RETHINKING THE SKYSCRAPER
THE GREEN SKYSCRAPERS OF KEN YEANG
On the cover: Menara Mesiniaga
“Yeang’s theoretical propositions and inventive solutions for the ‘green skyscraper’ typology set within an ecologically sustainable landscape offer a compelling vision of one form of urban habitation in the twenty-first century.”¹

Robert Powell

¹ Powell, 1999, p. 161
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FOREWORD

Currently the green way of living is more and more embraced. Terms like sustainability, recycling, cradle-to-cradle etcetera are becoming more and more popular topics. From the beginning of my study I am interested in the research and design of sustainable buildings, and considering the situation we live in now, this always seemed like an obvious choice for me. However, I noticed during my study and an internship at an architectural office, that this choice is not that obvious. Relatively there are only a few architectural offices that are truly interested in building sustainable, and some only because it is a ‘hot’ item. This was quite a disappointment for me. Now I am graduating, doing a Smart Architecture programme that focuses on sustainable development, and I would like to get inspired by architects that are really making an effort in designing green buildings. Ken Yeang is one of those architects and that is why I chose him as a topic for this thesis. And as he used his doctoral thesis as a basis for his research on designing ecological buildings, I hope I will be able to use my own thesis during my graduation as a inspiring reference.

Tatjana Maria Anholts
INTRODUCTION

Over the past four decades the Malaysian architect Ken Yeang realized more than 200 buildings. Most of them being low-energy green buildings, in over 20 countries worldwide. Among these buildings are several skyscrapers. Many of them have the name Menara in them, which is the Malaysian word for tower. Designing the typology of high-rise buildings Yeang acquired himself to do, but he went a step further than the regular architect who designs skyscrapers. In the past decades he developed an ecological design approach, meant especially for the design of high-rise buildings. Challenging himself to design built environments as artificial ecosystems that are seamlessly bio-integrated with the natural environment. One of his most recent realized buildings is Solaris, located in research and business park Fusionopolis in Singapore, of which the masterplan was designed by Zaha Hadid Architects. The building is a world-leading example of a building that has a landscape entwined around and throughout the built form, together with many other ecological features and it is rated BCA GreenMark 2009 Platinum, the highest level. But this is one of his most recent buildings. The first towers Yeang designed, like Plaza Atrium (1981-1984), were especially designed for the tropical climate, and their architectural language did not yet show the ecological theory behind it.

This thesis is about the development of his ecological design theory. Why and how Yeang started the research how to design buildings ecologically, why skyscrapers, and how he developed the theory from a local (tropical climate) point of view to a world-wide acknowledged ecological design theory. To set the context, this thesis will begin elaborating on Yeang’s background and education, where his research began, and the background of the skyscraper typology in general. Subsequently the chapters will explain Yeang’s choice of using skyscrapers, his thoughts on ecological design regarding to this typology and his process of his ever evolved theory and the actual built designs.

When Yeang started his business with T.R. Hamzah in 1976, many of the eco-technologies that are available today simply did not exist. The use of solar photovoltaic cells or wind generators were still experiments and not viable yet. Green materials were not readily available. Yeang and his team had to overcome these difficulties and invent solutions themselves. His ideas provokes incredulity from his clients at first, for the lack of existing theory or built examples. But Yeang worked consistently on his ecological design theory and was able to realize many buildings and write several books, “and now the impact of Yeang’s integrated roles-as architect, researcher, author and green spokesperson-can be fully seen.”

1 Bullivant, 2011, p. 7
2 Bullivant, 2011, p. 8
3 Powell, 1999, p. 24
4 Bullivant, 2011, p. 15
This thesis is written using three series of books. The first series is that about the skyscraper typology. These books include *Skyscraper: form and function* by David Bennett, which elaborates on the entire development of the typology through time and *The Sky is the Limit – A Century of Chicago Skyscrapers* edited by Pauline A. Saliga, which I used especially for writing the part about the first high-rise buildings in Chicago. Other books like *The Skyscraper* by Paul Goldberger and *Skyscrapers: An Architectural Type of Modern Urbanism* by Mario Campi as well as some of the lectures of Hans van Dijk of Bachelor 4 and 5 about skyscrapers and architects of skyscrapers were used for reading background information.

The second series of books are all written by Ken Yeang himself. The books I used especially was his primer *The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings*, in which he extensively explains about designing high-rise buildings in a green way, but he also writes about what he considers to be ecological design. This chapter has been derived from his doctoral thesis *Designing with Nature: The Ecological Basis for Architectural Design*, which he wrote during his study at the Architectural Association in London. The rest of the books of this series are about Yeang’s buildings and their design principles behind it, like *Ken Yeang: Bioclimatic Skyscrapers*, *The Skyscraper bioclimatically considered* and *Reinventing the Skyscraper: Vertical Theory of Urban Design*. I used these books less for writing, for the thesis it was not necessary to elaborate a lot about the buildings. I do intend to used these books during my graduation, where the specifics of the designs are excellent learning material for my own design project.

The third series of books I used the most. These contain the books of Robert Powell; *Rethinking the skyscraper: The Complete Architecture of Ken Yeang*, which is a continuation of *Ken Yeang: Rethinking the Environmental Filter*. These books really narrate the process of the theory of Yeang setting it in the context. I actually named my thesis after these books, because it exactly tells what I want to emphasize in this thesis. One of the most recent books about Ken Yeang is of Lucy Bullivant; *Ken Yeang – Eco Skyscrapers: Volume 2*, which I used for the most recent projects of Yeang.
CHAPTER 1: BACKGROUND OF KEN YEANG

Childhood
The Federation of Malaysia consists out of peninsulas; Peninsular Malaysia and East Malaysia. Ken Yeang was born on a small island of Peninsular Malaysia, Penang, in 1948. The spacious colonial mansion he lived in as a child was perfectly suited to the tropical climate. In 1954, his parents commissioned a new house from Berthold M. Iverson, who was one of the foremost modernists in Southeast Asia at that time. During the construction, Yeang was often on the building site and the switch from the colonial mansion to an early modernist-style villa left a deep impression on him. He remembers the modernist spaces and the lifestyle of a family with an international outlook very well and “one might speculate that in some subliminal way, these influenced his later choice of career and his lack of nostalgia for the past.” 1

In 1961 Yeang was sent to boarding school Cheltenham College in England. In that time the country he left behind was undergoing mature changes. The British Malaya had become independent in 1957 and formed the Federation of Malaysia with Sabah, Sarawak and Singapore in 1963. The latter would leave two the Federation two years later.

