Chapter 21
Generic Design Tools to Produce Site-Specific Solutions: Three Projects

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21.1 Introduction: Nature of Future Urbanization

In 2006, the earth was home to 6.6 billion people (UN DESA 2013). The United Nations estimated that beginning the same year, the majority of the world population would live in cities and urban areas (UN DESA 2013). Some estimate an increase in world population to as much as 10 billion in 2055 (Emmott 2013). At that point, 75 % of the world population is expected to live in cities and urban areas (UN DESA 2013). In arithmetic terms, cities for up to two billion people will emerge in the next decades, whether planned or unplanned.

The future and nature of urbanization remains open. While countries of the global north, such as Japan, Germany, and certain parts of the US, face demographic changes and decrease in population (UN DESA 2013), many regions of the global south are experiencing a massive increase in population (Burdett and Sudjic 2010), often in an unplanned way, manifested in the form of slums, favelas, ville spontanée, and informal camps (Davis 2006). In countries where economic development, urbanization, and population growth go hand in hand, such as Brazil, China, and those in West Africa, a large increase in urban population is expected (UN DESA 2014). Accordingly, newly built quarters, settlements, city districts, and even entire cities will emerge in such regions (Saunders 2011).

Sustainable urban planning is key to managing this explosive growth in population in an environmentally sound, economically robust, and socially responsible manner. Planning for (rapid) urbanization requires the integration of essential services, such as water and energy supply, consideration of low-emission forms of mobility, local climate conditions, and affordable and socially-appropriate housing, in order to orient these emerging settlements toward environmental sustainability

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and healthful lifestyles as early as possible. However, even with planned, well-intentioned projects, the nature of large-scale projects faces other challenges. For example, critics have problematized the decontextualized, faceless, and generic quality of such new districts (see Koolhaas 1995, 2002, 2010).

This article discusses how methodological design principles for sustainable design can be adapted in practice to produce site-specific solutions in different climatic and socio-cultural contexts. Specifically, this research focuses on three design principles, namely, the Five-Minute City, Blue and Green Network, and Preservation of Built Heritage, to demonstrate how they can be adapted to different contexts, with case studies in Asia, Europe, and Africa, to yield context-specific solutions. The article will also present a discussion of the challenges to sustainable urban development and planning unique to each context, and the creative ways each project responded to local limitations to meet the design principles goals.

21.2 Design Principles

In urban design, designers depend on certain design principles, or tools, to orient large-scale growth toward sustainability. These principles are guiding concepts, or methodologies, that can help determine the formal organization of a site, its density, distribution of institutions and services, and transportation network. While "generic" in the sense that these principles can be used as a starting point to guide the design of a site, they may and should also be adapted to specific local conditions of the site, in terms of the climate, culture, and logistic resources.

21.2.1 The Five-Minute City

The first of the three design principles under discussion is the Five-Minute City. The idea is relatively simple: everything that a person requires on a daily basis should be reachable within a five-minute walk from a public transport stop. This normally includes the home, educational facilities, a market or other shopping facilities, a public park or open area, and potentially also the workplace. With the average walking speed of a person calculated to be 5 km/h, the distance an average person will cover in five minutes is 420 m (Fig. 21.1).

The Five-Minute City is essentially a spatial module that contains the essential aspects of everyday life, scaled to be walkable, cyclable, and/or easily reachable by public transport, thus promoting at once healthy behavior and forms of mobility that are low emission and often also more socially equitable. The presupposition of the inclusion of a public transport system, existing or proposed, in the scope of the project indicates a clear reorientation of a city away from the private car toward public forms of transportation.

The Five-Minute City principle also promotes multi-functional zoning and transport-oriented development, one that features a mix of housing, commercial,

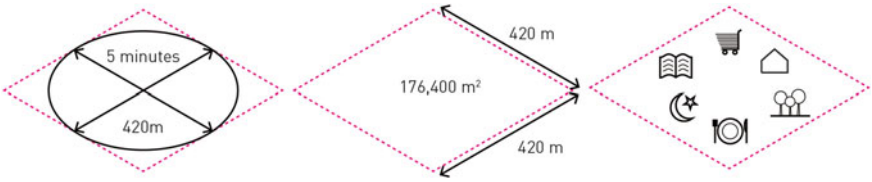

Fig. 21.1 Diagram of the Five-Minute City concept. Image by COBE Berlin

and educational facilities, as well as recreational areas around public transportation nodes, with the goal of fostering a more vibrant and diverse urban life. At the module scale, these elements can remain relatively modest. However, the principle remains that within a five-minute walking radius of any public transport stop, more than simply housing or commerce should be found.

Despite its simplicity, this design principle can yield a great variety of solutions. Programming of the daily needs alone varies depending on the society or culture. It can also yield highly distinct urban districts, depending on the parameters of density, plot ratio, lot coverage, and other urban design regulations.

21.2.2 The Blue and Green Network

The second design principle is the Blue and Green Network. The idea is that the design should preserve and enhance the networks of green (vegetation, e.g., trees, shrubs, woods), as well as the blue (water-related areas, e.g., lakes, ponds, wetlands) spaces existing in a site. By preserving such spaces, the project can protect habitats for the existing flora and fauna of the site, and also importantly, maintain whatever uses these spaces already host. By enhancing these spaces, or by providing improved connections and including design elements or additional programming, the project maintains the existing culture of the site and improves the daily life of its users. Thus, this tool is important for increasing ecological resilience as well as maintaining the history and identity of the site. Furthermore, these blue and green networks have the valuable possibility of additionally and more actively serving as ecosystem infrastructure, and can be incorporated into rainwater or wastewater management concepts; food or renewable energy production; concepts for improved natural lighting, cooling, heating, or ventilation; and recreational functions, among others. Naturally, the extent to which this tool can be applied to a project depends heavily on the existing conditions of the natural habitat of the site, local climate, and political will to value these aspects above economic growth or real estate potentials.

21.2.3 Preservation of Built Structures

Similar to the Blue and Green Network, this principle maintains and, if possible, improves upon the existing heritage of a site by preserving existing built structures.

