Focusing on natural elements in the early design process, new potentials for architects?

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Abstract

There is a large body of research on environmental planning, but a shortage of means for architects to implement environmental concerns in the early design process. This paper investigates the potentials of a more elaborated and conscious use of natural elements in the early design process. Natural elements are understood as considerations on the local climatic conditions such as sun, wind, water, soil and vegetation. Based on a case study of two urban scale projects in China, drawn by Danish and Chinese firms respectively, integration of natural elements, and the extent to which natural elements influence the drawn result, have been investigated. The result shows that simple means of environmental integration, as represented by natural elements, played an important role in the development of the design solutions, and had a much larger impact on the drawn result compared to proposed technological solutions. Furthermore the result shows that a more elaborated use of natural elements acts as a means to better implement environmental concerns in the early design process, and reinforces the connection to the local context, of particular importance in China, where rapid transformation processes make social and cultural patterns difficult to interpret.

Keywords: environmental planning, natural elements, design process, environmental sustainability.

1 Introduction

Since the opening up reforms in the 1980s, China has experienced unprecedented economic growth and has built extensively to accommodate the growing urban population. Such large scale development provides great opportunities, not at

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least for foreign companies within the building sector, but it is also a daunting challenge, accompanied by enormous environmental costs with global consequences. Environmental consideration has not been a high priority issue on the political agenda, although China has a long standing interest in urban ecology, with extensive research by ecourbanists like Rusong Wang (Downton [1]). The urgent need for environmentally viable strategies to cope with fast-paced urbanization, was put into sharp focus in the five year plan of 2006, introducing the concept of kexue fazhan (scientific development), putting environmental quality prior to fast development. Eco city initiatives like Dongtan, Caofeidian and Tianjin, act as test beds with the purpose to refine environmental frameworks and policies. But regardless of sharpened attention and expertise, conditions in China are harsh when it comes to environmental practice. The fast pace within which projects are developed, means that there is not much time to rethink practice (Wu [2]).

Due to the inherent cross disciplinary nature of environmental planning, environmental issues tend to be difficult to approach and access from an architect´s perspective. Environmental issues are often translated into technicalities to be dealt with by experts. But as architects are faced with stricter requirements concerning environmental performance, and are expected to design with environmental consideration, the ability to approach environmental issues is becoming increasingly important. Natural elements were at an early stage put forward by Geddes [3] and McHarg [4], but have until recently received little attention within conventional urban planning. Today natural elements are emphasized by ecourbanists, viewing the city as an ecosystem with focus on the complex relationships between environmental issues and urban concerns (Short and Short [5]). In China, natural elements have played an important role throughout the long history of urban planning (Eitel [6]), and today a strong incentive for an enhanced use of natural elements lies in the recognition that following nature is also cost beneficial.

The aim of this paper is to map the potentials related to a more conscious use of natural elements in the early design process. Based on a case study of two planning projects in China, the following three questions are investigated: What natural elements are emphasized in the projects? How are the natural elements integrated in the design process? To what extent do the natural elements influence the project design towards environmental responsiveness?

2 Definitions

2.1 Environmental planning

The term plan in this paper refers to a preliminary plan for urban areas of roughly 500,000 m^2 (neighbourhood plan). Environmental planning is generally defined as planning that takes into consideration the effects of climate (sun, wind, precipitation), vegetation, topography, geological and hydrological conditions, and also includes economic and social impacts of the development on the region and environment (Lynch [7]). This paper focuses on natural elements

as a basis for environmental planning, while recognizing the interrelationships of various other aspects. Design approaches to environmental planning are often described with the terms passive and active. A passive design approach refers to the use of natural elements and could be described as the basis for environmental planning, whereas an active design approach refers to the use of mechanical and technological solutions (Yeang [8]).

2.2 Natural elements

As defined by Michael Hough, natural elements refer to climate (sun, wind, precipitation) water, topography, soil, vegetation and wildlife [9].