Education:
The Architectural Association, Cambridge and Pennsylvania
In 1966 Yeang gained a place at the Architectural Association School of Architectuur (AA) in London, a choice influenced by his uncle Dennis Chung, who was a graduate of the school. Soon after Yeang had started, Alvin Boyarsky became chairman of the AA, who succeeded Otto Koenigsberger, the establisher of the AA Tropical School. When Yeang became president of the Malaysian Institute of Architects (Pertubuhan Akitek Malaysia) the influence of Boyarsky was strongly present in the programmes of Yeang to advance the image of the Malaysian architect and Malaysian architecture.

Yeang’s first-year tutor was Elia Zenghelis, who would later establish the Office for Metropolitan Architecture (OMA) group with Rem Koolhaas and Zaha Hadid. Zenghelis made Yeang interested in the modern movement. Other influences on Yeang’s early architecture “included, not surprisingly, Mies van der Rohe and Paul Rudolph, but also the work of the Greater London Council’s Architects Department and the ideas of Lord Lleywelyn Davies on ‘indeterminate architecture’.” 2

After a short internship in Asia where Yeang got more experience in building practice and drawing, he returned to the AA in 1971 to complete his diploma. One of his tutors was Ron Herron, a member of the Archigram group. The influence of the Archigram would later surface in the MBf Tower (1993) and a project for the Expo 2005 Nagoya Hyper-Tower (1998). Another tutor was Peter Cook, also a member of Archigram. “My fifth year under Peter Cook was memorable. He taught us how to design by making lyrical machines. We all grew and developed under him. His was an alternative view of the world as an architectural boffin. This was a view that somehow stuck”, recalls Yeang. 3

1 Powell, 1999, p. 7
2 Powell, 1999, p. 8
3 Powell, 1999, p 9
Next to his study, Yeang did graphic-design work, making posters and designs for the AA and he drew illustrations for the British magazine Architectural Design. His graphic work made him befriend Charles Jencks, for he made some illustrations for Jencks’ book Le Corbusier and the Tragic View of Architecture. The early buildings Yeang designed when he had just set up his practice were greatly influenced by Le Corbusier. Corbusien references are to be found in the Ulysses House (1980), the Dason House (1983) and the Roof-Roof House (1986), which is a residence for his own use in Kuala Lumpur, and the Plaza Atrium (1981-1984), his first major high-rise building.

In 1971 Yeang switched to Wolfson College, University of Cambridge, which was part of an arrangement with the AA to complete his diploma. He joined the Technical Research Division of the Cambridge School of University, which was led by Alex Pike, John Frazer and James Thring. Pike and Frazer were studying the feasibility of building an ‘autonomous house’, after the ideas of Buckminster Fuller. At the time, the 1960s and 1970s, there was a growing interest in environmental issues. The oil crisis of 1973 made countries aware of their vulnerability to the finite nature of fossil fuels and there was a general discomfort about the proliferation of nuclear power. Yeang started a separate research programme about the theoretical aspects of ecological design, which was, according to him, a necessary precursor to the design of the systems of the autonomous house. This research formed the basis of Yeang’s doctorate with the eventual title A Theoretical Framework for Incorporation of Ecological Considerations in the Design and Planning of the Built Environment. For the research programme Yeang did a course at the Department of Applied Biology under Professor J.L.W. Beament, where he became interested in environmental science and the properties of biological systems. He joined the British Ecological Society. It was in this period that he generated a theory which he constantly refined and referenced to during his later work in practice. The theme was “the concern for the relationship between buildings and the external ecological environment.”

Yeang met Kisho Kurokawa, one of the early exponents of Metabolism, in 1972. The ideas of the Metabolists; change, the biological analogy and an organic architecture, were similar to Yeang’s own research. Kurokawa urged Yeang to write a book, which would help Yeang to organize his ideas and reveal gaps in his knowledge. Years later Yeang wrote two books; The Tropical Verandah City (1986) and Tropical Urban Regionalism (1987). The latter examines his ideas on building in the context of Kuala Lumpur. Kurokawa became a great influence on Yeang and wrote the foreword of the first published monograph on Yeang’s work Ken Yeang: Rethinking the Environmental Filter (1989) written by Robert Powell.

During his study at Cambridge, Yeang did a landscape programme at the Department of Landscape Architecture and Regional Planning at the University of Pennsylvania, under Professor Ian L. McHarg. McHarg, whose was specialized on ecologically responsible planning, was one of the most influential teachers of the twentieth century.5 (Powell, 1999, p. 12) The methodology described in his book Design with Nature (1969) had a great influence on Yeang, who often used it for masterplanning projects.

4 Powell, 1999, p. 11
5 Powell, 1999, p. 12
In 1995 Yeang’s doctoral thesis was published as *Designing with Nature: The Ecological Basis for Architectural Design*. Yeang sees especially the two chapters ‘Framework for Ecological Design’ and ‘External Ecological Interdependencies of the Built Environment’ as the fundamental model for all his work. The similarity with McHarg’s book title was no coincidence. According to Yeang his book takes *Designing with Nature* to a next level, it is an extension of McHarg’s ideas into architecture and built form.

**Return to Malaysia**

In 1976, after he worked for a year in the office of Akitek Bersekutu in Kuala Lumpur, Yeang formed a partnership with Tengku Robert Hamzah. Their new firm was called T.R. Hamzah and Yeang, and currently they are still working together. They had met at the AA, back in 1966. Hamzah had studied in the AA’s Tropical School and thus was influenced by Otto Koenigsberger.

When Yeang came back to Malaysia, there was a period of extensive Malayanization. The government had introduced policies to encourage a sense of national identity. Yeang became involved in the discussions on nationalism, identity and critical regionalism that were going on in Malaysian architecture at that time, setting his theme ecology a bit to the background for a while. Yeang used these debates, interwoven with the architectural solutions generated in Southeast Asia for his book *Tropical Urban Regionalism* (1987), which is mentioned earlier.

In the period that Malaysia became independent, the country was longing for nationalism and searching for its identity. Yeang writes about this in his book *The Architecture of Malaysia*. He was uncomfortable with the replication of vernacular elements, like Islamic arches, which was pressured by the politics. He pleaded for a different approach, using architectural models that were responsive to the tropical climate incorporating the culture of traditional forms and decorative motifs. Chapter 5 will look into this more closely.