Built structures include streets, street structures, individual buildings or districts (such as historic city centers), and other artifacts of significance for the local community. In a sense, existing structures can be considered as energy already embedded in the site, in terms of its building materials, design and planning efforts, time, public investments, and history and memory. Again, whether this tool can be implemented within a project or not depends greatly on the political will of the owners and community to value the heritage and maintained memory of a place or respective planning objectives.

21.3 Site-Specific Design: Case Studies

This section of the paper discusses how the design principles mentioned in the previous section have been implemented in designs in a locally specific manner, for three projects in three extremely different contexts, namely, three different cities in three different continents. One is in an intensely urbanizing region of China, Chongqing, where the rural-to-urban migration and economic industrialization are driving a massive boom in population and building. One is in the European context of Copenhagen, where immigration is driving a modest population growth (Danmarks Statistik 2014). One is in a growing area of greater Dakar, between two established urban centers. These projects vary in their phase of development, but the design intent is nonetheless comprehensible in all three.

21.3.1 Magic Mountains, Chongqing, China[1]

The project proposal to be discussed is entitled the Magic Mountains. It is in Chongqing, China, located at the confluence of the Yangtze and Jialing Rivers (Fig. 21.2). The site is located in the mountainous and densely built center of Chongqing, where "the pace and scale of urbanization is faster and bigger than anywhere in the world today" (Watts 2006). This site is also heavily affected by the controversial Three Gorges Project. Although the retaining wall of the dam is situated in the neighboring province of Hubei, 80 % of the impact area of the mega-project is in Chongqing (Hartmann 2004). The project comprises an 800 km long water reservoir with a 2300 m long and 200 m high retaining wall. It is the largest hydroelectric dam ever constructed. As a consequence of the rising water level, 2005 estimates indicated that 13 cities, 140 towns, and 1352 villages would be submerged, and an estimated 1.2 million people would have to be resettled, 85 % of them from Chongqing (Carlow and Stubberggard 2006).

[1]This project was a collaboration between the Danish Architecture Centre, COBE, and Chongqing University.

Fig. 21.2 The Magic Mountains. Image by COBE

This city faced an extreme degree of urbanization at the time of the proposal in 2006 (Fig. 21.3). According to projections, by 2015, an additional 10 million people would have moved from the fields to the new skyscrapers in downtown Chongqing (between 2005 and 2015). By then, 37 million people would be registered residents in Chongqing, which was already the biggest municipality worldwide in 2006, with 31.7 million inhabitants. In this high-speed urbanization, 50 million m^2 of residential and commercial floor space would be developed, equivalent to the completion of three Chrysler buildings every other day. In addition, another 500 km of highways, 3 airports, and 17 new bridges were or are being built, nearly equal to two wide-span bridges being added to the urban landscape every year (Carlow and Stubberggard 2006).

In the context of this urbanism at break-neck speed, the task of this project was to design Chongqing's new "Green" Central Business District (GCBD), to accommodate one year's additional population of roughly 1 million people, and the associated buildings, facilities, infrastructures, public, and open spaces. The project aimed to reduce the overall consumption of resources and energy by 22 % using architectural and planning solutions. This reduction rate equals the amount of the national energy demand that the Three Gorges Dam produced at the time. The larger project ambition was to eliminate water, air, and soil pollution by reducing energy consumption and reversing the rise of private car ownership. The guiding question for the design was: How can this boom be steered in a sustainable way so that the millions who dream of a good life by migrating to the city do not exhaust the very resources needed to provide it?

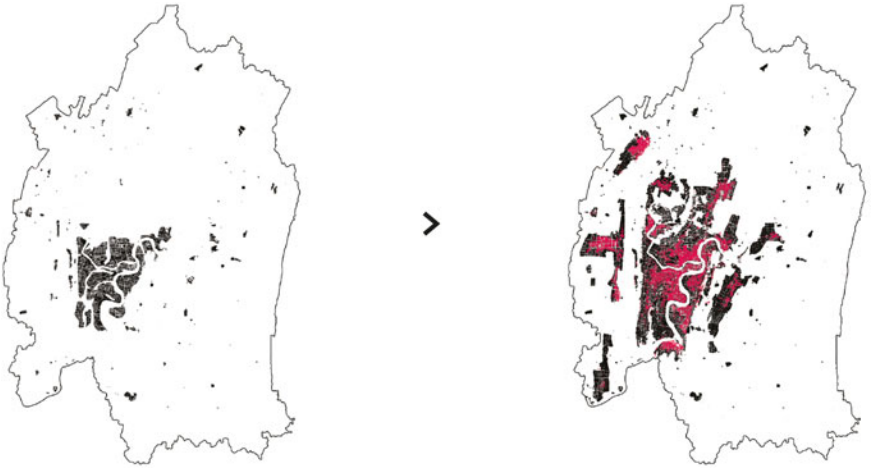

Fig. 21.3 Urban development in Chongqing from 2005 to 2015. Image by COBE

21.3.1.1 Connecting the GCBD

In this project, the Five-Minute City principle was implemented in the GCBD area: everything is reachable in this GCBD within a five-minute walk, namely, the next public transport stop, cultural, commercial, and social institutions, and a park. The urban layout radically promotes walking and the use of public transport, while deliberately excluding individual motorized transport. To justify this aspect, a state-of-the-art monorail spine is proposed, linking the site on a regional level to the "old" and the other planned business districts across the rivers, where such a monorail system is already in place. The 5.5 km long loop ensures fast and easy transit within the GCBD. Monorail stops are located in the densest centers of each neighborhood. Additional stations on the continuous green park take people to the social and cultural amenities or riverbanks quickly and efficiently. Every point within the site is within a five-minute walking distance from one of the monorail stops.

Discouraging the use of cars in favor of "green" transportation is no easy task in the contemporary Chinese cultural context, because car ownership is heavily associated with upward social mobility and economic prosperity. However, by making walking, cycling, and the use of public transport fast, efficient, attractive, and simply the most convenient way of getting around, it would be possible to make the GCBD a car-free district.

