approach with legislative, administrative and promotional measures. At the environmental protection side, legislations serve to facilitate sustainable and green developments in which architects often play an important role, and these include:

- The Building (Energy Efficiency) Regulation;
- The Environmental Impact Assessment Ordinance;
- The Noise Control Ordinance (covering the issue of construction noise); and
- The Waste Disposal Ordinance (covering the management of construction waste).

3. It is worth emphasizing that we have never intended to take the legislative requirements as the only reference for green and sustainable development. In fact, we are confident that our professional architects would be able to devise the optimal standards and create innovations for sustainable architecture using their sense of responsibility and professionalism. To foster the development of sustainable architecture, the Government has been working with the industry on a number of fronts, such as:

a. Publication of codes of practice and guidance notes/guidelines on energy efficiency of lighting and air conditioning installations and on housing design to abate road traffic noise, etc; as well as the issue of the Performance-based Building Energy Code;

b. Demonstration of the application of sustainable architecture: As a faithful supporter for sustainable architecture, we have been taking the lead to apply the concept to our building projects. Among the examples of

such projects are the Hong Kong Wetland Park Visitor Centre, the Sheung Shui Slaughter House and the award-winning Sheung Shui Veterinary Laboratory. These projects showcase the harmonious integration of green concepts such as energy conservation, use of renewable energy, waste reduction and water conservation, in architectural designs. In particular, the Hong Kong Wetland Park Visitor Centre was designed to fit in well with the surrounding wetland;

c. Organization of awards and recognition programs: The HK Energy Efficiency Registration Scheme for Buildings and the Hong Kong Energy Efficiency Awards organized by the Electrical and Mechanical Services Department (EMSD) are annual events to encourage the efforts of architects and other professionals in developing and applying the concept of sustainable architecture; and

d. Knowledge sharing: We pro-actively disseminate information and knowledge relating to sustainable architecture, including our showcases of green architecture projects and the directory of recycled construction products at the web-site of the Architectural Services Department and Environmental Protection Department.

The Architectural Profession Plays an Active Role

4. Regulations and supportive measures aside, innovation and initiatives of the architectural profession can also influence the environmental behavior of the community through incorporating designs and building features which are conducive to achieving our environmental objectives. To help reduce air pollution, the Environmental Protection Department has been advocating the concept of energy conservation in our daily lives and promoting public awareness of the importance of Indoor Air Quality (IAQ). There is substantial scope in architectural design to help improve our indoor air quality and reduce energy consumption through creative space planning

and building design, such as:

- Allocating the non-air-conditioned plant room locations to the external zone of a building to act as insulation buffers in screening off solar radiation;
- Use of linear building shape with suitable orientation to enhance daylight penetration;
- Use of balcony to enhance the natural lighting for a building;
- Use of external shading devices such as canopy, fin, etc as a means to control excessive solar radiation entering a building;
- Use of photo cells to switch on lighting when illumination level is low;
- Use of wind sensors to switch on fans when natural air movement is insufficient; and
- Application of Low-E laminated glass and incorporation of sunshade & canopy for glazing to minimize solar exposure.

Greening

5. Intelligent architects do not consider greening as a burden nor constraint to their designs. Instead, they have creatively utilized greening to enhance the aesthetic values of their designs as well as to achieve other purposes. Landscape architects have played an important role in softening the impacts of major infrastructural and residential developments in ecologically sensitive areas. For instance, some architects have used landscaped podium for greening and noise abatement at the same time. Some have used native species in compensatory landscaping design to enhance the harmony of their building designs with existing environment. During construction, careful measures to protect preserved trees and achieve minimal cutting of existing well-grown trees can substantially minimize the costs in compensation for tree felling.

Waste management

6. Architects can make direct and substantial

contribution in waste reduction. Recent years have seen notable progress of the architectural profession in reducing construction waste through methods like recycling old materials and using recyclable building materials. The Wetland Park Visitor Centre is one good illustration where old bricks from Mainland, granite rock paving from the boundary wall of Wanchai Police Headquarters and oyster shells from Lau Fau Shan were used in building the facility.

7. For domestic waste, it is our policy to promote source separation of domestic waste. Thanks to the extensive education and promotion programs by all parties concerned, the importance of source separation of domestic waste has now been widely recognized. As at end December 2006, 490 housing estates have already signed up to join the source separation of domestic waste programs. Up to 669,000 households and some 2,040,000 people in these estates are now participating in the programs. Yet, we need to admit that residents' participation level is still, to a certain extent, dependent on and limited by the supporting facilities available to them. For new and re-developed buildings, architects would make source separation of waste much easier if they take it as one of the daily needs of residents and allocate sufficient spaces for facilities like floor refuse storage and material recovery room.

Noise pollution

8. Hong Kong, like many other metropolitan cities, is facing severe road traffic noise problems. Residential developments are sometimes, and inevitably, close to busy traffic roads. With their creativity and wisdom, architects have been successful in devising innovative and practicable building designs for abating road traffic noise, thereby reducing noise exposure. For example, some architects have adopted the design of set back to increase the distances between traffic noise sources and receivers. Some, as mentioned before, have successfully achieved the dual

goals of greening and noise abatement by the use of landscaped podium as a shielding structure. Some have demonstrated their innovation in architectural layout and orientation by arranging noise tolerant portions of a building such as bathrooms and kitchens to face the noise sources, and by using suitable architectural fins for reducing noise.

9. Examples of how the architectural profession can assist in promoting our green policies abound. A detailed elaboration will merit a separate and long discussion. I therefore have no intention to go into details here. To put it in one simple statement, with the use of their ingenuity and the careful deliberation of environmental factors in the design stage, architects can make an environmentally-friendly life much easier to live, thereby contributing enormously to environmental protection and sustainable development.

Conclusion

10. As the citizens of the global village, it is incumbent upon us to work for the well-being of our future generations. With their tremendous influence on people's living styles, architects have a special and crucial role to play in advocating sustainable development. The architectural profession has always been our staunch partner in the promotion of sustainable architecture and the implementation of our green policies. Looking forward, I am confident that the synergy between the Government and the architectural profession will enable us to rise against future challenges.

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Designing for Thermal Comfort and Air Ventilation in High Density City Conditions - Air Ventilation Assessment System (AVAS)

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Figure 1: An urban skyline of Hong Kong.

More than 20 cities in the world are “mega” - they have more than 10 million inhabitants. High density city design is a topical issue. There is a need to deal with the scarcity of land, the need to design for a viable public transport system, and the need to re-build the community of our inner cities. High density living is increasingly an issue that planners have to confront with. (Figure 1) Hong Kong is a high density city with a population of about 7 million living in a piece of land of 1,100 square kilometres. According to Hong Kong Year Book 2004, the urban density in the most densely populated Kwun Tong District Council district could be as high as 50,910 persons per square kilometre.

The unfortunate events of Severe Acute Respiratory Syndrome (SARS) in 2003 has brought the Government and inhabitants of Hong Kong to realize that a “quality” built environment should be the aim for Hong Kong to become a “world class city that we can proudly call home”. Gradation of development height profiles; provision of breezeways; layout planning and disposition of building blocks to allow more open spaces; greater building setbacks to facilitate air movement; reduction

of development intensity; increased open space provisions especially in older districts; and more greenery, are measures to improve our built environment.

As an initiative to identify measures to improve the living environment, the Team Clean commissioned by the Chief Executive and led by the Chief Secretary proposed to examine the practicality of stipulating air ventilation assessment as one of the considerations for all major (re)development proposals and in future planning; including in particular, the standards, scope and mechanism for application of the assessment system in August 2003.