The practice T.R. Hamzah and Yeang achieved a breakthrough in 1978 with the Taman Sri Ukay project, a building with terraced houses, apartments and shophouses. They actually relocated their office in 1983 to one of a three-storey shophouse in the building. In 1984 Yeang completed his own Roof-Roof House, which advocated not only a strong identity, but was also one of his first experiments in designing with bioclimatical principles, related with his doctoral thesis.

In the early 1980s T.R. Hamzah and Yeang was commissioned for several high-rise buildings. This was the beginning of Yeang’s continuing research of the green skyscraper.

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6 Powell, 1999, p. 12
7 Powell, 1999, p. 13
8 Powell, 1999, p. 15
CHAPTER 2: THE EVOLUTION OF THE SKYSCRAPER

In order to understand how the ‘green’ skyscraper differs from a regular skyscraper, it is important to analyze the evolution of this typology and to understand why and how this building could arise in the first place. This chapter will elaborate shortly on the history of the skyscraper, giving an insight into this type of building.

Chicago

The city of Chicago was officially founded in 1837 and the small city expanded rapidly in the first decades, using especially the balloon frame as building construction.\(^1\) The population grew from 150 in the 1930s to over 300,000 in the 1960s. This was mainly the result of the developments of the transport.

In October 1871 disaster struck; the Great Chicago Fire destroyed nearly two thousand acres, one third of the city, including the central business district. 300 people were killed, 18,000 buildings were destroyed and 100,000 people became homeless. The wooden balloon frame houses were easily destroyed, but also the commercial and government buildings of cast iron did not survive the inferno. These unprotected cast iron frames were thought to be fireproof, but instead, the exposed cast iron had melted and the molten iron caused even more fire.\(^2\)

In 1874, Architects Peter B. Wight and Sanford Loring developed and patented real fireproofing systems, based on a first-hand inspection of the ruined city after the fire.

The fire of Chicago turned out to be a catalyst for the development of the skyscraper. The city had to be rebuilt and the population was eager to make Chicago better than before the disaster.\(^3\) The buildings that were constructed shortly after the fire were very similar to the ones of before the fire, both in form and style. They had four or five stories, with a sunken first floor for retail purposes. But the high land prices, the new technique of fireproof iron-and-steel construction and the newly developed electric safety elevator by Elisha Otis, stimulated the architects and engineers to go higher. Even though the first steam-driven elevator of Otis were already found in the Haughwout Building in New York in 1857, the first elevator in Chicago came in use only in 1887, thirty years later. By the time of 1895, there were already more than 3,000 elevators to be found in high-rise buildings in Chicago.

The first tall office buildings, called ‘skyscrapers’ by the contemporary writers, had ten to twenty stories in the 1880s and were a replacement of the five-story buildings of a decade before. In turn they were replaced by the even taller buildings of the twentieth century.\(^4\) The first high-rise buildings were heavy masonry edifices, but the tall-building technology revolutionized. The construction became a light, steel skeleton, which was well-engineered and cost-effective, with a façade of stone or terra-cotta. Because of the lighter construction it was possible to apply larger surfaces of glass.
Chicago School
The period of the first high-rise buildings in Chicago is often called the Chicago School, or Commercial Style. The most important architects of this movement were Henry Hobson Richardson (1838-1886), Daniel Burnham (1846-1912), John Wellborn Root (1850-1891), William Le Baron Jenney (1832-1907), Louis H. Sullivan (1856-1924), Frank Lloyd Wright (1867-1959) and the firm Holabird and Roche.5,6,7

The Home Insurance Building (1885) by William Le Baron Jenney is generally credited to be the first fireproof, iron-frame skyscraper.8 The building construction combined masonry-reinforced frames with masonry bearing-walls.

The Monadnock Building (1884-91) is the tallest monolithic masonry construction building, and was also the last building where this construction was applied. It has 17 stories and the walls on the base have a thickness of 8 foot (= 2,4 m).9 One of the best building examples of the Chicago School period is the Reliance Building (1890-94). It was designed by the office Burnham and Root, but after John Wellborn Root died in 1891, Charles Atwood became the main designer of this building. It was the first with a frame entirely made out of steel, which made it possible to use large windows for the exterior.

Louis H. Sullivan is seen as the architectural father of the skyscraper.10 He studied at the Massachusetts Institute of Technology and one year at the École des Beaux Arts in Paris. Dankmar Adler, engineer and architect, hired Sullivan and in 1881 they became partners until 1895. Sullivan wrote a book about his research on the aesthetics of the skyscraper: The Tall Office Building Artistically Considered (1896). From childhood he was interested in nature, which had an influence on his ideas. “He tended to look at the situation in ‘organic’ terms, meaning that the function must have an inherent and specific identity striving for direct and honest expression.”15

The form of the building follows the function. He divided skyscrapers in three parts; the base (shops and entrance), the core (an x-number of office floors) and the top (installations and framework).

The tallest building
By the end of the nineteenth century the battle for the tallest building had begun. Entrepreneurs like John Jacob Astor and Cornelius Vanderbilt made their fortunes in real estate, shipping and railroads. They saw skyscrapers as the perfect way to express their ambitions.12 Because of the dropping steel prices and lack of planning regulations building taller became even easier to accomplish. Some of the developed high-rise building turned out to be taller than was economically sensible, or even insensitive to the environment in which they stood, like the Equitable Building, built in 1915 by a design of Ernest R. Graham in New York. The building caused a lot of discussion for its size blocked the sunlight and in 1916 the Zoning Law was introduced; above 300 feet the buildings were required to be stepped back in varying ratios. Buildings that were equal to one-fourth of the lot’s size were allowed to have any height.

The Chrysler Building was the tallest building of the world for only a short time. It is built in the Art Deco period by a design of William Van Alen. It is seen as the ‘Cathedral of Capitalism’.13

1 Bennet, 1995, p. 41
2 Curtis, 2007, p. 41
3 Dijk, 2008
4 Saliga, 1990, p. 7
5 Bennet, 1995, p. 40
6 Bennet, 1995, p. 46
7 Curtis, 2007, p. 47
8 Bennet, 1995, p. 49
9 Dijk, 2008
One year later the Empire State Building was realized, which won the competition of being the tallest building (1,250 feet = 381 m), a design by Richmond Shreve, Thomas Lamb and Arthur Harmon. The Chrysler Building and the Empire State Building are, apart from the Twin Towers, probably the best known buildings in New York.

After the second World War a new style of skyscrapers began; the International Style. The new towers had to be economical and functional and were usually box-shaped, made out of steel, glass and concrete, without any decoration. One of the best examples of this style is the Seagram Building, by Ludwig Mies van der Rohe (1886-1969).