21.3.1.2 New Green Network

This project dealt with the intense competing needs of urbanization and preservation of the natural landscape. With the much employed and much-criticized practice of land clearances prior to development, a tabula rasa situation already existed on

site when the project was commissioned. All existing buildings, vegetation, and the local community had been removed. Already, as a mountainous region, land is especially scarce in metropolitan Chongqing. The fertile, arable land and human habitation are limited to the lower river valleys. These also constitute the prime locations for Chongqing's future growth. However, most of this land is already urbanized. Most of the area that is easily accessible is already under heavy use. Further, by 2008, large areas of this habitat were flooded as a consequence of the Three Gorges Project. The available land reserves have been dedicated as building sites to accommodate partially the growth up until 2015.

Thus, given the intense pressure of urbanization on the existing land, the main strategy for the design was to accommodate the population growth through an intensification of the existing land use, and an increase in urban density in metropolitan Chongqing, to limit sprawl. In the proposal, one-third of the site is dedicated to the "living machine," a productive green park landscape. The rest of the site is therefore more densely developed.

In the context of the especially intense degree of urbanization and the impacts of the Three Gorges Project, the Blue and Green Network principle was incorporated into the proposed architectural design itself. As the site is not sealed to motorized traffic, up to 95 % of the entire surface can be used to "bring back the trees." Even on the terraced roof spaces of each building, huge areas of greenery can be planted. This strategy not only creates high quality outdoor spaces but also helps to considerably reduce the carbon footprint and improve the micro-climate of the area, allowing for natural lightning and ventilation.

As another form of ecosystem infrastructure, an underground root zone system was proposed underneath the entire complex, for the purpose of cleaning wastewater from the area. This 0.75 km^2 ecological system is capable of cleaning almost all of the daily wastewater produced. By re-introducing clean water to the Yangtze and Jialing Rivers, the project could modestly contribute to their ecological restoration.

21.3.1.3 Reconstructing a Built Heritage

As a result of the densification, the current trend of construction of compounds or walls of high-rise buildings in the area not only blocks the visual connection with the surrounding mountains but also threatens to blur the city's image as a mountainous city. By 2015, only few buildings constructed before 1980 are left in Chongqing (Sucher 2005). The main impetus for the design was this question: Can the native landscape of Chongqing become a valuable element of identification, when much of its built heritage is already lost?

The proposed design, called Magic Mountains, sought to reinstate the mountainous feeling deep into the dense and urbanized areas of Chongqing. The proposed skyline consisted of a composition of inhabited mountains, with the peaks as the high-density centers mainly containing commercial functions, hotels, and places of business; the lower reaches of the mountains are areas with low density, mainly containing housing. The valleys are green open spaces.

The regulations allowed for an extremely dense floor area ratio (FAR) of 7, which meant the site had a capacity of 15.4 million m^2 of floor space. The design called for the reservation of a third of that area for the integration of an ecological chain, in which production, consumption, waste, and circulation are linked to produce less pollution, be more energy-efficient, and require low energy input. To realize the site's building potential of 15.4 million m^2 and to balance the loss of valuable square meters, density in the remaining area was increased to FAR = 10. The project sought to meet the demands for high-density settlement with low-density qualities of traditional Chinese neighborhoods: open green spaces, fresh air, lively street atmosphere. On an architectural scale, the living machine integrated low-tech solutions for the high-tech demands of high-speed urbanism (Figs. 21.4 and 21.5).

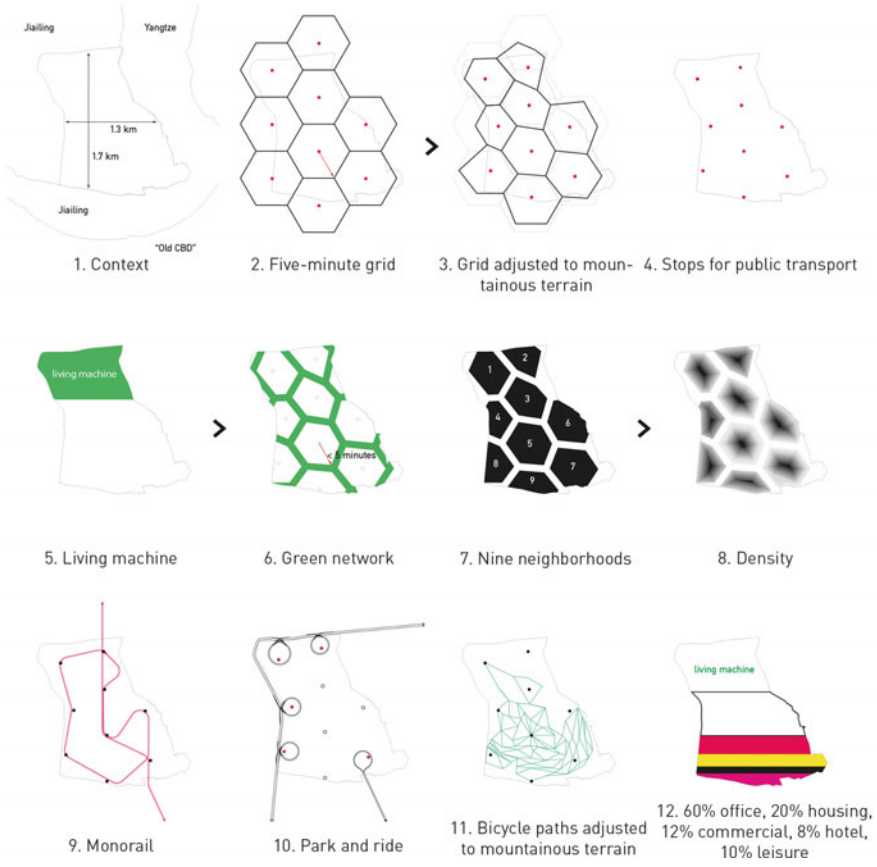

Fig. 21.4 Planning principles for the new district. Image by COBE

Fig. 21.5 Magic Mountains site plan. Image by COBE

21.3.1.4 Magic Mountains: Observations and Conclusions

Although never realized, this project offered valuable insights into the challenge of how to provide local connections within a very large-scale project built more or less from scratch. If this project had moved forward, it would have undoubtedly met some resistance to the measures to minimize the access of private automobiles for meeting the goals of the Five-Minute City principle, even with such provisions as a dedicated monorail service for the new development. With regard to the other two design principles of preserving and enhancing the natural networks (Blue and Green Network) and existing heritage (Existing Structures), a more inventive approach was needed, as the historic city was already razed. Much of the built heritage was already lost, and environmentally, the project had to deal with the consequences of the Three Gorges Project. Thus, the proposal took on a more inventive, daring approach, with a design that integrated the Green Network into architectural and infrastructural elements, and an infrastructure-oriented Blue Network, to manage the waste produced

Fig. 21.6 Magic Mountains at night. Image by COBE

by the development as well as help with the ecological health of the two rivers. However, this case study can be understood as an example where the design had to adapt radically to (re-)produce a localized context, by proposing a new built heritage to pay tribute to what was lost. The project was awarded the Golden Lion as part of the Danish Pavilion at the Architecture Biennale in Venice in 2006.