[1] As such, Planning Department, HKSAR commissioned Department of Architecture, Chinese University of Hong Kong, to undertake the “Feasibility Study for Establishment of Air Ventilation Assessment” (the “Study”) in October 2003. This paper summarises the research findings, and reports the Air Ventilation Assessment Method that has been proposed and is now adopted in Hong Kong to guide developments.

2. STUDY OBJECTIVE

The primary objective of this Study is “To explore the feasibility of establishing some protocols to assess the effects of major planning and development proposals on external air movement for achieving an acceptable macro wind environment”.

3. STUDY METHODOLOGY AND MAIN TASKS

“Find the problem, else one risks solving the wrong one”. This was the opening sentence of Prof Mat Santamouris when he was invited to be an expert reviewer during early stages of the Study. The methodology and main tasks are summarized as follows:

- (A) A desk top study of related works and study examples around the world - not just scientific investigations, but also policy measures.
- (B) A review to understand the current urban conditions of Hong Kong, and to identify issues and problems.
- (C) Explore the possibility to establish performance criteria needed for considering the impact of development on wind environment.
- (D) Define the critical issues and to explore the feasibility to develop a practical and cost effective assessment methodology.
- (E) Examine the practicality of an effective implementation mechanism, and to develop a methodology.
- (F) Establish principles and good practice for the use of professionals and practitioners in the shaping of the built environment for better wind environment.

The main roles of the planning consultant for this Study include (1) to advise on the framework for analyzing the urban fabric in relation to the planning context of Hong Kong; (2) to identify the key factors in planning terms that would have bearing on air ventilation; (3) to identify the key factors for consideration in determining the circumstances under which air ventilation assessment should be required having regard to the prevailing planning context; and (4) to advise on the implementation approaches and the corresponding implementation mechanisms.

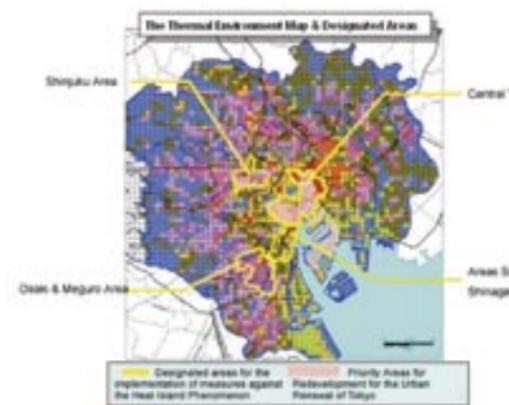


Figure 2: Tokyo Environmental Map.

4. REVIEWS

A quick survey was conducted. There are a lot of scientific studies dealing with the wind environment and modelling. [2][3][4] It was very quickly established that although many countries have codes and design guidelines for gust and strong wind problems, [5][6] few seems to have touched on the issue of urban air stagnation and city air ventilation problems. Notable exceptions are studies dealing with air pollution and dispersion [7][8], for example Prof Chris Baker's group at Birmingham University.[9][10] In Japan, The Tokyo Metropolitan Government has an Environmental Map so that designated areas for the implementation of measures could be identified and used as a guide for redevelopment projects.[11] (Figure 2)

In Germany, there is a requirement that developments should not worsen the climatic conditions of the site. Urban Climatic Maps have been produced. (Figure 3) They have been used to guide planning and development decisions. In the city of Kassel, the Climatic Map has been translated into a Planning Evaluation Map. This map further identifies possible action for planners.[12][13] Using this guiding map, which has factored the dynamic characteristics of the wind movement in the city to alleviate the adverse effects of urban heat island, planners could decide if a development might block the wind to the city, and if project proponent should be given permission, or is required to do further tests to provide justification.

The review also identified ad-hoc studies in Hong Kong dealing with the wind environment for extreme high density conditions. A study by RWDI of Canada for a client in Hong Kong as shown in Figure 4 is an example. But in Hong Kong, weak wind studies are still rare.

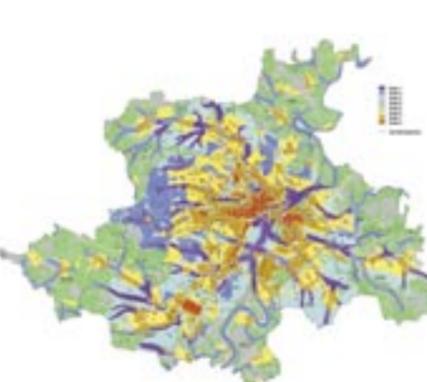


Figure 3: Planning Evaluation Map by Professor Lutz Katzschner of Kassel University.

5. REVIEW OF EXISTING CONDITIONS

To shorten the study period, the existing conditions in Hong Kong were evaluated based on expert qualitative evaluation. Professor Baruch Givoni, Professor Lutz Katzschner, Professor Shuzo Murakami, Professor Mat Santamouris, and Dr Wong Nyuk Hien were the five experts. With minor differences in opinion, the following key comments were received.

5.1 Breezeway / Air Path

As a general rule, the more air ventilation to the streets, the better it will be for these dense urban areas. The overall permeability of the district has to be increased at the ground level. This is to ensure that the prevailing wind travelling along breezeways and major roads can penetrate deep into the district. This can be achieved by proper linking of open spaces, creation of open plazas at road junctions, maintaining low-rise structures along prevailing wind direction routes (Figure 5), and widening of the minor roads connecting to major roads. Also avoid obstruction of the sea breeze. Any localised wind problem along the waterfront should be dealt with locally and not affect the overall air ventilation of the city.



Figure 4: A wind tunnel test of a high density estate in Hong Kong.

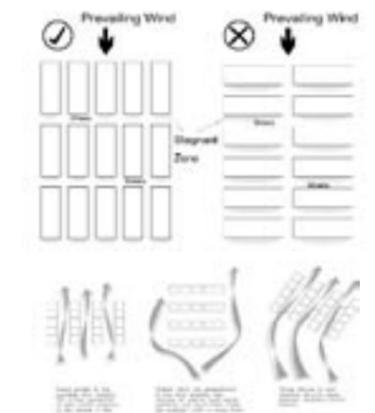


Figure 5: Aligning building blocks in parallel to the prevailing wind direction would help channel air into inner city areas.

5.2 Podium / Site Coverage

The effect of building layout (especially in terms of building site coverage) has a greater impact than that of building height on pedestrian wind environment. (Figure 6) Stepping building heights in rows would create better wind at higher levels if differences in building heights between rows are significant. The “podium” structures commonly found in Hong Kong are not desirable from the viewpoint of maximizing wind available to pedestrians. The podia with large site coverage not only block most of the wind to pedestrians (affecting comfort and air quality), but also minimize the “air volume” near the pedestrian level (affecting air quality).

5.3 Building Disposition

Proper orientation and layout of the buildings with adequate gaps between buildings are needed. (Figure 7) Stagger the arrangement of the blocks such that the blocks behind are able to receive the wind penetrating through the gaps between the blocks in the front row. In case of a new town, to avoid obstruction of the sea breeze, the axis of the buildings should be parallel to the prevailing wind. In order to maximize the wind availability to pedestrians, towers should preferably abut the podium edge that faces the main pedestrian area/street so as to enable most of the downwash wind to reach the street level.

5.4 Building Heights

Vary the heights of the blocks with decreasing heights towards the direction where the prevailing wind comes from (Figure 8). If not, it is better to have varying heights rather than similar / uniform height. Given the extremely high density of the urban fabric and narrow streets, a probable strategy for improving the air ventilation is by varying building heights for diverting winds to the lower levels. Nonetheless, assessment will be required to further quantify the actual performance of such potential in view of the common deep urban canyon situations in Hong Kong.