**Superskyscrapers**

Innovation in the technology of tall buildings led to a new period of even taller buildings. The newly developed construction of steel-frame tubes was embraced by the office Skidmore, Owings & Merrill, and used for buildings as the John Hancock Center (1969), 1,127 feet or 344 m high, and the Sears Tower (1974), 1,454 feet or 443 m high. The latter was the highest building of the world until shortly. In 1998 the Petronas Twin Towers in Kuala Lumpur by Cesar Pelli took over this record, taking this title away from the United States for the first time. Even higher buildings developed after this are the Tapei 101 by C.Y. Lee & partners (2004) in Taiwan and the Burj Khalifa by Skidmore, Owings and Merrill (2010) in Dubai.

**Current situation**

From the 1980s a new discussion joins the design of tall buildings. The skyscrapers were considered to be isolated towers, cut off from the street and therefore not part of the community. Since the height was no longer considered to be a problem, designers focused more on the link between skyscrapers and the urban landscape, in order to make the buildings part of the environment. From this period until the current situation, architects used different styles for the designs of the tall buildings. The typology is no longer used only in North America, but now can be seen all over the world, shaping the skylines of so many cities.

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14 Bennett, 1995, p. 60
Chapter 3: Typology versus Ecological Design

Context of tall buildings
Skyscrapers and other large buildings usually are large and complex buildings, situated in intensive, high-density urban contexts. Developing a green design building for a small regular building is already complex enough, so why does Yeang focuses on these tall buildings? His explanation is quite simple. Because of their scale and volume of consumption of energy and materials, the ecological design of these buildings is very crucial and much more effective than a green small building. The skyscraper is one of the most ubiquitous building types in the major cities and will continue to be built in large numbers well into the first quarter of the millennium. In 2007 it was the first time that there were more people living in towns and cities than in rural areas. By 2050, this has increased to more than six billion people, two thirds of humanity. With more and more people living in the same spaces, it is only natural to build upwards.

Can the skyscraper be green?
As already said before, the enormous size of tall buildings makes that they consume a lot of energy and materials, and also make extensive discharges into the natural environment, which makes them inherently un-green. But the scale of tall buildings is exactly why there are also so many changes for a green design approach. Looking at the entire life cycle of a building shows that skyscrapers offer the greatest possibilities for recycling of precious resources, because they simply have a lot of it, while the recycling of materials of small buildings may be less financially justifiable. Another important issue is transportation. A decentralized form of built environment requires higher consumption of non-renewable energy resources; the decentralized planning layout of structures means further travel distances between buildings. “Recent studies have shown that the greater the intensification of urban population, the lower is the energy consumption per inhabitant for travel in automobiles”. This issue could be a crucial justification of the dense building environment. And this applies to the vertical transportation systems as well. Elevators in skyscrapers are for instance significantly more energy- and material-efficient than an average car, and require only a small amount of space within a building compared to cars in a city. The adoption of higher density living and working space can reduce the need for car ownership and parking space and reduce overall urban travel, while increasing the use of public transport, which will be able to increase in efficiency. Less infrastructure and transport is needed, which makes a pedestrian life at the ground level possible and reduces the energy.

The smaller building footprint
By building upwards, and therefore using a relatively small footprint, the land at the ground plane surrounding the building becomes available for nature again. Through an increase of vegetated areas, ecological recovery of land will probably contribute to increasing biodiversity. Less buildings and impermeable surfaces, like roads and paving, can benefit the site’s hydrology; vegetated land improves water absorption and infiltration back into the land as ground water.
Also, there will be more land available for agricultural purposes.

The alternative to a centralized high-rise area is a context of widespread small- and medium-rise buildings. This means there is less area available for arable use, while at the same time, with the increasing population, this land is necessary for production. And with a greater area that is built, the natural ecosystems of a greater area is being disrupted, which makes the decentralized building style anti-ecological. ⁶

**Concerns regarding the skyscraper**

To describe a skyscraper one can say it is a tall building with a small footprint and small roof area, with large, long facades. The greatest structural stress is at the base. There are special engineering systems required because of its height; the mechanical and electrical service systems (like the water supply system), the vertical transportation and movement systems (elevators), fire-protection devices and other systems. In order to make a skyscraper economically attractive, the building has to have maximal internal area (net areas) and a minimum ‘net-to-gross’ ratio.

When an architect or engineer wants to design a ‘green’ skyscraper, it is important that he takes into account the following concerns because of the typology: ⁷

- The position of the service cores and how this affects the overall buildings configuration and layout.
- The orientation of main facades and window openings (especially in relation to the climatic characteristics of the locality).
- The façade design options.
- The colour of the building envelope.
- The effects and use of vegetation and planting on the skyscraper’s built form.
- The type of likely building operational systems.
- The selection of materials and energy sources.
- The management of these as potential waste products.

**Renovation of skyscrapers**

Even if there is a decline of skyscrapers being built around the world in the future, there are already a great many of this typology in existence, like Chicago or New York. These buildings may need to be renovated in order to keep up with the demands its users, but also to meet acceptable standards of ecological design. Therefore it is important to have an idea of how this can be done.

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⁶ Yeang, 1999, p. 22
⁷ Yeang, 1999, p. 28
CHAPTER 4: WHAT IS ECOLOGICAL DESIGN?

Connectedness

“Ecological design requires the architect to regard and to understand the environment as a functioning natural system and to recognize the dependence of the built environment on it.”  

1. Yeang calls this interdependence of the constructed and the given (as in natural) environment ‘connectedness’. 

2. An ecological design is constructing a practical application of ecology within the natural environment, “connectedness as applied ecology”. 

3. To design ecologically, it is important to consider and evaluate the consequences of:

- if we build
- where we build
- what we build
- how we build

Sustainable development

Over-exploitation and abuse of the biosphere decreases its ability to produce essential resources and makes it also harder for it to recover from such abuses. Therefore, buildings should be designed especially focusing on the recoverability, re-use and recyclability of its materials and components. This corresponds with the definition of sustainable development by the Brundtland Commission in 1987: “Meeting the needs of the present without compromising the ability of future generations to meet their own needs”.

It is important to work with the knowledge that has already been acquired and start designing today adapting a design approach with the best ecologically achievements possible, rather than waiting for the perfect solution and do nothing until then. While being aware, however, of the risks of a piecemeal approach to ecological design, which would not be effectively enough to address the global issue of the abuse of the biosphere. For facing this issue in the long term, economic, social and political systems at the global and national level must be based on holistic ecological principles. 