2.3 Design process

Within the design discipline, the term design process refers to the definition and solution of a design problem. The designer frames the problem and evolves its solutions in a cyclical reflective process (Schön [10]). Developing a design is a process including several phases such as, program phase, schematic design, detailed design, construction and reuse strategies. The two cases in this paper are both studied in the schematic design phase, from conceptual to preliminary design.

3 The two cases

The two urban scale projects in China chosen for this study, both set out an agenda of being environmentally conscious neighbourhood planning. The first project is a large scale residential area in Wuxi, drawn by the Danish firm Schmidt Hammer Lassen Architects (SHL). The second project is a business park in the new eco city Caofeidian, drawn by the Chinese firm Tsinghua Architectural Design & Consulting Institute (THCA). The material was collected through interviews, participant observation, literature review and study of drawing material at the SHL office in Copenhagen and at THCA, Tsinghua University in Beijing.

3.1 The Wuxi case, Sunshine 100 Tian Yi Town

Design team: Schmidt Hammer Lassen Architects (SHL), Denmark
Environmental consultants: WSPGroup, Great Britain
Landscape architects: PK3, Denmark
Client: Sunshine 100, China
Other involved actors: Wuxi local planning bureau, China

Wuxi Sunshine 100 Tian Yi Town is located in Wuxi South Yanqiao Town, in the Shanghai region (31°N, 120°E, subtropical zone). The project is predominantly residential with around 1,9 km^2 residential and 0,1 km^2 commercial buildings. The southern part of the development is designed by SHL (subject of this study) and has a total area of 400,000 m^2 with around 9,000

Figure 1: The Wuxi plan. (Drawings by SHL Architects, Copenhagen.)

residential units for 15,000 to 20,000 people. The design consists of apartment blocks with different heights, mainly facing south extending on an east-west axis. The project is directed towards the middle class, characterized of being economically efficient, simple and fast to build.

3.2 Results from the Wuxi case

3.2.1 Climatic consideration

Sun, wind and vegetation, were the main natural elements emphasized in the project. To the design team, environmental consideration was an important issue from the beginning of the project. The architects used the local solar and wind conditions as a basis for developing the design concept, and they described these climatic considerations as easy to take into the design process, and also easy to explain to the client, since they did not imply any extra cost. WSP environmental engineers got involved at the end of the schematic design phase, and developed a report to help guide the design decisions in an environmental conscious direction. The report from WSP consisted of evaluations and recommendations, covering microclimate (wind assessment, solar radiation studies, shading studies, day light studies) energy strategies (passive strategies, energy efficient strategies, renewable energy strategies), waste and water strategies. The environmental engineers stressed the importance of supporting passive measures with technology, but many of the proposed high-tech solutions turned out to be too expensive for the project. Environmental sustainability was seen as expensive, targeting high levels of performance through active strategies.

3.2.2 Sketching and environmental software

The natural elements were addressed early in the design process and were made inherent to the project idea, as the architects developed design concepts based on information on local sun code and prevailing wind direction. The architects approached environmental issues using their ordinary programs like AutoCad and 3DS Max, and referred to building codes. They also used the Chinese solar analysis program Sunshine 2.2, to verify the solar distances between the buildings, and were interested in Ecotect, an environmental analysis program used by WSP, which they described as very visual and rewarding to work with. WSP used Ecotect for solar and daylight studies, Computational Fluid Dynamics software (CFD) for wind analysis and Thermal Analysis Software (TAS) for residential unit analysis.

3.2.3 Building configuration and orientation

The architects developed the design in a very rational way, following the logics of the sunlight distances in relation to building heights and minimal distances. Together with wind considerations, the solar situation influenced configuration and orientation of the buildings.

