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ARCHITECTURE'S NEGOTIATING CAPACITY
Investigating the interface between high-performance building envelopes and planning standards in Hong Kong

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Abstract
This paper aims to demonstrate that high-performance building envelopes can improve both the ventilation of urban space and the revenue of real estate industry, and will investigate how such improvements can be used to negotiate between objective and regulation in planning standards. Building on the observations made by architecture and other related disciplines, that planning standards often fail to meet their own objectives, this paper addresses a research site with a small public open space in Mong Kok, Hong Kong, to contextualize design research at the interface between high-performance building envelopes and planning standards. Escalating property values catalyse high redevelopment pressure in Mong Kok. Due to amended planning standards, architecture in the vicinity is successively replaced by grander development. If the building mass is maximized in concurrence with amended planning standards, it will obstruct the climatological conditions of light and ventilation, and thus diminish the performance of the small public open space, which produces a socio-economic conflict between public good and real estate interests. To mediate the conflict, this paper will show that negotiations between high-performance building envelope and zoning envelope can both improve the performance of small public open space, and accommodate the amplified turn-over rate on land coverage.

Keywords. *high-performance building envelope; zoning envelope; airflow*

1. Planning objectives

Zoning is the key tool for carrying out planning policy. Aldo Rossi (1982) verifies that zoning was modernized in the 1870s by the Prussian planner Reinhard Baumeister, and Carol Willis (1995) describes that zoning was exported to the USA at the turn of the nineteenth century to tame the intensified problems of the laissez-faire city. The first comprehensive zoning ordinance was enacted 1916 in New York. Edward M. Bassett (1932) clarifies its objective to protect “the public safety, health, morals and general welfare.” Dividing New York into three classes of districts (residence, business, and unclassified), the ordinance consequently implemented the zoning envelope, which Per-Johan Dahl (2014) describes as “a formula in which height and setback restrictions combine to outline the maximum allowable construction.”

Following New York, comprehensive zoning was introduced to Hong Kong in 1939, which Lawrence Lai (1996) clarifies. Richard F. Babcock (1966) describes that zoning was molded into a universal tool for land-use control, while Jonathan Barnett (1982) and Christine M. Boyer (1983) combine to elucidate that comprehensive zoning was widely criticized during the post-World War II era for failing to comply with social, cultural, and technical advancements. Impervious to critical reviews, comprehensive zoning remained the key tool for carrying out planning policy in global cities. While the premises of urbanization have changed dramatically since the early twentieth century, the premises of comprehensive zoning remain largely unchanged. In Hong Kong, for example, the Town Planning Ordinance (1997) deploys comprehensive zoning to “promote the health, safety, convenience, and general welfare of the community.”

1.2 THE HEIGHT RESTRICTIONS

The building height restrictions at Mong Kok were introduced to guide future development and redevelopment. The Hong Kong Town Planning Board (HKTPB) (2010) says that “[g]iven its location and the fact that there are many old buildings in [Mong Kok, the] area is under immense redevelopment pressure.” Thus, the HKTPB imposed building height restrictions in Mong Kok because the existing building stock is likely to be demolished and replaced with grander developments.

1.3 THE GAP BETWEEN OBJECTIVE AND REGULATION IN PLANNING STANDARDS

Any comprehensive zoning prompts the standards for maximum allowable real estate. When the development pressure is high, as the in case of Mong Kok, real estate speculation will successively replace the existing building stock with developments that maximize the floor area ratio in concurrence with enacted provision. As the building height restrictions have been limited to 80 and 100 meters, depending on the plot area, we may expect the building mass in Mong Kok to increase with more than 200%, which will affect the ventilation of the sitting-out areas. Scholars have correlated ventilation with wind speed to demonstrate how building form affects the wind environment at the ground level. Edward Ng (2009), for example, explains that varying building heights in dense urban space diverts winds to the lower levels, and S.H.L Yim et.al. (2009) show that buildings shaped as a "wall" hamper the flow of natural air, which reduces wind ventilation and causes pollution to accumulate at the ground level. Drawing from previous scholarship, we can predict that the increased building mass in Mong Kok will obstruct the ventilation of the sitting-out areas, thus diminishing their performance.

Light and ventilation determine the performative aspects of public space; ventilation is interconnected with the health of urban dwellers. Ricky Burdett (2011), director of the London School of Economics Cities and Urban Age, argues that with "70 per cent of the world's population forecast to be living in urban areas by 2050, global well-being will increasingly be determined by the health of urban dwellers." Addressing the health of urban dwellers, Anna Tibaijuka (2005), executive director of the United Nations Human Settlements, argues that "city parks and recreation facilities make for better living environments." Thus, these arguments suggest that the health of urban dwellers improves in accordance with access to well performing sitting-out areas.