The basis for ecological design

Yeang describes the basis of ecological design through objectives in his primer: The Green Skyscraper – The Basis for Designing Sustainable Intensive Buildings. It is not necessary to explain all these objectives in detail for this thesis, therefore I will only mention them. 

Ecological design:

- acknowledges the resilience of the natural environment and its limit.
- acknowledges the importance of biodiversity.
- must acknowledge that manmade synthetic ecological systems can never adequately duplicate the complexity of natural ecological systems.
- must seek to repair and restore ecosystems.
- seeks a symbiosis between manmade systems and natural systems.

1 Yeang, 1999, p. 31
2 Yeang, 1999, p. 31
3 Yeang, 1999, p. 31
4 Yeang, 1999, p. 35
5 Yeang, 1999, p. 36-57
- takes into account entropy in natural systems.
- acknowledges that the environment is the final context for all design.
- acknowledges that the built environment is dependent upon the earth as the supplier of energy and material resources.
- in effect is design in which:
  - utilizes renewable resources ideally at rates less than the natural rate at which they regenerate.
  - optimizes the efficiency with which non-renewable resources are used.
- acknowledges that all design has a global impact because of ecosystem connectivity.
- involves the management of outputs from the built environment into the ecosystem.
- design acknowledges that all building activity involves ecosystem spatial displacement, and some displacement of energy and materials.
- must be environmentally holistic.
- must be an anticipatory design approach.
- is multi-disciplinary.

And:

- Biological design has to take into account the connectivity of ecological systems.
- Ecological principles require all design to be regarded in the context of its physical life cycle.

According to Yeang the most important thing to remember about ecological design, is that it is a complex endeavour. And this endeavour should not be a once-only effort. “To be environmentally holistic, the designer has to regard his built system as a set of connected interrelationships and interactions with the natural systems in the environment.”

This interaction between building and nature has to be observed and managed dynamically over time in order to succeed.

In the frame next to the text of this chapter are a few of many principles for skyscrapers which Yeang designed on an ecological approach. These principles can be seen in many of his skyscrapers on which chapter 5 will elaborate.

6 Yeang, 1999, p. 57
Chapter 1 ends with the beginning of Yeang’s research of the skyscraper in a tropical environment. This chapter will continue with this research, beginning with the design of tropical high-rise buildings and following Yeang’s process until the current status of his research, the green skyscraper agenda. All the while keeping the context of time and place in mind. His ideas about ecological design and skyscrapers, which are discussed in chapter 3 and 4, will present themselves during this process. The examples of towers mentioned in this chapter represent a certain value during Yeang’s process, but it is important to keep in mind that Yeang has designed and completed many more buildings than these.

Identity and regionalism
Next to his research on high-rise buildings, Yeang became closely involved in the discussions on identity and regionalism in architecture in Southeast Asia. These were issues of concern for architects and intellectuals in the former colonized countries. When Yeang returned to Malaysia after his education, he joined the Malaysian Institute of Architects (PAM). He was president of PAM from 1983 to 1985. During this time there was, beyond Malaysia, a debate going on about critical regionalism, a term that was first used by A. Tzonis and L. Lefaivre in 1981 and later by Kenneth Frampton in 1983 in Towards a Critical Regionalism. The main issue of the debate was the balance between International Style anonymity and local identity. “Yeang leans more towards modernism than towards an identifiable Malaysian vernacular expression, as might be expected from his training, but he tempers this with a highly specific climatic response.” The Institute hosted an Aga Khan Regional Seminar in Kuala Lumpur to discuss the issue of ‘Architecture and Identity’ in July 1983, and was attended by delegates from nine countries in Southeast Asia and further afield. They were able to agree that: “Identity is a dynamic evolving process and that it cannot be fabricated, there is a plurality in the many forms that it can take.” Bringing the discussion about identity and architecture on the forefront is what Yeang sees as his main achievement of his term in office. But this discussion only lasted for a decade, before other agenda got the overhand. Later, he considers the regionalist debate a necessary part of the process of decolonization at the time, but it was also narrowing for some Asian architects.

The office T.R. Hamzah and Yeang were commissioned for several high-rise buildings in the early 1980s. Retrospectively, Yeang calls these first high-rise buildings the Serie 1 Towers. With these buildings he examined ‘one big idea in a single building’, calling it ‘Primary-Level Design Experiments’. Yeang experimented here with the idea of the skyscraper in a tropical environment. The buildings have some Corbusien influences in the aesthetics.

Plaza Atrium (1981-1984)
The twenty-four-storey Plaza Atrium is situated in the commercial area of Kuala Lumpur, the Golden Triangle. The challenge of the design was to

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1 Tzonis and Lefaivre, 1981
2 Frampton, 1983
3 Powell, 1999, p. 22
4 Powell, 1999, p. 23
5 Powell, 1999, p. 16
design a tower suitable for the hot-humid tropical climate. The big idea of this project was the use of a large transitional space, lying between the inside and the outside of the building. This multi-storey ‘interstitial’ atrium is topped by a roof of Z-section concrete louvres, which filters the rain, permits accumulated hot air to disperse and diffuses sunlight.6

IBM Plaza (1983-1987)
The principal idea of this design, also a twenty-four-storey building, was that of vertical landscaping, which expressed itself in the form of a diagonal garden that climbs one side of the building. Yeang explored some design principles for the tropical urban high-rise prototype; the sun’s geometry on its east-west path and the geometry of the site in relation to the roads. The two do not always coincide within the building, due to other design choices that had to be made. The roof has the form of the traditional Kampong house of which the symbolic value reconciles with the new functional purpose of being a double roof.

Menara Boustead (1983-1987)
This building is located not far from the Plaza Atrium, in Kuala Lumpur’s Golden Triangle, and has thirty-two storeys. With this building Yeang investigated the use of a double-ventilated heat-sink shield to reduce the heat load on the building, ‘a double wall’. Compared to the Corbusien language of Plaza Atrium, this building is more soft edged and multi-layered. The sky-terraces are covered using local planting for sun-shading.