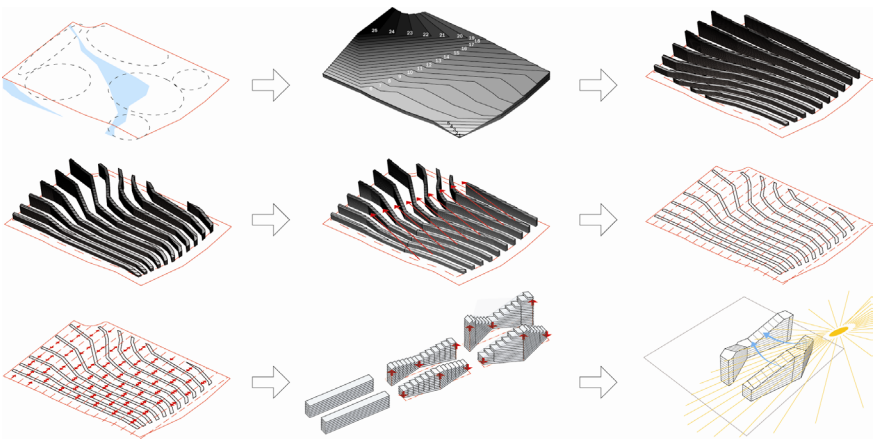

Figure 2: Concept drawings. (Drawings by SHL Architects, Copenhagen.)

The concept drawings show how the zoning diagram provided by the client Sunshine 100, is translated into a stepped terrain model. Maximum building mass is derived by subtracting the minimal distances according to the sunlight regulations starting from the northern and southern end of the site respectively (the local sun code for Wuxi is 1,31). The western and eastern parts of site are combined to comply with prevailing winds (from southeast). A grid is superimposed on the basic massing model, and each intersection between the grid and the building mass becomes a point that is offset. Neighbouring grid points are shifted in opposite directions to form courtyards to break down the scale. The building profiles create spatial variation and increase the building surface, providing better possibilities for natural ventilation and day lighting.

The areas between the buildings were carefully designed to improve the local microclimate, and open space activities were designed with the solar and wind conditions in mind. Planting was used to reduce high wind speeds in key areas and to provide shade in the hot summer period. Water features were introduced for cooling purposes and ground materials were selected to improve water infiltration and to reduce heat reflection in summer.

3.3 The Caofeidian case: business park in Caofeidian eco city

Design team: THCA (Tsinghua Architectural Design & Consulting Institute) Tsinghua Urban Planning and Design Institute, Beijing, China
Environmental consultants: Tsinghua University, Beijing, China
Client: Caofeidian Gongyequ Guangweihui, China
Other involved actors: Tangshan local planning bureau, China

Figure 3: Caofeidian business park plan. (Drawings by THCA, Tsinghua University, Beijing.)

THCA was invited to a competition together with nine other Chinese companies, to draw a business park for local government officials, an area of 560,000 m^2, to be built as the first area of the new eco city Caofeidian. Caofeidian eco city, located in the Beijing region (38°N, 118°E, temperate zone), was developed as a cooperation project between Tsinghua Urban Planning and Design Institute and the Swedish firm SWECO. The focus areas of Caofeidian eco city can be described within the sectors urban planning, eco indicators, eco cycle (energy, waste, waste water), landscape and water. The first phase of the

eco city is planned for an area of 30 km^2 for 300,000 people. The starting area is 12 km^2, within which Caofeidian business park is located.

3.4 Results from the Caofeidian case

3.4.1 Climatic consideration

Sun, wind, water, vegetation and soil were discussed among the architects. Although there was a strong emphasis on environmental consideration from the start of the project, the conceptual design phase was largely influenced by the idea of the government office building, which in a Chinese context refers to a specific type of monumental building. Among the natural parameters especially water was emphasized, since fresh water resources are scarce in the area, and the soil has a high percentage of salinity. The serious shortage of water resources forced design solutions to emphasize on reducing the usage of water, strengthening recycling and investigating applications for non-conventional water resources in various fields (rainwater, recycled water, sea water). The water management approach combined the local conditions with natural drainage methods, adopting measures of source control, nearby retention and infiltration, to restore the natural water cycle system. The architects relied on a thorough site analysis, that had been carried out earlier by the Tsinghua Urban Planning Institute, which in a regional perspective included studies on vegetation, geology, water and soil etc. The Tsinghua team emphasized the value of imitating and learning from natural processes (climatic consideration, the water cycle, soil conditions, vegetation etc). Environmental sustainability was seen as simple and cheap.