5.5 Building Permeability

The provision of permeability / gap nearer to the pedestrian level is far more important than that at high levels. Create permeability in the housing blocks. Try to create voids at ground level to improve ventilation for pedestrians. This will improve not only the air movement at the ground level (thus improving the pedestrian

comfort), but also help to remove the pollutants and heat generated at ground level. The channelling effect created by the void also helps to improve the ventilation performance for those residential units at the lower floors. Creation of openings in the building blocks to increase their permeability may be combined with appropriate wing walls that will contribute to pressure differences across the building facades and thus will permit the air to flow through the openings of the buildings. The wing walls have to be designed according to the known standards. For very deep canyons or very tall building blocks (Figure 9), mid-level permeability may be required to improve the ventilation performance for those occupants situated at mid-floors.

5.6 More the Better

It was in general opined that unlike most cities in the world, wind gust may not be a problem in Hong Kong. On the contrary, wind stagnation and blockage is a main problem. And for the tropical climatic conditions of Hong Kong where wind in the summer is a welcoming quantity, it was opined unanimously that “more the better” should be the guiding spirit. That is to say, designs and developments should focus on not blocking the incoming wind, as well as minimise the stagnant zones at the pedestrian levels.

6. CRITERIA - WIND FOR COMFORT

Givoni has conducted researches on outdoor comfort in two very different locations, both, like Hong Kong, are hot and humid in the summer: Japan and Israel, based on his findings, he developed formulas to predict the thermal sensation of people outdoors as a function of air temperature, solar radiation, and wind speed. According to the results of both studies, relative humidity RH has been shown to have statistically insignificant effect on comfort perception.[14][15] Based on his formulas and the meteorological data of Hong Kong, a comfort outdoor temperature chart for urban Hong Kong was developed (Figure 10). The x-axis of the chart is outdoor air temperature and y-axis is the level of solar radiation. The shaded area represents the neutral comfort region which could be obtained by a proper combination of air temperature, solar radiation and wind speed. The chart provides a rough guide to the kind of wind environment that is desirable in Hong Kong. For example, a people in shade, given high summer air temperature of 28 degree C, a gentle wind of 1.0-1.5 m/s is optimum.



Figure 6: A typical building morphology in Hong Kong: tower blocks sitting on a podium that occupies the entire site. When podiums are very close together, they significantly reduce the air space at pedestrian levels.



Figure 7: Tall buildings too closely pack together creating an 'effective' wind block to the city behind.

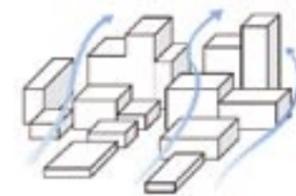
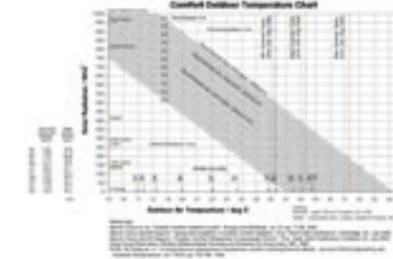


Figure 8: Appropriate variation in building height would help alleviate 'canyon effect'.



Figure 9: Parallel rows of tall building blocks with narrow gaps in-between inhibit natural air ventilation.

Based on an examination of wind data in the urban areas of Hong Kong, a mean roof top (approximately 50m above ground) wind of some 2.5 m/s could be expected. As such, one immediately sees the need for the planning of the city to optimise this wind availability so that at pedestrian level of 2m above ground, wind can be available.



7. AIR VENTILATION ASSESSMENT (AVA)

A key objective of the Study is not scientific, but to try to find an objective protocol and methodology to guide planning practice. Planners have control of a number of design parameters. For example, site coverage,

building bulk, building alignment and deposition and so on. Fundamentally, it is important to ensure that buildings and their planning do not block the ambient mechanical wind. Localised thermal wind is therefore a relatively minor consideration from a practical planning point of view.

Wind Velocity Ratio (VR) is used as an indicator. V_8 is the wind velocity at the top of the wind boundary layer not affected by the ground roughness, buildings and local site features (typically assumed to be a certain height above the roof tops of the city centre and is site dependent). V_p is the wind velocity at the pedestrian level (2m above ground) after taking into account the effects of buildings. (see diagram below) V_p / V_8 is the Wind Velocity Ratio (VRw) that indicates how much of the wind availability of a location could be experienced and enjoyed by pedestrians on ground taking into account the surrounding buildings. As VRw is solely affected by the buildings of the location, it is a simple indicator one might use to assess the effects of proposals. The higher the value of VRw, the lesser the impact of buildings on wind availability. (Figure 11 and 12)

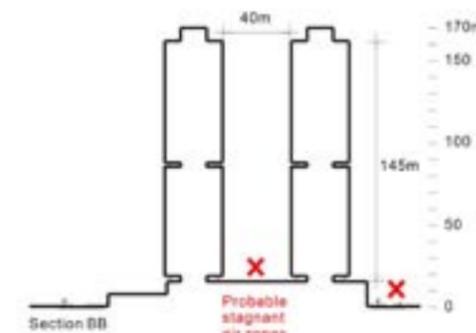


Figure 10: Comfort chart based on researches of Professor B Givoni and Hong Kong meteorological data.

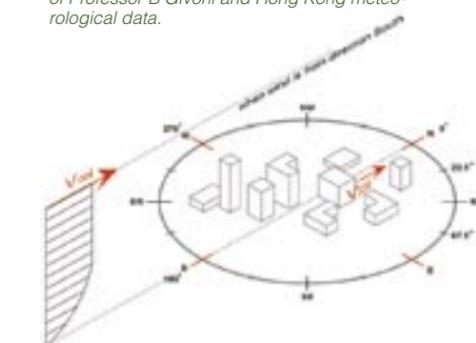


Figure 12: 18 directions are factored. The VR of each direction will then be factored with wind coming from that direction.

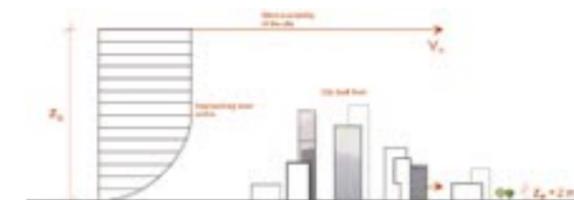


Figure 11: The concept of VR. Using VR, it is possible to factor the effects of developments to the wind environment.

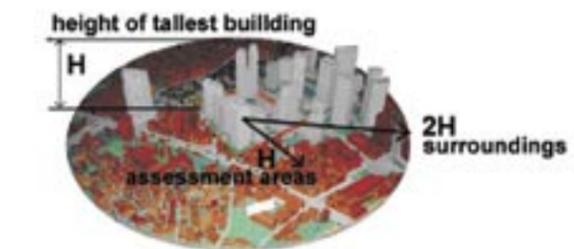


Figure 13: The assessment area and the surrounding area defined by the height of buildings on site.

the test site and evenly distributed. Test points must be planted at the junctions of all roads leading to the test site, at corners, as well as at the main entrances of the test site. This set of test points will be known as Perimeter Test Points. They will later provide data to calculate the Site Spatial Average Wind Velocity Ratio (SVRw). This gives a hint of how the development proposal impacts the wind environment of its immediate vicinity.