In the middle of the 1980s the Malaysian economy was hit hard by a worldwide recession, being mostly dependent on the export of commodities such as rubber and palm oil.7 It would take several years before the economy was recovered and the change was made into high technology and heavy industry, which provided an impetus for the next series of high-rise buildings. In 1989 the monograph Ken Yeang: Rethinking the Environmental Filter was published, written by Robert Powell. With the book, Yeang was able to assess the progress he had made from 1976 to 1989, but he was also aware that he was missing a concise theoretical framework and that he needed to define his ecological agenda in more practical terms. His focus sharpened and “he set himself the task of ‘rethinking the skyscraper’ from very first principles.” 8 In 1990 there was an exhibition of Yeang’s work held in Tokyo entitled ‘Tropical Skyscrapers’. Yeang got positive response from the Japanese critics, which convinced him to continue his research on the skyscraper. He started working on a new series of high-rise buildings, shifting his work from ‘aesthetic’ to ‘scientific’ and from a ‘divergent’ to a ‘convergent’ viewpoint.9 While the towers of Serie 1 were driven by ‘one big idea’, the towers of Serie 2 were experiments of combining these ideas. Also Yeang worked on prototypes for different site conditions.

Menara Mesiniaga (completed 1992)
Menara Mesiniaga is the headquarters of an IBM franchise, situated in Subang Jaya, near Kuala Lumpur. Yeang was asked to design a high-tech corporate showcase. It is a modest high-rise building, being only fifteen storeys high. It is a circular building, with a landscape spiraling up outside of the tower, which is connected with a sloping base.

6 Powell, 1999, p. 16
7 Powell, 1999, p. 34
8 Powell, 1999, p. 41
9 Powell, 1999, p. 41
This encourages species diversity. The landscape of the sky-courts and terraces are well executed and regularly maintained, a great improvement compared to previous projects. The façade of the building is an environmentally responsive filter. The circular form provides less surface exposure for solar penetration. It is the first building where Yeang integrates his research into the principles of the design of high-rise buildings in a tropical climate. A new type of skyscraper is born, of which the form is derived from the application of ecological principles.10

The building was received very well and it won the AGA Khan Award for Architecture in 1995. Charles Jencks, which was one of the members of the jury, explains: “This striking interpretation of the corporate ‘landmark’ skyscraper explores a new direction for an often pompous building type. [...] The result recalls the climatic architecture of the 1950s and Frank Lloyd Wright’s skyscraper projects, in a move towards a new architecture for the 1990s. It is a striking alternative to the reigning mode of corporate towers and a new synthesis for contemporary architecture that is responsive to the climate of a particular place and finds inspiration for a new architectural language from forces that are ultimately cosmic”.11

**MBf Tower (completed 1994)**
The MBf Tower is a thirty-one-storey building located on the island Penang. Its architectural language forms a bridge between Corbusien elements, like the those of the towers of Serie 1, and the new towers of Serie 2. As mentioned in Chapter 1, the building shows the influence of Archigram, of which some members were Yeang’s tutors at the AA. With the building Yeang examined transitional spaces in the upper parts and the placement of residential apartments into the structure as ‘detached bungalows’ in the sky.12 Unfortunately the landscaping is inadequate, for only a few residents planted their balconies.

**Central Plaza**
The Central Plaza tower has twenty-nine storeys and is located on a long narrow site in Kuala Lumpur. The climatically responsive features as the deeply recessed balconies and the stepped planter-boxes give the tower a strong and outstanding identity, which attracted an amount of small companies looking for a prestigious building.

**Menara TA1 (completed 1996)**
Located closely to the Petronas Twin Towers by Cesar Pelli in Kuala Lumpur is the thirty-seven-storey Menara TA1. Although there are several climate-responsive features, due to its orientation and configuration the bioclimatic advances are minimal compared with the Menara Mesiniaga.

**Serie 3 (1994-1997): bioclimatic skyscrapers**
In the beginning of the 1990s the Yeang’s focus gradually changed from tropical skyscraper to bioclimatical skyscraper, loosening the ties with the identity debate and accepting the “coexistence of local identities and global identities and the universal applicability of his ecological agenda”.13 The bioclimatical skyscraper would be suitable in both temperate and subtropical locations. The design of which has to use the natural climatic energies of the location to the fullest. In 1995 *Designing with Nature: The Ecological Basis for Architectural Design* of Yeang was published, being an updated version of his doctoral thesis and the fundamental model for all his work.
For the next series of towers Yeang’s strategy is to reduce the impact of the buildings upon the natural environment. He presented this strategy in a partitioned matrix, where the interactions between the built environment and the ecological environment are set. To design in the ecological approach these four aspects of the matrix should all be considered simultaneously just as their connections with each other.\(^{14}\)

\[
(LP) = \begin{pmatrix} L_{11} & L_{12} \\ L_{21} & L_{22} \end{pmatrix}
\]

L11 refers to the process and activities that take place within the system or the area of internal interdependencies.

L22 refers to the process and activities that take place in the environment of the system, or the external interdependencies.

L12 refers to the exchanges of the systems with its environment, or the transactional interdependencies of the system/environment.

L21 refers to the exchanges of the environment with the system, or the transactional interdependencies of the environment/system.

Yeang compares his design approach with that of other architects who are less motivated to design sustainable by the following table.

<table>
<thead>
<tr>
<th>Built-form Configuration</th>
<th>Bioclimatic</th>
<th>Ecological</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Orientation</td>
<td>Climate Influenced</td>
<td>Environment Influenced</td>
<td>Other Influences</td>
</tr>
<tr>
<td>Façade and Windows</td>
<td>Climate Responsive</td>
<td>Environmental Responsive</td>
<td>Other Influences</td>
</tr>
<tr>
<td>Energy Source</td>
<td>Generated/Ambient</td>
<td>Generated/Ambient/Local</td>
<td>Generated</td>
</tr>
<tr>
<td>Energy Loss</td>
<td>Crucial</td>
<td>Crucial/Reused</td>
<td>Relatively Unimportant</td>
</tr>
<tr>
<td>Comfort Level</td>
<td>Variable/Consistent</td>
<td>Variable/Consistent</td>
<td>Consistent</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>Low Energy</td>
<td>Low Energy</td>
<td>Generally High Energy</td>
</tr>
<tr>
<td>Materials Source</td>
<td>Relatively Unimportant</td>
<td>Low Environmental Impact</td>
<td>Relatively Unimportant</td>
</tr>
<tr>
<td>Materials Output</td>
<td>Relatively Unimportant</td>
<td>Reuse/Recycle/ Reintegrate</td>
<td>Relatively Unimportant</td>
</tr>
<tr>
<td>Site Output</td>
<td>Important</td>
<td>Crucial</td>
<td>Relatively Unimportant</td>
</tr>
</tbody>
</table>

5a Comparison design approaches

For the towers of Serie 3 Yeang collaborated more with engineers and material and environmental scientists, by what increased the technical understanding and precision. The buildings of this Serie reflect the low environmental impact of material sourcing and the reuse and recycling of materials.