As the increased building mass amplifies the turn-over rate on land coverage, the regulation responds to the financial interests of real estate industry by diminishing the ventilation of sitting-out areas. As already verified, the objective in Hong Kong's planning standards serves the public good by promoting the health of the community. When the regulation in planning standards stimulates intensified building mass, which will have negative impact on the health of urban dwellers, then comprehensive zoning produces a socio-economic conflict between the public good and real estate interests. This conflict, thus, is upheld by the gap between objective and regulation in planning standards.

1.4 RESEARCH DESIGN

This research project puts forth the hypothesis that planning standards tend to prevent architecture from actively participating in improving the performance of sitting-out areas. The objective of this research project is, therefore, to demonstrate that architects can shape building forms that accelerate wind speeds and, thus, improve the performance of sitting-out areas by advancing the ventilation of the ground level in a high density urban area. As such an objective requires negotiation between design and regulation, this project targets the interface between high-performance building envelopes and planning standards to postulate the research question: Can architecture mediate the conflict between real estate interests and the public good by designing a building form that accommodates both the financial interests of maximized floor area ratio, and the community interests of ventilated urban space? Design thinking was deployed for this project because such methodology allows research to oscillate between empirical data, scientific data, and form experiments.

2. Study method

Eight city blocks in the Mong Kok district of Hong Kong were used to contextualize design research (See Figure 1). The massing of the eight city blocks is comprised of medium-sized buildings, and five sitting-out areas. A building inventory was made for the research area, which informed the creation of a digital model for computer simulation purposes, with Rhinoceros software used for digital modelling: the Rhinoceros software was deployed because it supports both Euclidian geometry and topological transformations. Climatological data was obtained from the Hong Kong Observatory. The data verified median values during the 30-year period of 1981-2010: the average wind speed is 11 km/h (3.056 m/s), the prevailing wind direction is 90° (east wind), and the average temperature is 23.2℃.

Fig. 1. Research area and research site.

Following the building inventory, the documents that combine to outline comprehensive zoning in Hong Kong were collected, and the empirical data was consolidated. These documents are the Outline Zoning Plan (OZP S/K3/30) and the CAP 123F Building (Planning) Regulations (BPR). Hence a zoning table was compiled to outline the comprehensive zoning of the research area. (See Table 1) By correlating the zoning table with the size of each plot, the zoning envelopes of the eight city blocks were drafted to guide the subsequent investigation.

Table 1. (a) Comprehensive zoning at Mong Kok.

Code	Measure	Condition	Source
Height restriction	100 m	R(A), R(A)4; Site Area > 400 m^2	OZP S/K3/30
Height restriction	80 m	R(A), R(A)4; Site Area < 400 m^2	OZP S/K3/30
Plot ratio	3.3-7.5	Domestic in R(A)	OZP S/K3/30, BPR
Plot ratio	3.3-9.0	Non-domestic in R(A), R(A)4	OZP S/K3/30, BPR
Site coverage	33.33%-80%	Domestic	BPR
Height of story	2-2.5 m	Floor/Ceiling 2.5; Floor/Beam 2.3; Inclination ≥2	BPR
Open space	1/2-1/4	Domestic; A: 1/2, B: 1/3, C, 1/4 of covered area	BPR
Setback, open space	1.5 m	Setback to open space	BPR
Setback, street	2.25 m	Street width <4.5 m, setback from center line	BPR
Setback, cuttings	2.5 m	2.5 m, 1/4 height of the cuttings	BPR
Setback, retaining wall	1.5 m	Height of retaining wall > 4.5 m	BPR

Table 1 (b) Building height, site coverage, and plot ratio (buildings in Class A – C).