Test points should also be evenly distributed over the assessment area of the model. For detailed study, one test point per 200 to 300 square metres of the assessment area would typically suffice, except when doing rough initial study, or when the site condition is simpler. Test points should be positioned where pedestrians can or will mostly access. This may include pavement, open spaces, piazzas, concourses and so on, but exclude back-lanes or minor alleyways. For streets, the tests point should be located on their centerlines. Some of the test points must be located at major entrances, as well as identified areas where people are known to congregate. This group of test points will be known as Overall Test Points, together with the Perimeter Test Points, will provide data to calculate the Local Spatial Average Wind Velocity Ratio (LVRw). This gives a hint of how the development proposal impacts the wind environment of the local area.

8. IMPLEMENTATION

In view of the time required for further scientific researches on different aspects of the urban climate and its correlation with urban geometry, the Study recommends that AVA be implemented in four key stages. The key stages and their corresponding timeframe are illustrated in the following figure. These four stages are not sequential and may be carried out concurrently but the durations are different.

8.1 Stage A - Performance-based Evaluation (without benchmark standards)

The implementation of an AVA system would depend on how robust the AVA system is and how important AVA is considered by the decision makers amongst all factors in the consideration of development proposals. Based on the Study findings, it could only recommend an advisory AVA system at this stage. If AVA were to be introduced as mandatory, then it will have to go through a much more lengthy process of testing and validation, and when a more definitive local benchmark standard could be established.

The Study recommends that the AVA system can be implemented in stages, taking into

	Year 1	Year 2	Year 3	Year 4
Stage A - Performance-based Evaluation with Technical Brief but without Benchmark Standards Establishment of a generic framework and methodology for AVA to enable objective comparison between different design options and formulation of qualitative urban design guidelines.		Immediately		

	Year 1	Year 2	Year 3	Year 4
Stage B - Urban Climatic Mapping Identification of climatically problematic/sensitive areas that require particular attention or in need of planning and design interventions.		1-2year		
Stage C -Performance-based Evaluation with Technical Specifications and Benchmark Standards Establishment of a set of objective assessment standards and criteria for AVA.		2-3year		
Stage D - Quantitative Guidelines Formulation of quantitative design guidelines to enable the practitioners to grasp the basic and most important design requirements for a well-ventilated urban environment at an early design stage.		2-4year		

account the time needed for building up the necessary data and information and the degree of robustness expected for the AVA system.

At the initial stage (Stage A) when the “Urban Climatic Map” and benchmarking are not yet available, the Government/ quasi-government organizations are still encouraged to undertake AVA where practicable under any one of the following circumstances:

- Preparation of new town plans and major revision of such plans.
- Development that deviates from the statutory development restriction(s) other than minor relaxations.
- Erection of building structure within a designated breezeway.
- Urban renewal development that involves agglomeration of sites together with closure and building over of existing streets.
- Development with shielding effect on waterfront, particularly in confined airsheds.
- Large-scale development with a high density, e.g. site area over 2 hectares and an overall plot ratio of 5 or above, development with a total GFA of 100,000 sq.m. or above.
- Massive elevated structures over a road in the dense urban areas.

- For developments situated in an exposed location where there is no apparent shielding from the approaching wind, an assessment of the potential occurrence of windy conditions that may affect the safety of pedestrians should also be included.

It is recommended that AVA be carried out for different design options to identify better design scenarios and potential problem areas, based on velocity ratio as an indicator. A design having a higher velocity ratio would be considered as a better design than one having a lower velocity ratio. At this stage, only the better design option is known but whether the better design option meets a standard cannot be known due to the lack of benchmarking. The aim is to move “towards a better future” rather than for precision.

The proponents initiating the proposals should be responsible for conducting, overseeing and self-appraising the AVA.

As for private projects, AVA should also be encouraged as good practice guide at the initial stage. To encourage the private project proponents to carry out AVA, incentives may be provided through performance labeling scheme.

It is considered appropriate that the qualitative guidelines and the need for AVA be promulgated through revision to the Hong Kong Planning Standards and Guidelines (HKPSG). It should be noted that some of the qualitative guidelines recommended in this Study for better air ventilation in the city are already included in Chapter 11 of the HKPSG, and hence, they only reinforce or complement the existing guidelines. The approach to the AVA system recommended in this Study is only a facilitating tool but not the primary decision making tool.

8.2 Stage B - Urban Climatic Map

This stage would involve the preparation of an urban climatic map for Hong Kong. It would involve collating relevant data on meteorology, topography, urban fabric, land use pattern etc. of Hong Kong. The resultant urban climatic map would identify the areas which are more in need of attention and improvements from an air ventilation perspective, e.g. highlighting locations poor in wind circulation or sensitive to wind variation, and where important breezeways and open spaces should be protected or reserved.

8.3 Stage C - Performance-based Evaluation (with benchmark standards)

This stage will establish the existing general wind performance condition of Hong Kong. This would serve as a local benchmark standard that major projects should try to achieve, if possible, for optimum wind performance. This would allow direct comparison of air ventilation performance against known benchmark criteria, rather than revealing only the better or worse of design options (as in Stage A). The criteria established would provide a clear yardstick for evaluation of development projects where air ventilation is a major concern and the projects have to be justified through the existing institutional framework (such as town planning, land grant/ lease and building control and/or environmental impact assessment). Technical specifications for conducting AVA would need to be prepared to ensure no dispute in the AVA requirements and vetting process.

8.4 Stage D - Quantitative Guidelines

This stage would develop quantitative design guidelines to facilitate early designs of development proposals. Projects are assessed against pre-set design criteria, design parameters, ratios or indices concerning developments, such as site / district openness and building mass geometry (street width to building height ratio, variation in building height within site, permeability of the building facade etc.). These quantitative design guidelines have to be derived through iterative empirical tests by varying different design scenarios and assumed conditions to validate their magnitudes of impact on the wind environment.

Quantitative guidelines can be in the form of simple ratios, indexes. When applied, development proposals would be deemed to satisfy air ventilation requirements without the need to go through the testing process.

For example: An air path or air paths along the direction of the prevailing wind should be provided on site equal to 25% of the site area. And For example (above): An Openness Index could be speculated to guide the needs for open space, set back, as well as air channels and paths. Development schemes that are designed in accordance with the quantitative design guidelines would be deemed to satisfy air ventilation requirements, without the need to go through the performance based AVA testing. This would be less time consuming and more cost-effective, as compared to the performance based approach which the performance can only be tested after the design is generated.



At the completion of Stages B, C and /or D, a widely accepted assessment method and a set of definitive assessment standards and criteria could be established in detail. It would then enable the Government to ascertain the types

of project/circumstances that should warrant an AVA. With definitive assessment standards/ criteria and the availability of an urban climatic map, it would provide a stronger case for more extensive application to private projects, and for consideration of a regulatory approach, if necessary.

9. QUALITATIVE URBAN DESIGN GUIDELINES

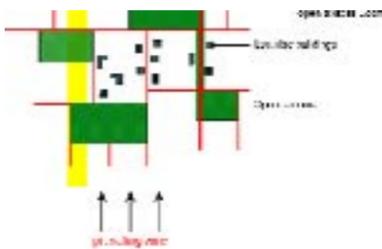
Before further stages of AVA are developed, based on the advice of international experts, the following design guidelines provide useful design reference for better air ventilation. The qualitative guidelines also provide designers with a strategic sense of how to start off their design initially.

By observing the guidelines, there would be a higher probability that the resultant design would be better for the wind environment. This could then later be confirmed with the Air Ventilation Assessment tests, if necessary.



Breezeway / Air path

It is important for better urban air ventilation in a dense, hot-humid city to let more wind penetrate through the urban district. Breezeways can be in forms of roads, open spaces and low-rise building corridors through which air reaches inner parts of urbanised areas largely occupied by high-rise buildings. Projecting obstructions over breezeways/air paths should be avoided to minimize wind blockage.