21.3.2 Nordhavnen Urban Delta, Copenhagen, Denmark[2]

The project Nordhavnen (English: North Harbor) is a master plan for the conversion of a former industrial harbor site into a new urban district, where up to 80,000 people will work and live (Figs. 21.6 and 21.7). Currently under construction, the planning began in 2009 with an open international competition. The project's first phase is scheduled to be completed by 2017. A number of the design principles developed within the study of Magic Mountains were employed in the design of this new urban district.

[2]This project was undertaken as a collaboration between the City and Port Development of Copenhagen and the firms COBE, SLETH, Polyform, and Rambøll.

Fig. 21.7 Nordhavnen, Copenhagen. Image by COBE

21.3.2.1 The Five-Minute Urban Delta

The concept of the Five-Minute City is not radical in the context of Copenhagen or compact European cities in general. For Copenhagen, promoting sustainable modes of transport is already a major part of the city's culture and political goals (City of Copenhagen 2012b). In recent years, the City of Copenhagen has emerged as a role model in promoting smart and sustainable mobility. In this project, the ambition is, as a minimum, to live up to the objective of the City of Copenhagen of obtaining the following distribution: at least one-third of all traffic in the area should be

cyclists, at least one-third should be public transport, and car traffic should account for no more than one-third (City of Copenhagen 2009). To accomplish the above, the Nordhavnen project was designed such that inhabitants and visitors would find it simply much easier to walk, cycle, or use public transport than travel by car. In addition, the scale of the project opens the opportunity to make walking or biking even more attractive and enjoyable than in other parts of the city, which must be retrofitted for those uses.

The master plan is consistently laid out on the basis of the Five-Minute City principle, with short, walkable distances from housing and workplaces to public transport stops, public institutions, recreational spaces, the waterfront, and commercial facilities. Bicycle paths and green areas are distributed throughout the entire district to form a continuous network (Figs. 21.8 and 21.9). A green mobility loop is used as the unifying, identity-creating element in the district. The loop serves multiple purposes and works on several scales. As a figure, the loop connects the various neighborhoods in Nordhavnen with one another, as well as the rest of Copenhagen. The green loop contains the public transport systems at Nordhavnen: an elevated Metro line and a public Bus Rapid Transit (BRT) in the initial phases of the project. In addition, there will be a "super bicycle highway" that will enable cyclists to reach their destinations quickly, directly, and efficiently without having to share the road with automobiles. Up to two-thirds of all people going in or out of the district in the future will move along the green loop; the rest will cross the loop

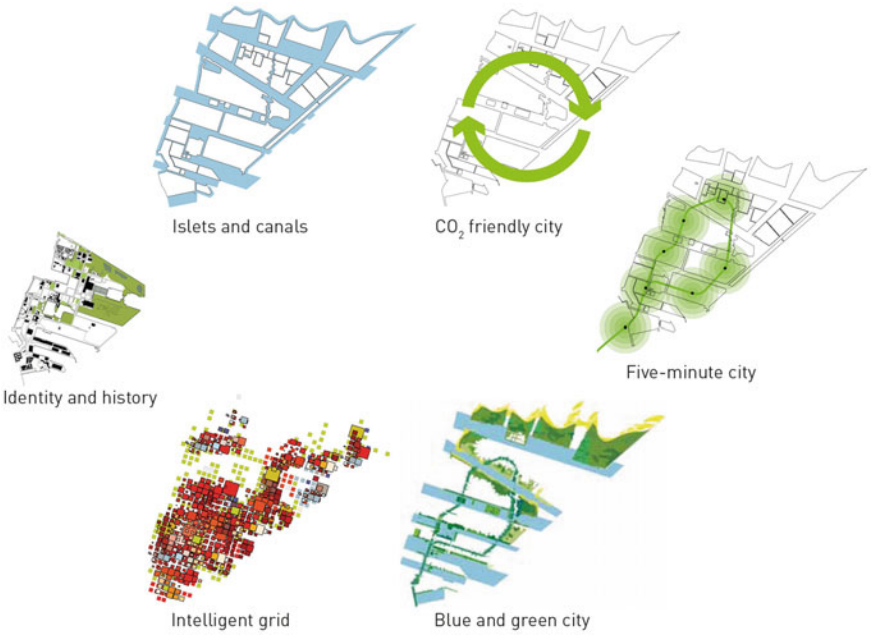

Fig. 21.8 Nordhavnen design principles. Image by COBE

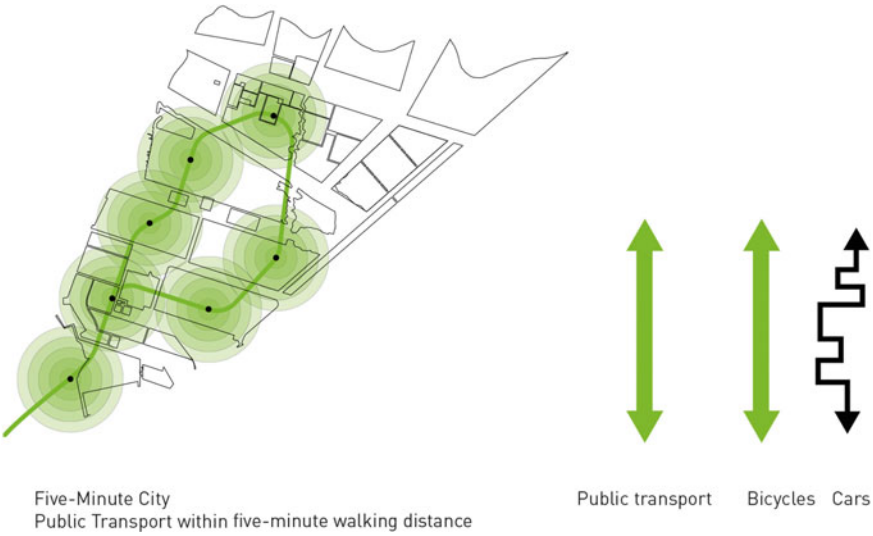

Fig. 21.9 Nordhavnen, Five-Minute City principle. Image by COBE

on their way through Nordhavnen. Education, sports, trade, and cultural facilities are vital to the urban structure, and are located at places intersecting the loop. The green loop will thus be a lively urban space hosting multiple urban functions.