Building height (meters)	Site coverage (%)			Plot Ratio		
	Class A	Class B	Class C	Class A	Class B	Class C
H≤15	66.6	75	80	3.3	3.75	4.0
15<H≤18	60	67	72	3.6	4.0	4.3
18<H≤21	56	62	67	3.9	4.3	4.7
21<H≤24	52	58	63	4.2	4.6	5.0
24<H≤27	49	55	59	4.4	4.9	5.3
27<H≤30	46	52	55	4.6	5.2	5.5
30<H≤36	42	47.5	50	5.0	5.7	6.0
36<H≤43	39	44	47	5.4	6.1	6.5
43<H≤49	37	41	44	5.9	6.5	7.0
49<H≤55	35	39	42	6.3	7.0	7.5
55<H≤61	34	38	41	6.8	7.6	8.0
H≥61	33.33	37.5	40	8.0	9.0	10.0

With climatological data and empirical data that verifies the discrepancy between current building mass and planning standards, computer simulations were executed to verify wind flow, illumination, and solar radiation at the ground level in Mong Kok's urban canyons (See Figure 2). Both the existing building stock and the projected building stock, which maximizes the floor area ratio in concurrence with comprehensive zoning, were used for simulations. As singular buildings can be replaced in the digital model, form experiments were additionally initiated, and scientific data was collected on the correlation between the shifting climatological conditions at the ground level and the specific shape of buildings. Multiple data with relevance to the fields of urbanism, urban design, environmental science, and architecture was collected. The extensive data additionally served to verify the accuracy of obtained values. As this article takes the ventilation of sitting-out areas as the subject matter to problematize the interface between high-performance building envelopes and planning standards, the following text will focus on the relationship between wind speeds and building forms.

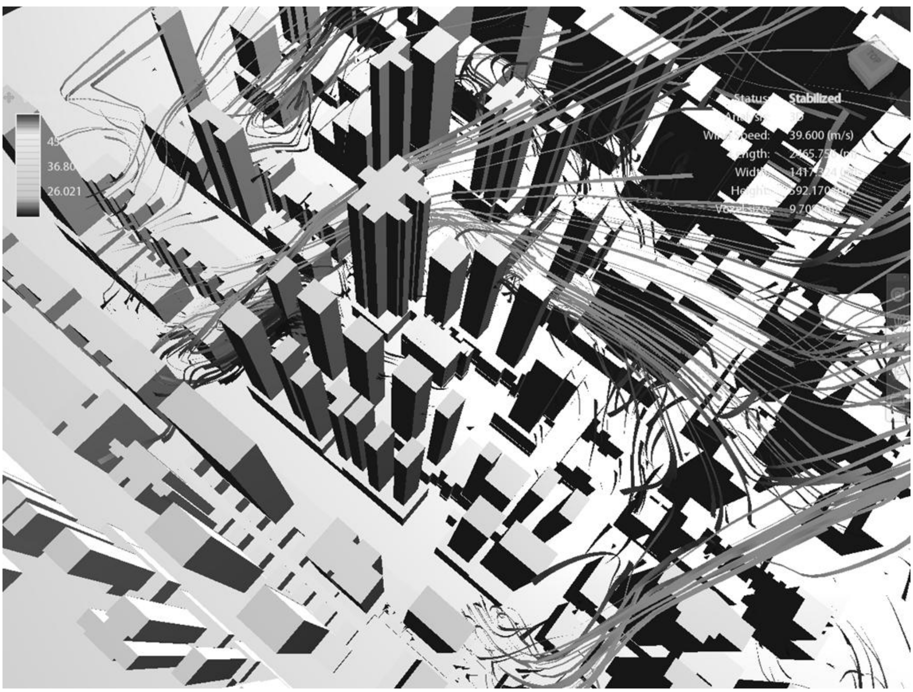

Fig. 2. Computer simulation of wind flows.

2.1. DETECTING THE RESEARCH SITE

To answer the research question, a research site was needed for in-depth analysis (See Figure 1). As the research objective was to collect data on building forms that improve the performance of small public open spaces by accelerating wind speeds at the ground level, the research site ought to include one sitting-out area and one built-out plot. The research plan was to measure the impact from the existing building envelope; from the as-of-right building envelope; and from multiple high-performance building envelopes. Comparison analysis would, hence, point to correlations and discrepancies between the efficiency of planning standards and the performative aspects of building form.

Fig. 3. The research site with the Portland Street/Man Ming Lane Sitting-Out area.

As computer simulations of the eight city blocks had proved the eastern façades to be superior in advancing ventilation at the ground level in Mong Kok, a research site was composed to include the east-facing Portland Street/Man Ming Lane Sitting-Out Area, and the two aligning plots at 370 Shanghai Street and 364-368 Shanghai Street (See Figure 3). The research site measures 857 m^2; the sitting-out area measures 443 m^2. As the larger plot at 364-368 Shanghai Street comprises 270 m^2, the zoning envelope measures 80 meters; as the combined plots with easement comprise 414 m^2, the zoning envelope measures 100 meters.