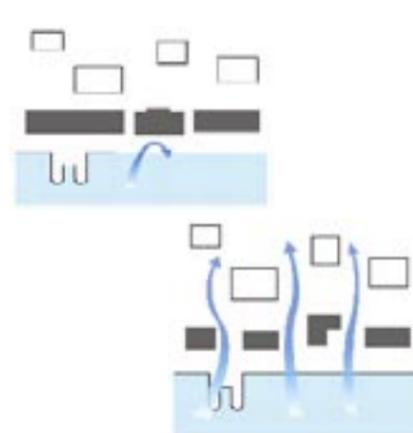


Orientation of Street Grids

An array of main streets, wide main avenues and/or breezeways should be aligned in parallel, or up to 30 degrees to the prevailing wind direction, in order to maximize the penetration of prevailing wind through the district.

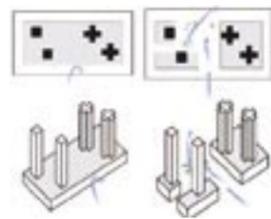
Linkage of Open Spaces

Where possible, open spaces may be linked and aligned in such a way to form breezeways or ventilation corridors. Structures along breezeways/ventilation corridors should be low-rise.



Waterfront Sites

Waterfront sites are the gateways of sea breezes and land breezes due to the sea cooling and sun warming effects. Buildings along the waterfront should avoid blockage of sea/land breezes and prevailing winds.

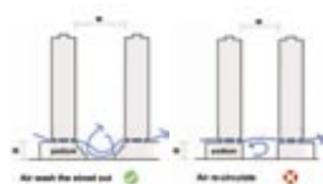


Non-building Area

The tendency for many developments to maximize views to certain direction and site development potential often results in congested building masses and minimum spaces between buildings to meet Building (Planning) Regulations. Large sites with compact developments are particularly impeding air movement. Development plots should be laid out and orientated to maximize air penetration by aligning the longer frontage in parallel to the wind direction and by introducing non-building areas and setbacks where appropriate.

Building Heights

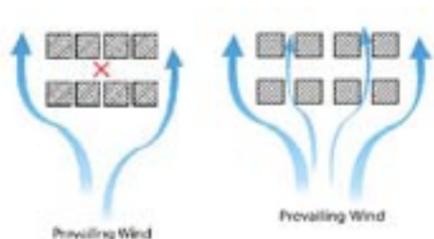
Height variation should be considered as much as possible with the principle that the height decreases towards the direction where prevailing wind comes from. The stepped height concept can help optimize the wind capturing potential of the development itself.



Scale of Podium

The 100% site coverage for non-domestic part of developments up to some 15m high as permitted under the Building (Planning) Regulations often results in large podiums. For

large development/ redevelopment sites particularly in the existing urban areas, it would be critical to increase permeability of the podium structure at the street levels by providing some ventilation corridors or setback in parallel to the prevailing wind. Where appropriate, a terraced podium design should be adopted to direct downward airflow, which can help enhance air movement at the pedestrian level and disperse the pollutants emitted by vehicles.



Building Disposition

Where practicable, adequately wide gaps should be provided between building blocks to maximize the air permeability of the development and minimize its impact on wind capturing potential of adjacent developments. The gaps for enhancing air permeability are preferably at a face perpendicular to the prevailing wind. Towers should preferably abut the podium edge that faces the concerned pedestrian area/street so as to enable most of the downwash wind to reach the street level.



Shading and greenery

Tall trees with wide and dense canopy should be planted along streets / entrance plazas/ setback areas for maximizing pedestrian comfort - reducing urban heat island effect, blockage to air movements at the pedestrian level by additional planting should be avoided.

Cool materials

Use of cool materials in the pavements and building facades to decrease absorption of solar radiation. Cool materials are characterized by high solar reflectivity and if possible by a high level of emission. For

streets, the use of asphalt with a high percentage of white aggregates should be considered. A large water body can also serve as a cool sink.

Horizontal Projections

Vertical Projections

Projecting obstructions

Massive projecting obstructions, such as elevated walkways, may adversely affect the wind environment at pedestrian level, as observed in Mongkok.

Signage is preferably of the vertical type in order to minimize wind blockage, particularly in those areas with a high density of projecting signs over streets.

10. CONCLUSION

The study recommendation and proposed implementation actions echo with one of the key initiatives proposed in "A First Sustainable Development Strategy for Hong Kong" promulgated by the Office of the Chief Secretary for Administration in June 2005, that is, to promote sustainable urban planning and design practices.

The Study opines that there is a need to find ways to improve air ventilation and the pedestrian wind environment of our city. Given Hong Kong's dense urban conditions, wind is beneficial. In general, the more wind the better.

Velocity Ratio has been proposed to be the indicator for Air Ventilation Assessment. This would provide an objective basis for evaluating and comparing design options.

The "Technical Guide for Air Ventilation Assessment for Developments in Hong Kong" proposed by the Study allows design options to be compared on a scientific and objective basis with respect to the effect on air ventilation. An advisory approach to implementation with the government taking a lead is recommended. A technical circular setting out the guidance for applying air ventilation assessments to major government projects was promulgated in July 2006. In addition, Chapter 11 of HKPSG on urban design guidelines was expanded to incorporate guidelines on air ventilation based on the recommendations of this Study in August 2006.

The AVA study is unique and highly original. As such one must regard it as a first step in the direction of understanding the wind environment. For more understanding of the problems, further studies and researches are essential and strongly recommended, namely: Stage B - Urban Climatic Map, Stage C - Benchmarking, and Stage D - Quantitative Guidelines. Stage B and C studies have just been commenced in August 2006. The study is scheduled to complete July 2009.

Last but not least, improving air ventilation for a better wind environment is only one of the many considerations towards sustainable development in Hong Kong. In planning, one must attempt to balance other equally if not more important considerations and as far as possible synergize needs to result in an optimized design.

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WANCHAI 2010: TOWARDS A SUSTAINABLE URBAN TRANSFORMATION

James Charles Bermejo Acuna

James is a Design Architect from the United States practicing in Hong Kong. He is currently pursuing research work on Manila Micro-Urban Developments and writes about Interiors and Travel for a local lifestyle publication.

URBAN ENVIRONMENTAL DEGRADATION

Within the last few years Hong Kong has been following the general consciousness shared by most world class cities in its attitudes towards generating an overall sustainable urban environment. Google-search “sustainable Hong Kong” and chances are several websites from either private-sector organizations, like the HKSDP (Hong Kong Sustainable Development Forum) to public-interest groups like Hong Kong People’s Council for Sustainable Development will appear. Most issues raised within each group are similar and everyone is trying to find the right solutions towards a more holistic and cooperative urban development. For example, air pollution and how to alleviate it has been by far the most important topic of concern. Besides the obvious health issues, the visual impact is particularly striking especially for most tourists who are straining their eyes to get a view of the Hong Kong skyline as a whole through a thick cloud of “urban fog”. While many contributors to this “urban fog”, like factory emissions from China are seemingly out of our control, the most pressing problem for most city dwellers are the accumulation of pollutants emitted by vehicles that get trapped in areas in and around Hong Kong where high density pedestrian zones exist.