\(^{14}\) Powell, 1999, p. 72
Tokyo-Nara Tower (1995 – conceptual project)
The Tokyo-Nara Tower has not been built, but was a conceptual project for the 1995 World Architecture Exposition in Japan. It has eighty stories in where the floor-plate is rotated to serve as sun-shading to the floor below. The principal idea is the use of vertical landscaping, spiraling around, trough and within the building. This landscaping has three functions; cooling the building, controlling the air movements and providing a balanced built environment with a biosystem that is acting symbiotically with mechanical systems.

Menara UMNO (completed 1998)
The Menara UMNO is executed and located on the island of Penang, with twenty-one storeys. The form is derived from the conflict between the geometry of the site and the geometry of the climate. The building represents a breakthrough for being a energy-efficient, naturally ventilated skyscraper. The use of ‘wing-walls’, protruding vertical walls the full height of the building channel the prevailing wind into the building and establish high- and low-pressure areas. Variable transitional zones function as ventilators as well.

Serie 4 (1997-current): green skyscrapers
In 1997 Yeang started with a new Serie of skyscrapers. But at the same time the economies of Southeast Asia plummeted into recession; the devaluation of the Thai baht and the subsequent fall in value of the Indonesian and Malaysian currencies meant that many projects were not executed or did not progress until the next century. Yeang used this ‘free’ time to refine his ecological approach and wrote the primer The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings, which was published in 1999. He changed his terminology from the bioclimatical to the green skyscraper, which has a more inclusive expression and fits the current concern for the need of ecologically sustainable designed large buildings. The ecological approach include that Yeang is more focused on the input of materials used in the operations of the building, as well as its outputs during the operational phase. He assessed the entire life-cycle of the building. While the bioclimatical approach is less rigorous and addresses only the issues of conserving energy in an in-use building and reducing its waste products. The table on the next page shows the strategies of the ecological design approach. “The green skyscraper that Yeang proposes encourages users to interact with the local external environment, instead of being encapsulated inside a hermetically sealed artificial environment.”

In his primer Yeang explains that building vertically instead of expanding a city horizontally is a more sustainable way to built. He sees skyscrapers as ‘vertical cities’, with good pedestrian linkages, public realms, civic zones, vistas and a sense of place extended upwards. “You map a tall building the same way you do a city, with zones for parking, offices, and social places.” In order for this to work, it is important to give great attention to the internal spaces. Privacy, security and lifestyle options have to be assured to make high-density living in compact urban environments acceptable.

Solaris, Fusionopolis (completed 2010)
A 1.5 km long ecological park wraps itself around the building,
5b Design strategy Ken Yeang, Serie 4

connecting the park at ground level to the roof-gardens at the highest levels. Other ecological design features are a solar shaft, a naturally ventilated and day lit grand atrium, extensive sun-shading louvers and the harvesting and recycling of rainwater. In 2009 the project was awarded first prize of the Skyrise Greenery Awards 2009, by the Singapore Institute of Architects & Singapore National Parks. And it got a BCA GreenMark 2009 Platinum Rating, the highest level of certification, by the Singapore Building Control Authority.

Spire Edge Manesar (under construction)
Located in Manesar India, this twenty-one-storey building accommodates offices, an auditorium, a gallery and other facilities and stands as an iconic landmark on a new IT park. The ecological design features include a continuous green ecoinfrastructure at the north façade, a self sufficient water reuse/recycling system, sun-shading devices, roof gardens and sky courts.

Methodology of Research, Design and Development
Ken Yeang calls his method of working Research, Design and Development (RD+D). He considers that architectural design is a research-based activity which requires simulation and prototyping with subsequent verification. It is an approach that can be traced back to his studies at Cambridge. Yeang describes this process as ‘rapid-prototyping’ or ‘rapid product development’, a terminology borrowed from the automobile design and manufacturing. Both invention and generation of new technology and ideas lead to a new production model and take place at once. Yeang sees the design of skyscrapers as a similar process.

17 Powell, 1999, p. 99
Innovations and subsequent refinements should take place in a parallel process to produce an operational prototype, where a later stage of refinements improves the product and fine-tunes its performance. This instead of a linear process, in which all aspects of the design are fully refined in a sequential process and which takes a considerably longer time. The rapid-prototyping process is very suitable for those economic environments where fast-design-and-build developments are taking place, like the Asian economies. According to Yeang, "appropriate designs that work have to be produced extremely quickly in order to meet the rapidly changing market conditions and fulfill the instant demands of the client that is predominant in the emerging market-place." He uses the Japanese word *kaizen* to explain how the office T.R. Hamzah and Yeang operates; it literally means a method of working that stresses continuous improvement.

5.11 Spire Edge Manesar

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18 Powell, 1999, p. 99
Critics
During his process of developing the first Serie of towers Yeang received some critics, but even so his designs generated considerable international interest and were widely published. Yeang used the critics to improve his theory and his buildings.

The Malaysian architecture Lim Chong Keat criticized Plaza Atrium for its absence of having shaded areas for social interaction at the ground-floor level, which are part of the lifestyle in the tropics. Yeang resolves this critic in the IBM Plaza, which he completed three years later than Plaza Atrium. In this building there is an open foyer at ground level which receives cooling breezes and creates the behavioural setting for the street life.

The Singapore architect Tay Kheng Soon had remarks on the Corbusien style of the towers of Serie 1. The architectural language of the buildings, which is the hard-edged planar aesthetic of Le Corbusier, does not match the soft-edged message of the tropical style the buildings want to express. The architectural historian William Curtis agreed with this remark. Yeang took up this critic and he began to develop a new aesthetic. The Corbusien style is not visible anymore in the towers of Serie 2 and further.

Charles Correa, an Indian architect, acknowledges the value of the first built towers of Serie 1, saying that Yeang has taken important steps, both in his own development and in the development of high-rise building more generally.

During the Asian Design Forum No. 7 Yeang presented his latest design of Hitechnia HG (Serie 3). The chairman of the AA, Mohsen Mostafavi, argued that for all the technical determinism of his presentation, Yeang manipulated the aesthetics to a desired effect. Mostafavi advised Yeang to take a better look at the quality of the internal spaces being produced and “that dressing the facades should not take the place of a continuing investigation of inhabitation and its pleasures.”

Yeang is also often criticized for the disparity of his theoretical writing and his buildings. But actually this is quite understandable. Buildings, particularly skyscrapers, usually are designed several years before they are completed. Therefore, the theory used for the design, is already dated, and a newer theory has been developed. This disparity between the completing of the works and the current state of theoretical and technical development is inevitable.