3. Results

Any dense urban block affects wind flow, thus the performance of a small public open space is linked to the density of the surrounding building mass. With a digital model of the research area, and with wind data from the Hong Kong Observatory, wind flow at the ground level of the research site was measured through computer simulation. An 80-meter as-of-right tower was modeled with the Rhinoceros software and inserted into the digital model. Two software products were deployed for computer simulation: Autodesk Ecotect Analysis, and Autodesk Flow Design. Both software products verified the prevailing wind speed at the ground level of the research site to 0.09 m/s.

As the zoning envelope at the research site measures 100 meters, the 80-meter tower was replaced by a 100-meter tower. The computer simulation verified that the prevailing wind speed remained at 0.09 m/s, which demonstrates that a tower as-of-right does not accelerate wind speeds at the ground level of the research site.

3.1. SHAPING THE HIGH-PERFORMANCE BUILDING ENVELOPE

Per-Johan Dahl (2014) argues that comprehensive zoning complies with Euclidian geometry, while Greg Lynn (2004) states that the performative aspect of building form complies with topology. As the speculative forces of real estate tend to maximize the floor area ratio in concurrence with enacted provision, the geometrical principles implicit in zoning tend to guide the architecture of most developments. As economics comprise our main mode of city governance – a connotation Pier Vittorio Aureli (2011) clearly articulates – topology is rarely an alternative for building designs as-of-right. We may therefor assume that building envelopes shaped beyond the zoning envelope can comply with topology and thus accelerate stronger wind speeds than building envelopes shaped as-of-right.

While scholarship on high-performance building envelopes, such as scholarship by Sheila J. Hayter, Paul A. Torcellini, Richard B. Hayter and Ron Judkoff (2001), tends to focus on the functions taking place within the private realm of buildings, this paper expands disciplinary impact by elucidating means for high-performance building envelopes to improve the quality of public space. If the regulations in planning standards prevent architecture from shaping high-performance building envelopes capable of improving the performance of public space, then the objective in planning standards may assist architecture in negotiating the restrictions imposed by the zoning envelope.

After measuring the wind speed created by the tower as-of-right, 20 high-performance building envelopes were modelled with the Rhinoceros software and used for simulation: ten high-performance building envelopes measured 100 meters, thus the same height as the tower as-of-right, and ten high-performance building envelopes measured 120 meters, thus 20 meters above the tower as-of- right. All 20 high-performance building envelopes were modelled as closed polysurface volumes, and they all rebelled against the zoning envelope because they accelerated wind speeds through correlation between maximized building footprints and cantilevering façades (See Figure 4). The cantilevering façades were composed of flat and curved angulations of 2°, 4°, 6°, 8°, and 10°. All 20 high-performance building envelopes exceeded the zoning envelope, thus they all submitted to the real estate interests at Mong Kok by implying floor area ratios beyond the tower as-of-right.

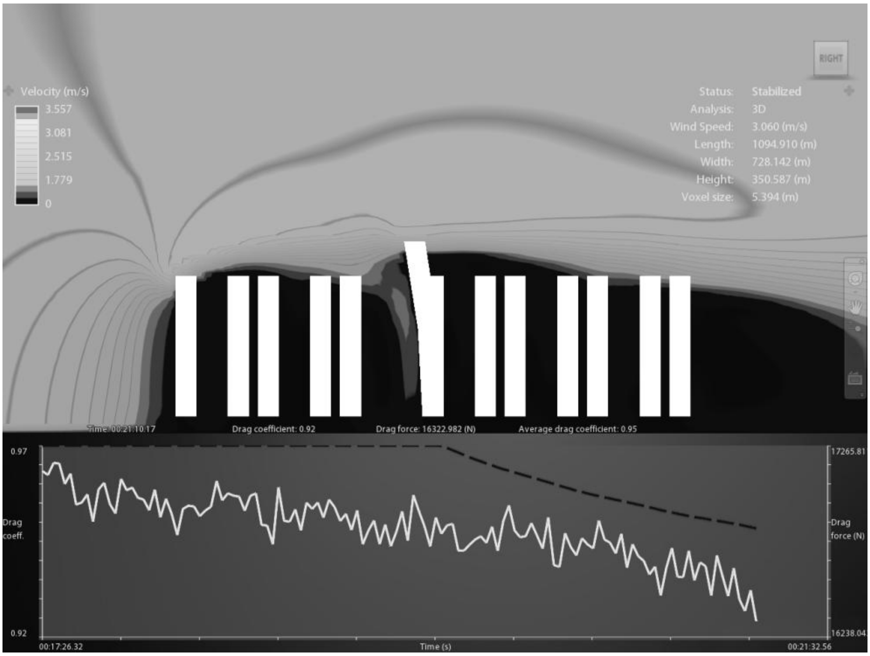

Fig. 4. Computer simulation of a 120-meter high-performance building envelope.