Another major cause of urban environmental degradation is the Hong Kong attitude towards waste, most specifically building waste disposal. While a few builders are gradually working towards a more efficient zero-waste construction approach, there is still the issue of waste accumulated through demolition, and the choice of materials and method of construction which should minimize further building waste disposal in the future. In an ever evolving city like Hong Kong, the issue of a building material as waste and its life-cycles are very important in gauging the “greenness” of new development methods. According to Angela Tam, author of “Sustainable building in Hong Kong: the past, present and future”, 99% of all building materials are reusable and/or

recyclable. The most common materials that can be recycled are aluminum air ducts, steel, and lighting boxes. Other materials such as concrete, bricks and other aggregates can be used for paving or creating decorative walls.

A better approach of reuse and recycle would be no demolition at all but a program retrofit, especially appropriate for older cities like Hong Kong with plenty of architectural history. Transformations could be small-scale, like the preservation of old Chinese buildings, or have a larger impact, like the new headquarters of the Electrical and Mechanical Services Department (EMSD) which was born out of an old air-cargo terminal in Kowloon Bay. If new buildings have to be constructed, the Chater House in Central is a great example, then it would be best to make of use of the latest in prefabricated technology to construct facades and internal architectural features off site with a great degree of precision, in order to minimize waste in construction as well as its own re-appropriation or reuse.

SUSTAINABLE URBAN ENVIRONMENTS CAN DEVELOP

So does Hong Kong have a greener future ahead? Fortunately with the possibility of two environmental assessment schemes to help rate the greening of new construction, with HK-BEAM (Hong Kong Building Environmental Assessment Method) and the CEPAS (the Comprehensive Environmental Performance Assessment Scheme), theory will move aggressively forward into common practice. Besides working towards greener building methods, green developments can occur within already existing neighborhoods.

There is a possibility for more holistic sustainable developments to be made off of current Urban Renewal Authority projects, with the most controversial of them being the future re-development of Lee Tung Street in Wanchai. Existing post-war buildings on that street may not meet the criteria for preservation but in order to reduce construction waste

and to reinforce architectural heritage in the upper Wanchai area, transforming Lee Tung Street into a modern tourists and community attraction may be the key to spur Sustainable development within a larger existing context. Historically, Wanchai has always been a very integral business hub for Hong Kong. Today, upper-Wanchai and Queen’s Road East, a major link between Causeway Bay and Central, is home to several important offices of Government, non-Government, and private business institutions.

The Urban Renewal Authority aims to upgrade the areas around key business centers, with new towers, new residences, and a new indoor air-conditioned food market which will eventually transform the Wanchai of history into something perhaps generic and ordinary. A holistic sustainable urban development would take account the tree players of sustainability: the environmental, the social, and the economic, as a driving precedence for a new development concept. Lee Tung Street is a perfect canvas for a future case study for sustainability because all the elements already exist. A design focus on sustainability for this neighborhood is not quite as innovative or revolutionary as it is just plain common sense.

To alleviate further micro-climactic pollution of the area, the street should be pedestrian oriented and vehicle-free. Presently, there are plenty of streets around north-Wanchai that are vehicle-free. This is nothing new. If it were to be implemented, one of the major blows to social and community culture would be the demolition of open-air food markets in and around Cross Street due to the emergence of a new-indoor Wanchai Market within the same area. An existing open air street market also exists on Gresson Street towards Admiralty. These street markets actually alleviate traffic pollution and invigorate social and communal interaction among residents of the area and their visitors. The reduction of vehicular traffic (which contributes to the reduction of vehicular noise and emissions) and the solidification of a sustainable market community are major systems within an ideal sustainable urban environment. If the city builds and plans for

vehicles, then the area will only be inviting more vehicles. If the city builds and plans for more pedestrians, then more pedestrians will make use of these environments.

In order to reduce the impact of building waste, planners, designers, engineers, and developers must be serious about the conservation of most existing building structures and architectures on the site. There have been many successful re-appropriation projects in Europe and even Mainland China of existing structures as residential/business lofts, studios, restaurants, and shopping areas, and Lee Tung Street has the advantage and the opportunity for that kind of enlightened development. Additionally, old building parts can be reused and retrofitted into the project in many other ways. Products and materials used can either be recycled from site or be fitted with one of the thousands of newly recycled building products currently available on the market.

As for Economic sustainability, the incorporation of local and community oriented businesses should be considered when renting out spaces. It’s about time more art-based and local designer oriented trades like furniture and fashion get focus and frontage here in Hong Kong as they do in cities like Beijing and Shanghai. With Queen’s road east as an interior design sourcing street and Start Street as a gallery destination, Lee Tung Street as a commercial, art-based, and open-air market destination may be a way to generate a new kind of economy that is produced and sold in a self-sustaining way for that specific area. If one were to look at the self-sustaining 798 Artist’s Compound in Beijing, generating a micro-economy rooted in Art not only benefits community and tourism, but overall urban culture as well. This is a program not borne out of number crunching but a basic environmental, social, and economic need with plenty of long-term rewards for Wanchai and the future of urban sustainable development as a whole. Now that we have the ideas and the education at our hands, all we need now is the essential willpower of the city of Hong Kong to help make these changes a reality.



Artist Video Installations on the surfaces of vacated post-war buildings on Lee Tung Street.

What (really) Matters for the Planning for a Sustainable Community?

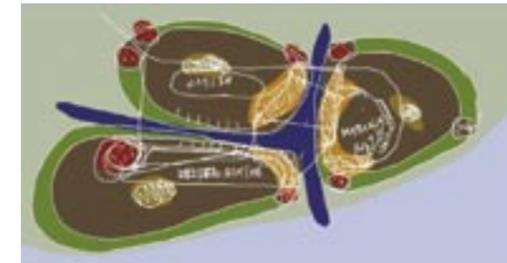
The Case of the Dongtan, Shanghai



Shanghai Dongtan Eco-city



Two of villages in harmony with nature



Three Communities in Phase One



Landscape and Open Space

Sustainable Communities – How Sustainable are they?

Over the last 5 years, one sees the surging trends around the world to apply sustainable planning and design principles in the building of new communities. Hence one also finds numerous planning projects coined ‘sustainable communities’, ‘eco-towns’, ‘eco-cities’, etc. This phenomenon is particularly marked in China where the rate of urbanization has led to an unprecedented number of new communities being planned on the drawing boards.

Yet a close assessment of these projects points out that most of these ‘sustainable’ development projects have been, unfortunately, planned based on superficial understanding of the city activity systems and with minimal technical knowledge on the consumption of our global resources. Design ideas are toyed around physical forms, massing and locations of the various components of the built environment --- and yet with little, if any, reference made to how the planned communities would demand the use of our scarce resources in terms of energy, food, water, clean air, etc. Neither are much comments made in these plans on how the waste generated out of urban development should best be managed and how energy be conserved.

One must understand that sustainability design is only the means, and the end is to plan the communities in order to conserve our global resources in a sustainable manner. Therefore, what matters first is the understanding of the life cycle processes of how the new communities function (including the lifestyles, the behaviours, and the ways the economic and social environment systems work in integration). It is only we have the right approach to understand and change the ways the communities function that we can start to seriously assess how sustainable they will be.

Dongtan, Shanghai --- Where the Vision Begins ...

Arup, the global planning, engineering and design consultancy, has been commissioned by Shanghai Industrial Investment Corporation (SIIC) to plan the world’s first sustainable city – an eco-city – at Dongtan, in Shanghai, China. SIIC has appointed Arup as a strategic partner to work with them in the development of Dongtan as a dynamic, livable and eco-friendly city, which will in turn define the future of sustainable urban development in China and beyond.

The approach to integrated sustainable urban planning and design will help to turn SIIC’s vision into reality and will create a city with lower energy consumption and one which is as close to being carbon neutral as possible within economic constraints. The project starts with the primary objective to effect changes to how our urban systems should (and could) functions to be sustainable.