21.3.2.2 Blue Fingers, Green Links

The idea of developing the site's larger Blue and Green Network was also easy to integrate, as the site is formerly an industrial harbor (Fig. 21.10). The entire site area is on reclaimed land, and with its basins, canals, and coastlines, Nordhavnen is a water-oriented site. A central element of the proposal is to increase the water–land interface, by digging out new canals to form an archipelago of islands. Each island functions as a micro-neighborhood. By enlarging the waterfront, the hope was to provide a number of those qualities that people seek when settling outside the core city: proximity to nature. The island structure ensures that the water is never far away. Canals and basins create different spatial experiences and provide a setting for a variety of activities. All waterfronts are public. Direct contact with water is important, especially in south-facing, sun-lit areas. Blue spaces were developed as open coastal expanses, enclosed water squares that can be used for different sports, beaches, and large scenic areas. Access to these water-oriented spaces is provided by stairs, low promenades, and piers. The water spaces will be integrated to adjacent facilities on land, which will reveal the special qualities of a city along the waterside.

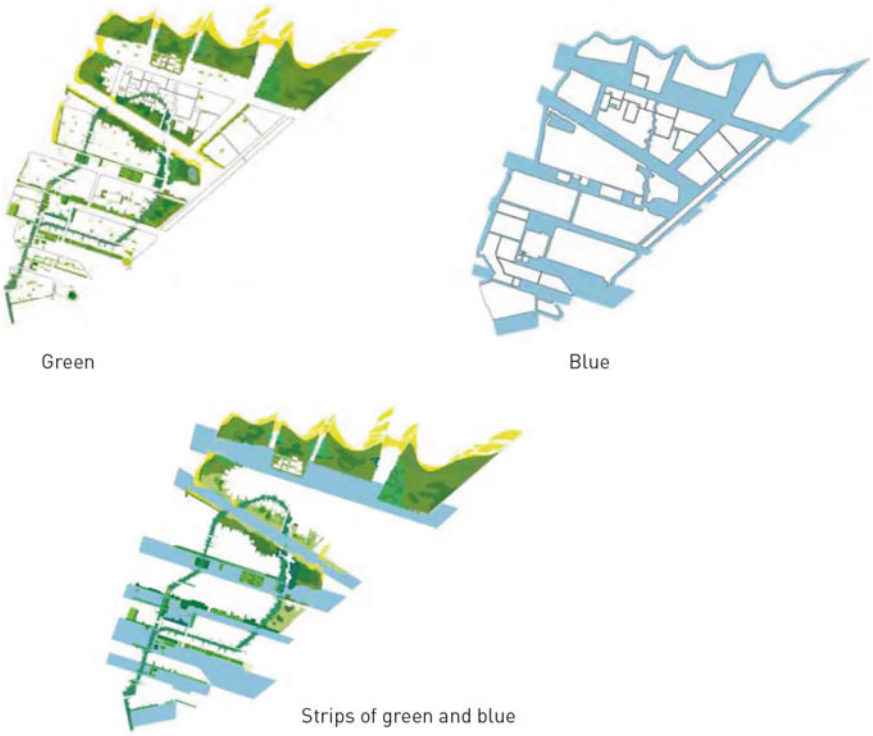

Fig. 21.10 Nordhavnen Blue and Green Network. Image by COBE

In the design, green features, such as pocket parks, playgrounds, planted promenades, and green urban spaces, were integrated with water features in each islet. Extensive grass plains, presently a nesting site for migrating birds, are preserved and integrated into the network. The green structure in Nordhavnen is laid out as an uninterrupted network that interweaves with the blue network. There are smooth transitions between the different types of natural and nature-like landscapes. As such, special places and new opportunities for special experiences are created. In all, a transition from more urban open spaces closer to the central city to more natural urban spaces toward the open sea can be felt in moving from the city to the harbor. The green loop is an integral part of this green structure, which ensures that Nordhavnen will feel like a green city district to the people moving about in it.

This structure delivers a series of different landscape experiences. The strips of green and blue running east to west draw the natural landscape and water across the district. People going through the area will therefore see the varied urban spaces. The closeness of natural landscapes is conducive to a rich and active outdoor life for Nordhavnen's and Copenhagen's residents and visitors. Canals and basins will be used for sailing and other water sports, whereas the green areas offer a wealth of opportunities for physical exercise.

21.3.2.3 Built and Unbuilt Heritage

In this project, the design principle of preserving existing structures was a part of the larger development strategy. The existing harbor lent itself to this principle. However, the challenge in this case was how to install the future in historic surroundings and design the site to be developed over a long time span, adapted for new functions. A dynamic structure to govern the physical organization of the site was proposed, as opposed to a classical master plan. The reasoning behind this approach was that this structure must be sufficiently strong to form a robust framework for urban development, yet sufficiently flexible to adapt to future trends without jeopardizing the main structure. In other words, there is a framework, but not a detailed plan.

Incentives were offered to encourage the preservation of existing industrial and maritime structures, such as silos or other harbor-related buildings. For example, a higher-than-average plot development allowance was offered for those projects that could preserve and renovate existing structures (City of Copenhagen 2012a). Under this strategy, the use and development of existing buildings on a temporary or permanent basis could serve as an anchor of sorts in an as-yet indeterminate plan. While the layout of the islets was determined on the structure plan level, the size and function of building zones will not be determined until buildings are ready to be erected. The ratio of housing to commercial facilities was defined for each individual islet on the basis of its position in the greater urban fabric, but there is greater flexibility inside the boundaries of the individual islets, in terms of the location of housing and commercial facilities (Fig. 21.11). Thus, the urban structure can be developed on the basis of market demand within a flexible buffer zone over a number of years, without deviating from the urban development principles of mixed functions and diversity (Fig. 21.12).