3.2. ANALYZING THE HIGH-PERFORMANCE BUILDING ENVELOPE

As Autodesk Ecotect Analysis proved incapable of measuring data on cantilevering façades, Autodesk Flow Design was deployed for computer simulations of the 20 high-performance building envelopes. An axonometric drawing was composed to instigate comparison analysis between the 20 high-performance building envelopes, and the zoning envelope, see Fig. 5. The axonometric drawing was used because it correlates the urban plan with the building profiles and the massing impacts. While representing the relationship between the different profiles and the sitting-out area, the axonometric drawing also facilitated the drafting of an 80-meter street wall, which measures relationships between the different building height regulations of the zoning plan and the building height beyond the zoning plan, which was used by the research project, see Fig. 5. Of the ten 100-meter high-performance building envelopes, eight increased the wind speeds at the research site, while two decreased the wind speeds, see Fig. 5. Of the ten 120-meter high-performance building envelopes, seven increased the wind speeds at the research site, while one proved similar capacities as the tower as-of-right and two decreased the wind speeds, see Fig. 5.

The high-performance building envelope that accelerated the strongest wind speeds at the research site, and thus proved to be most successful in improving the performance of the sitting-out area, was composed of curved angulation of 8° (8° Tilt + Curve) and measured 120 meters: this high-performance building envelope increased the wind speed at the ground level of the research area with 290%, see Fig. 5.

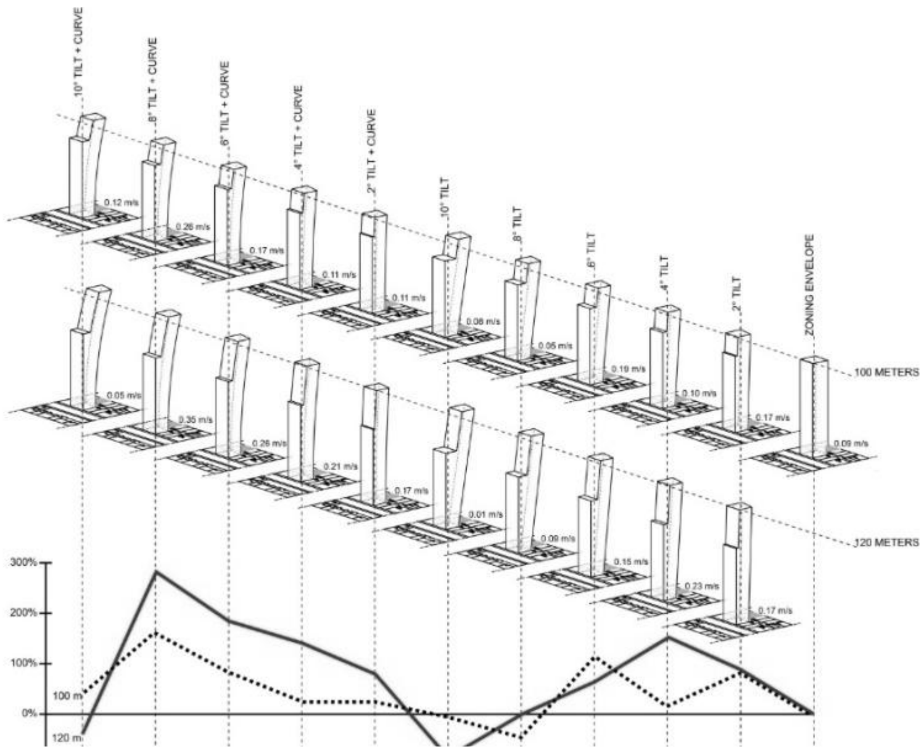

Fig. 5. Wind speed fluctuations at the center of the small public open space (%) building heights 100 meters and 120 meters (m).

4. Conclusions

This research project elucidates discrepancies between the planning objectives and the planning standards in Mong Kok, Hong Kong. The research project shows that negotiations between architectural design and comprehensive zoning encompass a viable method for the Hong Kong Town Planning Board to deploy when seeking to accomplish the objective in planning standards. This project additionally demonstrates that well-performing public spaces do not necessary correlate with building height restrictions, which call for new routines in planning administration. As this project is limited to one in-depth analysis, further studies are needed to verify its impact on the wider scope of urbanization.