The project is located at the southern end of Chongming Island at the northern side of Shanghai. Dongtan is situated in an extremely strategic position very close to Shanghai and on the third largest island in China, situated at the mouth of the Yangtze River. Dongtan is three quarters the size of Manhattan and will be developed as a sustainable city to attract a whole range of commercial and leisure investments. It will be a city where people will be able to live and work in a high quality environment. The intention is to evolve Arup’s sustainable urban design and planning into a blueprint for the future planning of Chinese cities.

Dongtan is currently a large area of mostly agricultural land which has been earmarked by the Mayor of Shanghai and the Chinese Premier as the site of China’s first sustainable eco city. A high quality road infrastructure is currently being built that connects Dongtan to the Shanghai mainland.

The Planning Principles - Sustainable Use and ‘Non-use’ of our Scarce Energy

The first phase of Dongtan is planned to be completed by 2010 when the Expo will be held in Shanghai. This phase will include a wide range of developments with urban parks, ecological parks and world class leisure facilities.

An outline of the resource management principles and highlights of the unique aspects of the energy planning process are summarized below:

- Incorporate the process of capturing and purifying water in the landscape to support life in the city
- Community waste management recycling will generate clean energy from organic waste, reducing landfills that damage the environment
- Combined heat and power systems will provide the technology to source clean and reliable energy
- Dongtan will be energy self-sufficient, with all its transport, residential and commercial buildings powered by a combination of wind, sun and other renewable energy sources.
- Electric and hydrogen-cell cars will be the main forms of transport on the island site.
- In principle, Dongtan will also be self-sufficient in food, with Chongming’s farmers encouraged to use organic agricultural methods where possible.
- Up to 80% of solid waste is recycled. Organic waste is burned in an incinerator, catering for part of the town’s electricity requirements.

- Other burners consume rice husks, which produce a lot of heat and are plentiful in China. On the outskirts giant windmills, driven by the sea breeze, produce electricity too. Each building is fitted with photovoltaic panels and its own, smaller windmill.

From Eco-Footprint to the Master Plan

The project team applied the Eco-footprint model to assess and compare the various master plan options in terms of their overall consumption of the global resources. The Eco-footprinting approach has been well established and the project could compare the demand on the global resources by the new Dongtan against other cities around the world.

Eco-footprint is: “the area of productive land and sea (on our globe) needed to provide a given quantity of energy, food and materials for a defined population in a given land mass, and the area of land required to absorb the emissions”. While urban Shanghai demands 5.83 global hectare per capita, and Houston needs more than 12 global hectare per capita, in Dongtan, the target is to reduce that consumption to below 2.8 global hectares per capita. The eco-footprint modeling has provided a scientific and objective way to assess the scale of the development and the level of resources consumption associated with it.

The scale of the project proposes an initial ‘demonstrator’ habitation for 60,000 people to be built by 2010, when Shanghai will become the centre of world business attention, with its 2010 Expo. This is projected to rise to 500,000 by 2040.

The Phase One demonstration project includes three ‘villages’ each with its village centres and social infrastructure. An open space system that encourages pedestrian and an efficient public transportation network

are incorporated into the urban fabric. To respect the original cultural heritage of the rural arable communities, the open spaces and parks hierarchy is planned to reflect the traditional land parcel configurations. All the public facilities and work places are located to maximize walking and reduce use of car.

The Total Sustainability Solution

What has been clearly demonstrated in the Dongtan project is the fact that to be serious about planning for sustainable communities, the owners and the professionals must adopt a ‘total solution’. This means one must look at the physical design in the light of the consumption of the resources; and look at the consumption of resources from an understanding of the way our cities functions; and manage both the intangibles (the lifestyle, ways of use of energy, behaviours) as well as the tangibles (the form, mass and shape) of the subject city to achieve sustainability. That is what (really) matters.

Stanley C T Yip, FHKIP, RTP, CIP, MLI
Director, Planning & Development, Arup China

Green Design for Sports Facility: Fukien Secondary School Swimming Pool

The design of The Fukien Secondary School new sports facility at Kwun Tong represents a fruitful attempt of Green design approach for a low-energy, high comfort and environmental-sustainable sports facility for the future. Research team from HKU led by Prof. Stephen Lau and Prof. Yuguo Li from the architecture and mechanical engineering departments, respectively, work closely with the design team adhering to an integrated design process (IDP). There are several sustainable design technologies.

Passive daylighting design: light pipe system

The light pipe system directs daylight into the interior, to reduce energy consumption by artificial lighting. The design combines Anidolic¹ (Scartezini & Courret 2002, Lau & Baharuddin, 2006) daylight theory projection for interior space with solar geometry and light pipe. By making use of daylight design software, predictive and visual results are able to be generated.

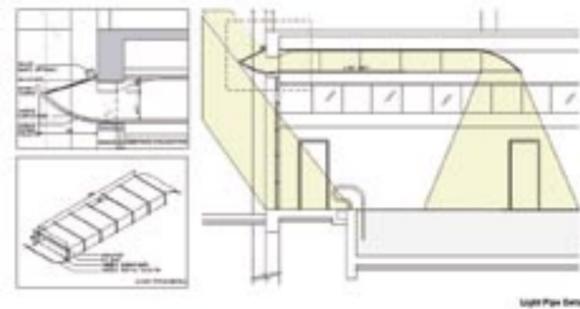


fig 1 Light pipe details

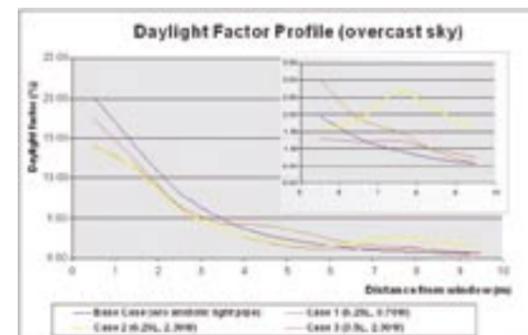


fig 2 Comparison of Simulated daylight factor distribution of light pipes

Once the local sun-path is tracked, it is then possible to introduce PASALI (Hopkinson & Kay, 1972) design that integrates natural and artificial lighting by means of electronic (dimming) control system and light sensors.

The proposed swimming pool complex will offer a unique opportunity to demonstrate the use of advanced daylight enhancement system such as light pipes. The proposed installation shall include the installation of 6 light-reflecting pipes to bring light down into the teaching space below. Light sensors will be installed to gauge daylight performance and operate electric lighting for energy saving purpose.

Based on a simulation study² using Ecotect and Radiance, drawing on data from Hong Kong Observatory, it is concluded that the benefit of Anidolic light pipes include reduction of artificial lighting energy requirement by about 19% compared to the window system; improve the illuminance uniformity by 3.3 times of the window system; reduce heat gains produced by artificial lighting system; reduce the illuminance near the window by 30%, benefits for glare protection; reduce environmental impact by lowering the use of electricity produce from fossil fuels; suitable for the location that is dominated by overcast sky conditions like Hong Kong. Anidolic light pipes require higher initial cost for construction of the system, but require no maintenance cost. Therefore, even though the initial cost for constructing this system is higher, its underlying benefits should make it feasible for most deep interior spaces.

Natural Ventilation using solar chimney

In contrast with the conventional design based on a fully air-conditioning approach, our energy-saving and environmental-friendly design incorporates passive energy strategy to facilitate natural ventilation in the swimming pool hall. A CFD (Computational Fluid Dynamics) analysis is carried out to help to

integrate the combined use of solar chimney that operates on stack effect, and mechanical ventilation operated by humidity sensor.