21.3.2.4 Foundation for Adaptive Development

The case study illustrates that the design principles of the Five-Minute City, Blue and Green Networks, and Preservation of Built Structures can provide a robust backbone for the development of a new urban district over time, while integrating and building on top of local cultural and historical qualities. In a planning culture like that of Denmark, high considerations are placed on participatory forms of planning and building a city. These design principles accommodate both the daily needs and wants of the city's population, for example by fostering a local urban culture of walking and cycling. In combination with additional design strategies, current requirements, such as the provision of affordable housing, can also be achieved. The first phase of the project shows that basing the development on the above mentioned design principles also allows different actors, both public and private, to participate in the development. Further, the methodological approach allows for a phased development that can be adjusted to the current demands of the city and its population, while safeguarding the overall quality of open space provisions and sustainable mobility.

Fig. 21.11 Preservation of Built (and unbuilt) Heritage in Nordhavnen. Image by COBE

21.3.3 The City Between the Forest and the Ocean, Dakar, Senegal[3]

The third project under discussion is set outside Dakar, in Senegal, Africa, currently in the preliminary design phase. In Africa, under the pressure of urbanization, entire cities are being built into deserts without proper infrastructure, such as water or electricity, and without any involvement of the local workforce. These ghost towns

[3]The project team consists of COBE Berlin, Mobility in Chain MIC, Transsolar, Gesswein Landschaftsarchitekten, Ingenieurbüro Kraft, and the Institute for Sustainable Urbanism TU Braunschweig. The project was commissioned by iQ Engineering.

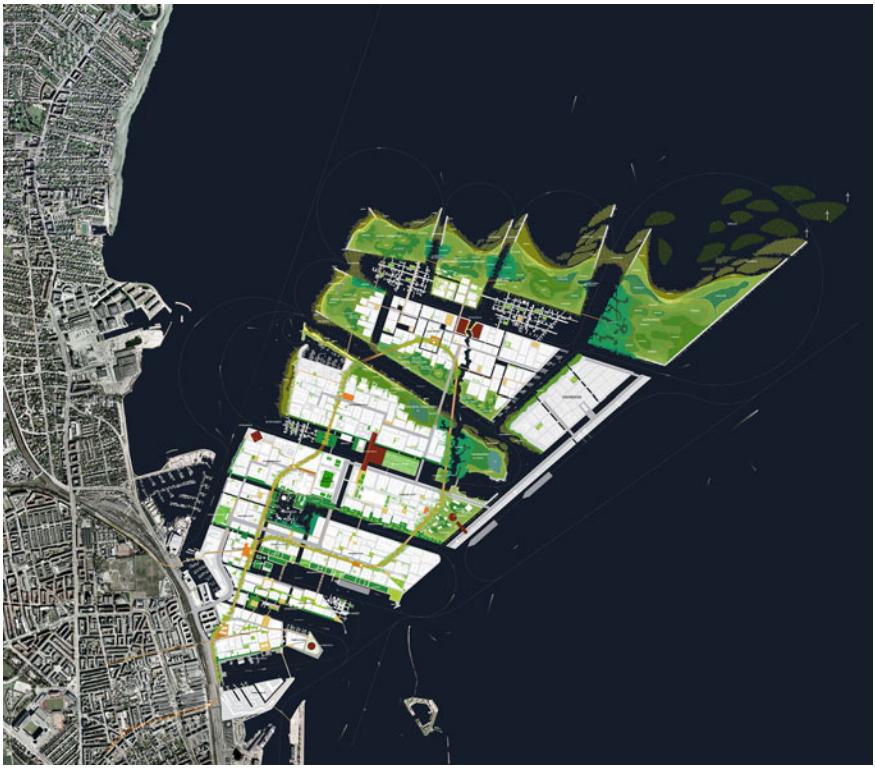

Fig. 21.12 Nordhavnen, structure plan. Image by COBE

are devoid of identity or benefit for the local communities. These developments, often built by foreign developers, can be considered as symptoms of an un-integrated, un-sustainable, and un-ethical approach to planning.

The project under discussion has as its basis the construction of 125,000 new houses to be built in and around Dakar in the near future (Fig. 21.13). With an average household size of six to eight people, a city with up to one million inhabitants will emerge in or around Dakar. This new city provides a huge potential to positively impact the wellbeing of its citizens, as well as push the development of the Dakar region as a whole toward sustainability.

This project takes an integrated approach, with an interdisciplinary team of architects, urban designers, landscape architects, water-, climate-, and transportation engineers, and in collaboration with a material technology firm that provides high-tech materials to be assembled in low-tech manner within a short timeframe and in a responsible way. The goal is to build a truly sustainable, resource-saving, livable, inclusive, and human-scale city, while meeting the challenges posed by the pressure to urbanize rapidly in Africa.

Fig. 21.13 The city between the forest and the ocean, Dakar. Image by COBE Berlin

21.3.3.1 The Five-Minute City as a Basic Building Block

The Five-Minute City principle is used in this project as the basic building block for urban design. The main impetus for this design decision is that this project requires a large amount of housing to be built quickly, but a main goal for the project is to "grow" the city, rather than build it from scratch, in order to successfully embed it in its local context. In Dakar's context, the daily requirements within this radius include the mosque, a kindergarten or schools, the market or other shopping facilities, sports fields and playgrounds, a park, and possibly the workplace. As a building module, the Five-Minute City module makes this massive project essentially phase-able, and thus able to flexibly address the shifting demands under different phases of development.

Each module of the Five-Minute City can be subdivided into micro-neighborhoods and then developed individually, with a variety of plot sizes and housing types. The maximum density of single-family homes is set at 50 % per Five-Minute City module, to encourage population mixing in terms of family size and lifestyle or housing preferences. The maximum amount of housing is set to 40 %, to encourage a mix of functions. Accordingly, within each Five-Minute City, functional and housing mix can be observed, which would increase social cohesion and facilitate everyday activities without dependency on private cars.