3.4.2 Natural elements

The architects used their ordinary tools like AutoCad and TArch and referred to building codes and regulations as basis for environmental consideration. Most environmentally related issues were carried out in collaboration with engineers and urban planners. With assistance from the urban planning department a strategy for storm water collection and decentralized grey water treatment was worked out. The architects expressed interest for natural elements, but they did not know how to more precisely work with these, and they were not familiar with environmental simulation programs like GIS (geographical information system) which was used by the urban planners, Ecotect and CFD (Phoenics) which were used by the engineers.

3.4.3 Roof greening, wetlands and waste water treatment

The green superstructure under which the offices are placed, functions as an insulating roof which collects rainwater and also incorporates different technologies such as photovoltaic panels and solar collectors. The green roof is intended to be used by the public to experience different environmental strategies, and to become more aware of environmental concerns.

An existing wetland area influenced the design of the waterfront park. Wetlands have a buffer function, storing and releasing water, reducing flood risks, regulating climate and purifying water through plants. Wetlands also play an important role within the local agriculture, functioning as habitats for fish and

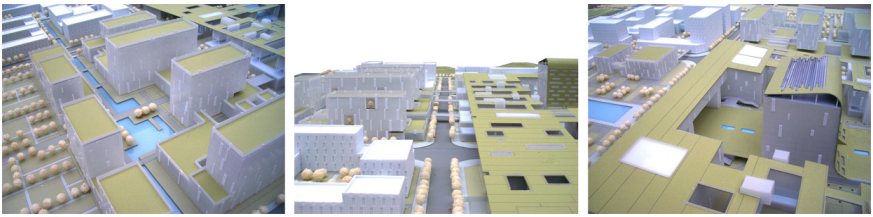

Figure 4: Green superstructure. (Drawings by THCA, Tsinghua University, Beijing.)

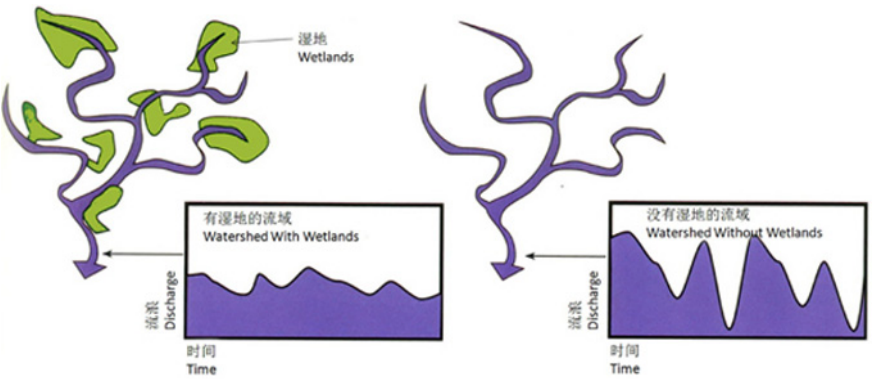

Figure 5: Wetlands. (Drawing by Tsinghua Urban Planning and Design Institute, Beijing.)

birds. By treating the anticipated runoff from the development, the integrity of the landscape system is preserved, and the impact of the development on the site is reduced. Besides a water storage system for storm water purification and infiltration, an inspiring water landscape is created.

Roof greening, permeable pavements, biological storm water detention, rain gardens and wetlands systems were suggested approaches for storm water utilization. On a block level, a decentralized waste water treatment system was suggested, a small scale system with local processing and recycling of nutrients.