The CFD simulation is an effective tool for designers to visualize thermal performance under simulated scenarios. In this design, The CFD software Flovent was used to investigate the air flow pattern, temperature and relative humidity distribution in the pool hall under conditions of different natural winds, with the inlet wind speed of 3 m/s, 0.2m/s, and 0m/s respectively. Under the condition of no natural wind and operated fans, the "chimney effect" was investigated separately to evaluate the ability of buoyancy ventilation. It can be seen from the graphic simulation outcomes that with the solar chimney, air movement is improved by the buoyancy effect.

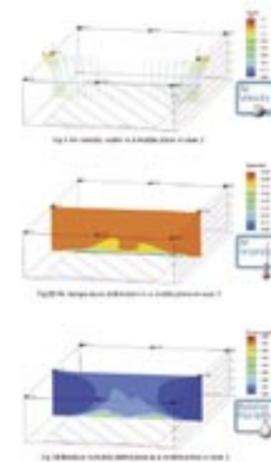


fig 5 CFD Study of environmental performance of swimming pool without solar chimneys

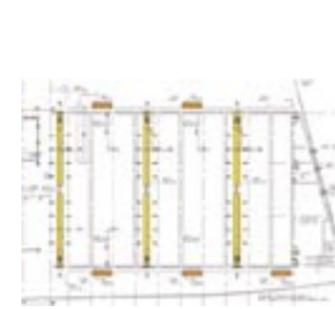


fig 3 The plan showing the solar chimney and the Fans & Dampers control system

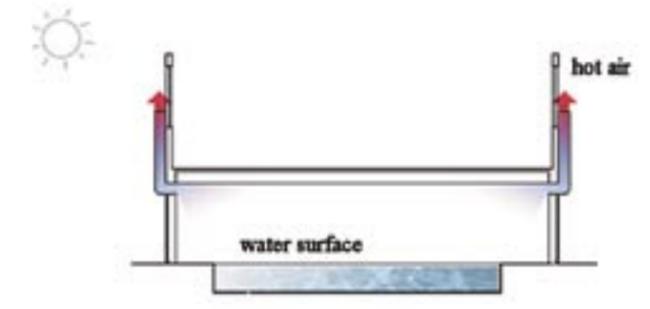


fig 4 Section showing the solar chimney

With the aid of the simulation tool, a solid understanding and knowledge on the applicability of passive ventilation strategy - solar chimneys in deep plan sports facilities design was achieved. Since the passive system consumes no electricity in use, buildings using it could save a considerable amount of non-renewable energy during their operation compared with a counterpart with conventional centralized air conditioning system.

Refinement of mechanical extract system

The third feature is the refinement of the mechanical extract system for the changing rooms in response to potential health threats experienced during the 2003 SARS incidents. The designers insist on relocating the extract ducting to be immediate next to the washroom utensils so that foul air could be extracted

at source opposed to ceiling extractors in a traditional layout. This is deemed an important statement for maintaining sustainability in an architectural design.

Renewable energy

The fourth feature is the introduction of renewable energy facility for demonstrative and education purpose. Due to limited space, the designers could only find restricted locations for installing photovoltaic panels on the roof and incorporation of data display installation for demonstrative purpose and educational applications.

Last but not the least feature is the use of 'green tile', a proprietary external facing tiles that is designed to be self cleansing and pollutant-free.

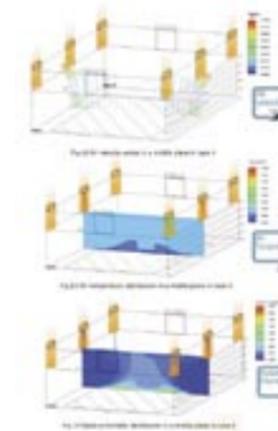


fig 6 CFD Study of environmental performance of swimming pool with the chimney effect

¹ Anidolic (An: without, eidolon: image in ancient Greek) systems refer to the daylighting systems that apply non-imaging optics principles to the design of new reflectors.

² The research project is a part of the Integrated Design Process whereby researchers provided quantitative data for the building services engineers' evaluation of the performance of the sustainable design features.

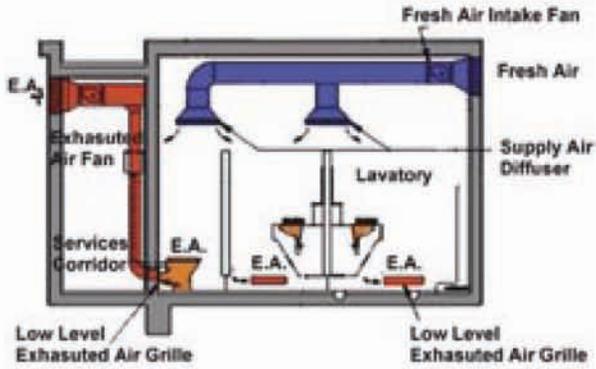


fig7-Air supplied from ceiling and exhausted from low level



fig8-Air exhaust grille within each cubicle

The entire design process is documented for the university team as educational seminars for educating the school students as well as teachers. This is considered the most important contribution for the education of young people, to bring them closer to sustainability consideration.

Everything in this project will serve an educational purpose to educate its users, visitors and operators to represent its collective efforts towards a lesser CO₂ emission, and lesser non-renewable energy consumption. It is also used as an applied research, combining the best of academic researchers and that of the professionals.

Conclusion

As it was commented³, the Fukien Swimming pool hall design "is a modest project but with

unprecedented planning/design efforts in integrating natural ventilation with mechanical ventilation and natural lighting for an indoor swimming pool facility towards energy conservation and sustainability." The project represents an integrated design process to achieve a "small efforts but big impact".

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- 3) Scartezzini, J.L. and G. Courret 2002, Anidolic Daylighting Systems, Solar Energy, 73 (2), p123-135

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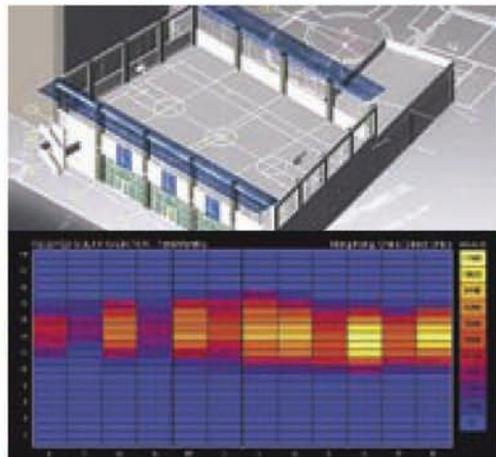


fig9c-Total monthly solar exposure for flat panels , Hong Kong, China(Direct radiation only, using Ecotect software and Hong Kong Observatory data

MONTH	GLOBAL (kWh/m ²)	AVERAGE SHADE	COLLECTED (kWh/m ²)	TOTAL (kWh/m ²) For 45m ²
January	89.7	23%	24.1	1083.99
February	68.1	36%	15.2	683.26
March	128.8	18%	42.7	1920.38
April	94.0	26%	23.1	1040.33
May	143.3	17%	48.2	2168.28
June	134.6	22%	39.3	1766.86
July	176.1	14%	61.9	2785.37
August	167.6	13%	61.0	2746.64
September	129.5	16%	41.8	1879.32
October	168.9	11%	67.7	3046.74
November	122.3	18%	41.5	1869.64
December	150.2	6%	55.9	2517.15
TOTAL	1573.1		522.4	23507.96

³ Jury's Citation, GBA 2006 Research and Planning Studies Category, HKGBC, Green Building Award 2006, p.62
⁴ Ibid, p.62