When six Five-Minute Cities are established, this cluster forms the larger unit called a Jumma City, derived from the name of a typical Friday mosque. Home to

between 30,000 and 40,000 people, this district is large enough to host additional functions, such as a larger Friday mosque, fire and police stations, a post office, places for adult education, healthcare facilities, and larger sports fields. This district is also of a size large enough to make local management of rainwater economically and logistically sensible. To realize the total of 125,000 housing units, 25 such districts should be built. Together they form what can be called the New City between the Forest and the Ocean (Fig. 21.14).

To help achieve the functional goal of the Five-Minute City, a public BRT system is proposed to provide the backbone of the development. The BRT system allows for efficient and flexible connection within the area and to its surroundings, the core city of Dakar, and the newly built airport. By developing the new city around the existing old town of Diamniadio, located approximately 30 km from the existing urban poles of Thiès and Dakar, the large project can take advantage of existing infrastructure, namely, the existing national road, highways, and railways. A new bus and train station located in the heart of the proposed master plan will provide direct access into the center of the new city. With the functional mix of the city itself, this transport model considerably reduces the overall need for individual motorized transport.

Fig. 21.14 Modular masterplan. Image by COBE Berlin

21.3.3.2 Integrated Blue and Green Network as Soft Infrastructure

All existing green (trees, shrubs, etc.) and blue (lakes, ponds, ravines) networks in the area are preserved. These spaces give a sense of identity to the new city, help manage rain- and stormwater, and greatly improve the micro-climate of their immediate areas, improving livability for the inhabitants. An internal park system connects all the green and blue patches to enhance their overall performance and appeal. These spaces can also be used for recreational purposes.

A large Green Belt landscape is employed in the master plan as a means to prevent uncontrolled sprawl. This Green Belt is conceived as a productive landscape, containing tree nurseries, reforestation areas, agricultural fields, renewable energy production, water treatment and waste handling facilities, and larger-scale recreational and sports areas, including a public beach at the waterfront, which will attract visitors as well as enhance the quality of life for the residents. The Green Belt allows preservation and extension of existing agricultural areas. In this area, much of the trees and shrubbery in the design will be locally produced. Apart from the designated tree farms, the Green Belt provides additional spaces for local and ecological energy production, such as on-shore wind power or biogas plants. The Green Belt also hosts cemeteries.

Another key function of the Blue and Green Network in this project is its role in flood and water management. Dakar has a tropical climate, with a rainy reason lasting for three months followed by nine hot and dry months. The highest temperatures in southern Senegal are measured in April, when temperatures of 40 °C are not uncommon. The lowest temperatures are measured between December and February at around 17 °C.

For long-term sustainability, the management of water in this climatically challenging environment is key. To minimize the impact of the additional demand for water by the new city, the project plans the extensive capture and reuse of storm and wastewater (Fig. 21.15). To accomplish this, the provision of large storage capacity to distribute the harvested water evenly over a period of nine months is required.

Within each Five-Minute City block, storm water runoff is drained from the surface of the roads into a Stormwater Retention Basin (SRB). The flow direction of the runoff follows the slope of the area, which is orientated to the south, toward the sea. Therefore, the SRBs are located in the southern corner of each block. From here, the accumulated runoff can be drained onto the surface of two roads, which drain into to the SRB. The profile of these streets is designed to handle the required amount of storm water runoff. With this strategy, the construction of expensive piping can be avoided and the speed with which the city can be built in a resilient way can be drastically increased.

The inflow to the SRB must be treated mechanically and biologically. In order to accomplish this, new lakes are introduced in each Jumma City district. The lakes will be provided with a recirculation system that pumps the water from the bottom of the lake to the inflow of the treatment facilities along the lakeshore. This system provides a continuous flow and exchange of water in the lake. Keeping the water in circulation

Fig. 21.15 Local storm water management through green networks and road surface drainage in a Jumma City district for up to 40,000 inhabitants. Image by COBE Berlin

helps to avoid breeding mosquitoes. Additionally, fish will inhabit the lake system. The lake will be the main purification stage for harvested rainwater. For the production of potable water, the lake water will be pumped to a waterworks facility where the final purification will take place. All organic matter and remaining bacteria will be removed by membrane filtration before the water is supplied to the city.

This system of rainwater harvesting in the area of the new city and from the catchment area of the adjacent valleys can meet up to a third of the water demand in the new city. The remaining needs to be supplied from an external source, preferably groundwater from a nearby source.

Thus, the new Blue Network will contribute significantly to the overall sustainability of the region by providing an essential water management function. The spaces associated with this function, such as retention ponds and purification facilities, are expected to become highly significant landmarks for the area. These places ensure that the new settlement will not overwhelm the currently scarce and precious sources of water. Further, they can also serve recreational functions for the communities.

One last small additional function of the Blue and Green Network is its role in orientation within the new city. The entire city is rotated 22.6° from north to

maximize shading and cooling winds in the hot season. In the new design, palms are used in streets oriented north to south, and deciduous trees are used in streets oriented east to west. This scheme will help orient visitors within the new districts.

21.3.3.3 Building upon Existing Settlements

Also important to this project is for this growing city to develop its own distinct identity, while fitting well into its existing context. The master plan is based on the growth of an existing town, Diamniadio; the new city can grow from existing landmarks and features, rather than being built from scratch. Set between Dakar and the new airport, Diamniadio has great location potential as the core of a new city. This new city can function as an overspill area and a complimentary town to Dakar. Diamniadio is connected to Dakar by the national road, toll road, and rail. Building on the town of Diamniadio as the core for a new city relieves Dakar of the high development pressure it currently faces, as well as utilizes the large economic potential the development of the airport entails. The site around Diamniadio is not a tabula rasa. A high-resolution satellite image helps identify existing settlements and valuable natural elements, such as agricultural land use, vegetation (such as Baobabs), ravines, and water networks. These elements should be preserved where possible and integrated into the new city to enhance its distinctive identity. Citizens already in the area should benefit from the new development, rather than being dislocated by it.