1 Powell, 1999, p. 24
2 Powell, 1999, p. 24
3 Powell, 1999, p. 92
Recognition

With the amount of built buildings and his background in ecology, Yeang is a quite unique architect. He has built and is still building his own theoretical agenda and that has earned him the respect of other practicing architects. William Lim Siew Wai, a Singaporean architect, notes “Yeang is perhaps the first Asian architect outside Japan to have been accepted by the ‘Metropolitan architectural elite on their turf’.”

Yeang gives lectures at universities all over the world. He has published several books and there were many exhibitions held about him in places like London, Tokyo, Orleans and Berlin. He won prices as an architect including the Norway Award for outstanding contribution to quality in the field of architecture (1992), the Honorary Fellow AIA (America Institute of Architects, Washington, 1999), the Prins Claus Fonds Award (the Netherlands, 1999) and the Sir Robert Mathew Award, Commonwealth Association of Architects (CAA, London, 2000). His buildings also received several awards like the PAM Architectural Awards for the IBM Plaza for excellence in design and building (Malaysia, 1989), the Kenneth F. Brown Asia Pacific Culture and Architecture Design Award for the Roof-Roof House (Hawaii, 1995), the Aga Khan Award for Architecture for the Menara Mesiniaga (Geneva, 1996) and the RAIA (Royal Australian Institute of Architects) International Award for the Menara UMNO (1998).

He is no longer the Malaysian architect working in Southeast Asia; he operates an international practice with T.R. Hamzah with associated offices in Singapore, China and Australia. Yeang attributes his success to his having ecological agenda that has, during his process, become independent of issues as identity, tropicality and regionalism. With his continuous refinement and technical improvement of the design of ecological skyscrapers his theory matured, and the international architectural community now has embraced his ecological agenda, for it offers solutions to many of the problems existing in the developed nations. Ivor Richards, a practicing architect and member of the Royal Institute of British Architects, has written some introductory essays in books about Ken Yeang. He sets Yeang among a number of architects who ‘are developing an ecological architecture in different regions of the world’. As examples he names Nicholas Grimshaw, Richard Rogers, Norman Foster and Renzo Piano as architects who have had ‘a long involvement with an ecological evolutionary process that generates new buildings like new species in nature’.

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4 Powell, 1999, p. 73
5 Yeang, 2012
6 Richards, 1994, p. 10
CONCLUSION

This thesis elaborates on Yeang’s process of the design of green skyscrapers. Retrospectively it becomes clear that there were many factors that made him doing a research on an ecological design approach for skyscrapers.

He was born in Malaysia, where the first house he lived in was a mansion completely adapted to the tropical climate, and the second house was built in an early modernist-style. Yeang went to the Architectural Association in London, where he met several tutors and fellow students who would have an certain influence on his later career. The start of his ideas about an ecological design approach started already during his study, when he was doing a research programme at Cambridge, led by Alex Pike, John Frazer and James Thring. They studied the feasibility of building an ‘autonomous’ house and Yeang began on researching the theoretical aspects of ecological design which would be a necessary precursor to the design of the systems of the autonomous house. This research formed the basis of his doctoral thesis that eventually would be published in 1995 as Designing with Nature: The Ecological Basis for Architectural Design and is still used by Yeang as a basis for this ever evolving theory on an ecological design approach. In 1999 he publishes a primer for designing green skyscrapers, The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings, which contains chapters that are derived from his doctoral thesis.

When Yeang started his business with T.R. Hamzah, a fellow student of the AA, in 1976, many of the eco-technologies that are available today simply did not exist. Yeang and his team had to overcome these difficulties and invent solutions themselves. The office uses a Methodology of Research, Design and Development, a parallel process of designing, where innovations and subsequent refinements take place at once. This makes rapid developments possible concerning the built environment. Yeang started on the first towers of Serie 1 from 1980, and these designs show a Corbusien style that he was influenced by when making some drawings of Le Corbusier’s buildings for a book of Charles Jencks. The buildings were especially designed for a tropical climate, but Yeang received the criticism that the aesthetics of the Corbusien style did not match the identity of a tropical environment. At the time there was a debate going on about identity and regionalism in architecture. Yeang considers this debate as a necessary part of the process of decolonization, but in the end he himself leans more towards a modernism style, which can be derived from his second house where he lived as a child and his education in London, yet he tempers this with a highly specific climatic response.

Under influence of Kisho Kurokawa Yeang writes a couple of books in 1986 and 1987, which help him to organize his ideas and reveal gaps in his knowledge. Also the publication of Robert Powell, Ken Yeang: Rethinking the Environmental Filter, shows he was missing a concise theoretical framework. He sharpened his focus and for the towers of Serie 2 he experimented with combining the ideas he used for the buildings of Serie 1. The aesthetics changed, showing no more the hard Corbusien style, the form of the building is derived from the application of ecological
principles. Some of the buildings of these Serie do not work completely, for the maintenance of the landscaping is not always taken care of. Yeang improves this on his next Series. With Serie 3 he changes his terminology, going from tropical to bioclimatical skyscrapers. These towers would be suitable in both temperate and subtropical locations. He uses his theoretical thesis, published in 1995, as basis. Working more closely together with material and environmental scientists, he improves the technical understanding and precision. With the building designs he focuses on the low environmental impact of material sourcing and the reuse and recycling of materials.

Currently Yeang is working on Serie 4, green skyscrapers, a terminology that fits in the contemporary concern for the need of ecologically sustainable designed buildings. He focuses more on the skyscraper as a vertical city, with good pedestrian linkages, public realms, civic zones, vistas and a sense of place extended upwards. Yeang considers building vertically as being more sustainable than expanding a city horizontally. Where the skyscraper could arise for the high land prices and innovations in technology, now building high-rise buildings is necessary to make the expansion of cities possible in the next decades, for more and more people will live in cities. Skyscrapers are tall buildings and consume an enormous amount of energy and materials. Making these buildings green, will have a major positive impact on the environment.

Now, Yeang is highly appraised for the work he has achieved in the last decades. When he started, there was no theory of how to design green skyscrapers. Yeang started from scratch, developing an ecological design approach based on his research. His ideas provoked incredulity from his clients at first, but Yeang worked consistently on his ecological design theory and was able to realize many buildings and write several books, “and now the impact of Yeang’s integrated roles—as architect, researcher, author and green spokesperson—can be fully seen.”

1 Bullivant, 2011, p. 15
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