This research project deployed architecture to investigate issues of urbanization. As the discipline of architecture addresses the question of scale, which tends to be disregarded by urban practices, this research project uncovers new information on the detail in urban processes. City agencies administrate urban space through planning; architects shape urban space through design. As design is much more responsive to the specific qualities of a site, architecture provides valuable methods for how to negotiate the private interests of building form with the public interests of the urban realm. The results from this research project, for example, demonstrate that miniscule adjustments of façade geometries catalyses tremendous impact on the performative aspects of public space. Thus the care for detail should go beyond the discipline of architecture and involve also the discipline of urbanism. Such a shift in the attention to scale opens up a field of research on the proficiency of planning standards to embrace incremental approaches to urban development and transformation.

5. References

Aureli, P.V. 2011 *The Possibility of an Absolute Architecture*, Cambridge, Mass: The MIT Press

Babcock, R.F. 1966 *The Zoning Game: Municipal Practices and Policies,* Madison: The University of Wisconsin Press

Bassett, E.M. 1932 *Zoning*, New York: National Municipal League

Barnett, J. 1982 *An Introduction to Urban Design,* New York: Harper & Row, Publishers

Boyer, M.C. 1983 *Dreaming the Rational City: The Myth of American City Planning*, Cambridge, Mass: The MIT Press

Bristow, R. 1984 *Land-Use Planning in Hong Kong: History, Policies and Procedures*, Hong Kong: Oxford University Press

Dahl, P.: 2014 *Form and Policy: HL23 and the Shape of Real Estate* F. Madeo and M.A. Schnabel (eds), Across: Architectural Research through to Practice: 48th International Conference of the Architectural Science Association 2014, The Architectural Science Association & Genova University Press, Genoa

Hayter, S.J., Torcellini P.A., Hayter R.B. and Judkoff R.: 2001 *The Energy Design Process for Designing and Constructing High-Performance Buildings* CLIMA 2000, Naples

Hong Kong Town Planning Board: 2010, "*YTMDC Paper No. 169/2010: Amendments to the Draft Mong Kok Outline Zoning Plan No. S/K3/27*". Available from: Open Source Repository - http://www.districtcouncils.gov.hk/archive/ytm_d/pdf/2010/YTM_2010_169_EN.pdf (accessed 5 October 2015).

Hong Kong Town Planning Board: 2012, "*CAP 123F Building (Planning) Regulations*". Available from: Open Source Repository – http://www.legislation.gov.hk/blis_pdf.nsf/6799165D2FEE3FA94825755E0033E532/25C2868DA2669A12482575EE003F079B/$FILE/CAP_123F_e_b5.pdf (accessed 5 October 2015).

Hong Kong Town Planning Board: 1997, "*Cap 131 Town Planning Ordinance*". Available from: Open Source Repository – http://www.legislation.gov.hk/blis_pdf.nsf/4f0db701c6c25d4a4825755c00352e35/AEA02550B541AC16482575EE003FB1D8/$FILE/CAP_131_e_b5.pdf (accessed 5 October 2015).

Lai, L.W.C.1996 *Zoning and Property Rights: A Hong Kong Case Study*, Hong Kong: Hong Kong University Press

LSE: 2013, "*Hong Kong tops Global Health Index*". Available from: Open Source Repository – http://www.lse.ac.uk/newsAndMedia/news/archives/2011/11/Hongkong.aspx (accessed 5 October 2015).

Lynn, G. 2004 *Folds, Bodies & Blobs: Collected Essays*, Brussels: La Lettre Volée

Ng, E: 2009, *Policies and Technical Guidelines for Urban Planning of High-Density Cities – Air Ventilation Assessment (Ava) of Hong Kong*, *Building and Environment* 44, 1478–88

Rossi, A. 1982 *The Architecture of the City*, New York: The Institute for Architecture and Urban Studies

UN-Habitat: 2005, "*Saving for more city parks, sports facilities*". Available from: Open Source Repository – http://www.unhabitat.org/content.asp?cid=1485&catid=271&typeid=6. (accessed 28 October 2013).

Willis, C. 1995 *Form Follows Finance: Skyscrapers and Skylines in New York and Chicago*, New York: Princeton Architectural Press.

Yim, S.H.L., Fung J.C.H., Lau A.K.H., and Kot S.C: 2009, *Air Ventilation Impacts of the ''Wall Effect'' Resulting from the Alignment of High-Rise Buildings*, Atmospheric Environment 43, 4982–94