In exploring the rich building culture in and around Dakar, in particular in the historic site of Touba, a few design principles become apparent that can also be replicated in the new city (Fig. 21.16). These include the grid of streets, the human- and walking-scale of the existing streets, the central place the mosque occupies in each neighborhood (its spires are almost always the tallest point in an area), the mix of walled and solitary buildings, varied and usually small plot sizes, infiltration of the landscape into the settlements, and specific elements of architectural detailing to provide shading and passive cooling.

The architecture and urban design for the new district draws heavily from principles and design elements of traditional Senegalese town planning and architecture. Design-wise, the new city is conceived of as a re-combination of the achievements of contemporary infrastructure planning, water management, climate design, and building techniques with the old city, featuring a lively blend of African, Arab and European influences. This aspect is special, and visible on all scales: from the design of public spaces, architectural typologies, well into the detailing and coloring of the buildings. The hybridization of African, Arab and European influences is especially visible in public buildings, but also in everyday constructions, such as markets and residential buildings.

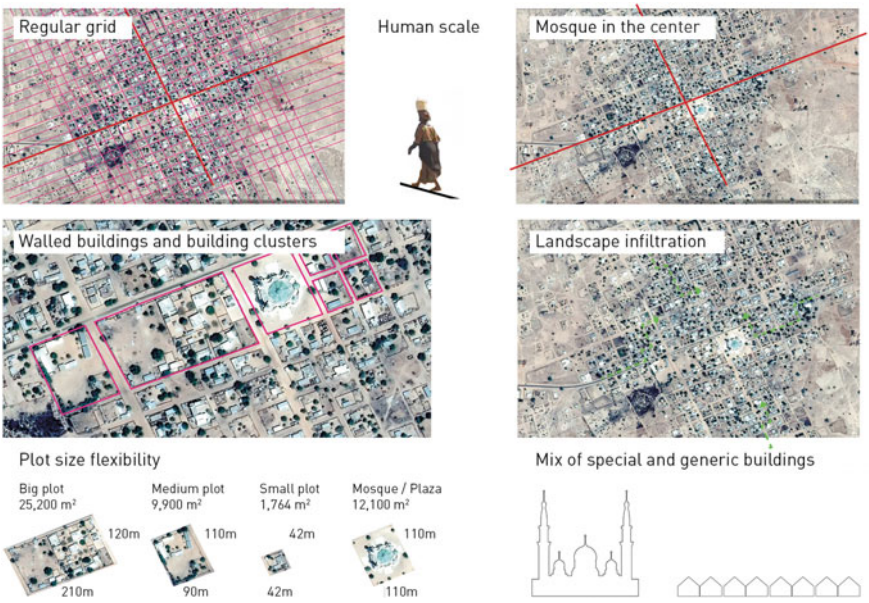

Fig. 21.16 Design principles for a new sustainable city. Image by COBE Berlin

Unlike many other metropolises in Africa, Dakar is more compact and less sprawling, a major advantage that should be preserved in the future. In particular, the well-proportioned, elegant and sleek, light-colored modernist apartment and commercial buildings often radiate a great sense of style. According to architect Adjaye and Allison (2011), most middle-class people live in well-organized apartment buildings that contribute to the urban character of the city, whereas the colonial villas along the waterfront are prime examples of elegant architecture. In the new city, elements found through analysis of typical examples of Dakar architecture will be used to continue the building culture and sense of place currently existing in Dakar.

21.3.3.4 Dakar: Vision for a New City

The vision for this New City between the Forest and the Ocean is that it be a radically sustainable city, for everyone. The current design is marked by its mix of housing, workplaces, and facilities attracting a large diversity of people from different social strata. Mixing types of housing and functions, and thus people, will reduce the overall need for transportation in the Dakar region, help overcome social disparities, and increase the overall quality of life in the area. With its parks, beach,

Fig. 21.17 Vision for a new sustainable city. Image by COBE Berlin

hospitals, university, and water treatment facilities, the city provides opportunities for already existing communities in the region and invites visitors from the outside (Fig. 21.17).

21.4 Conclusion

In this research, three cases of how the generic design principles of the Five-Minute City, Blue and Green Networks, and Preservation of Existing Structures can be adapted to local contexts were presented: The Magic Mountains, which was never realized but whose design principles have been successfully employed in other realized projects; Nordhavnen in Copenhagen, which is under construction; and The City between the Forest and the Ocean, in Dakar, Senegal, which is in its initial planning stage. The three generic tools were adapted to each context to reflect the local culture and habits of its communities, and to compensate for deficiencies of each site where required, thus to establish an urban structure that would be more conducive to environmentally and socially sustainable growth. Specific measures include ways to encourage walking, cycling, and using public transport to get around, as opposed to owning private automobiles; taking full advantage of the existing natural environments to increase liveability, to improve the micro-climate and resilience to disasters; reducing the use of resources and energy; and utilizing

buildings and other existing artifacts in the site as a part of the site's unique heritage, as objects with embedded grey energy.

Often, generic design tools form the basis for the larger design strategy, for example, as a means to "grow" a city in a more integrated, more involved manner, as in the case of the Dakar project; as a means to provide other essential services, such as transport or water engineering, as in the Nordhavnen project; or as a means to improve local climate and environmental conditions, such as in the Chongqing project.

As shown in the three case studies, the foundation of a project can vary greatly in different contexts owing to climate and societal differences, or the specific requirements of the development. However, these tools can be adapted specifically to each of these contexts. Often, the tools cannot be fully applied because of financial, logistical, cultural, or socio-political limitations, as was discussed above. However, in such cases, the designer may find creative ways with which to achieve the goals behind the principles.

In the context of today's rapid urbanization in developing economies, as well as shifting development agendas in established urban centers, sustainability principles such as those described above are important tools to lay the groundwork for sustainable urban development. As demonstrated in this work, these generic tools do not produce generic results but are fully flexible to produce local, site-specific solutions. Responding to site-specific challenges and project requirements while steering the project toward greater sustainability requires ingenuity on the part of the designer. Adapting and implementing these principles to the widely varying cultural, political, socio-economic contexts (and limitations) are crucial to the design process. By navigating and negotiating the limitations and challenges of the local context, these generic design principles can be adapted and deployed to achieve the goals behind these principles, and thus establish a sound foundation for sustainable growth.

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