4 Discussion

The study shows that enhanced use of natural elements has potential to contribute to more appropriate environmental solutions to existing characteristics of an area. An elaborated use of natural elements functions as a means to approach more locally based methods of environmental problem solving.

4.1 Emphasis on natural elements

The tradition of taking natural elements into account is represented in very early works on Chinese urban planning like Guanzi [11], and is also present in the theory of Dao (Laozi [12]). Although the influence of such traditions in China today is difficult to define, the links to tradition have potential to facilitate a more elaborated use of natural elements in urban planning. Since industrialization, response to nature has shifted from an arcadian view of peaceful coexistence, to what could be described as a utilitarian view of nature as a resource (Hagan [13]). With industrialization, design started to respond to the constraints of engineering rather than the constraints of site and climate.

"When more and more green technologies are imported into China following the tide of globalization and more applied into buildings and construction of cities, China forgot the ancient principles." (Liu [14])

With this in relief, traditional vernacular approaches represent an investment in nature and cultural landscapes, which is a very valuable attitude today (Rudofsky [15]). "We should learn from nature, repeat and imitate nature, instead of using our own logic to change natural processes. When we use technology, we should use it properly." (Liang [16])

The cost issue was very present in both cases, and often the proposed high-tech solutions were too expensive and had to be abandoned. In the Caofeidian project it was very clear from the beginning that environmental solutions had to be cheap, and a natural element approach with localized and distributed solutions was put forward as means to deal with the cost issue. "The environmental can be made cheaper, even cheaper than practice as usual. You have examples of engineers mentioning high-tech to solve every problem, actually when you go back to traditional human life, it´s very cheap and also very eco. Ecology and economy are very much connected, the key word is cheap." (Liang [17])

4.2 Integration of natural elements

Since natural elements are inherent in the work of architects and urban planners, a more conscious use is easier achievable than approaching high-tech systems. Natural elements constitute the basis of environmental planning, to which more high-tech solutions can be added. The study shows that early integration of natural elements influenced the development of the design concept to a greater extent than integration at a later stage. In the Wuxi project for example natural elements, among other parameters, clearly influenced the design concept. Various environmental simulation software (GIS, CFD, Ecotect etc.), which support a more conscious use of natural elements, could potentially be more actively used by architects from the beginning of the design process. But environmental consideration should not be reduced to an exercise in optimization, optimizing a few environmental parameters at a time. A more discursive, locally based method of environmental problem solving is needed, where flexible and adaptive approaches support decisions instead of prescriptive models. The role of natural elements within the culture of urban planning needs to be more strongly acknowledged. It is clear that to be able to make use of natural elements, it is

essential with a thorough understanding of their operations, otherwise they risk ending up as superficial arguments for certain design solutions. Although interdisciplinary collaboration is a prerequisite for environmental planning, architects could to a greater extent include knowledge on natural elements in education and practice. Stephen Boyden [18] describes culture as a force in nature, and views the environmental degradation seen today as a result of that force. A shift of thinking could achieve quite a different result, and correspondingly the culture of urban planning urgently needs to shift priorities and increase the understanding of natural elements, and assume top priority to living systems.

4.3 Influence of natural elements on the design

Natural elements are more closely linked to the design process compared to technologies, and have potential to generate ideas and concepts and thus influence design decisions to a larger extent. In the cases natural elements had influence on orientation and configuration of buildings, distribution of permeable surfaces and storm water gardens and the use of vegetation etc. Considering that cultural and social structures are under transformation in contemporary China, an expanded use of natural elements, through careful readings of the natural conditions, could potentially be a way to develop stronger local connections. Critical regionalism is of particular relevance to environmentally responsive planning, reflecting an ecological sensitivity in its concern to respond to context, climate and people (Frampton [19]). Improving environmental responsiveness through an enhanced use of natural elements certainly implies potentials for architects, and as expressed by Michael Hough already 15 years ago: “If it can be shown that there are less costly and more socially valuable ways of shaping urban landscapes than has traditionally been the norm, then there is a realistic and practical basis for action.” [20]

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