CONVERSATION WITH THE ENGINEER: BEYOND GREEN BUILDINGS— ENTERING THE ECOLOGICAL AGE

Steffen Lehmann[1] and Peter Head[2]

INTRODUCTION

Arup, the global design, engineering, and business consultancy, is the creative force behind many of the world's most innovative and sustainable buildings and transport and civil engineering projects. Founded over 60 years ago, Arup has operated in China for more than three decades, and almost a quarter of their worldwide staff of 9,000 is based in Hong Kong and China. Arup was initially commissioned by the Shanghai Industrial Investment Corporation in 2006 to put forward concept proposals for a new sustainable city: Wanzhuang Eco-City*, located in Hebei Province. Plans for the 80 sq km site are now being guided by a Development Strategy, the Preliminary Control Plan and Sustainability Design Guidelines.*

British engineer Peter Head has been a director at Arup since 2004 and is based in London. He is chairman of global planning and leads the company's planning and integrated urbanism business, which includes development planning, economics and policy, integrated urbanism, transport and environmental consulting and sustainable development. In his early career, Peter worked at the forefront of steel bridge technology, and in 1998 he was awarded an OBE for his services to bridge engineering. He is also chairman of the Steel Construction Institute. Peter was appointed a Commissioner on the London Sustainable Development Commission in 2002, representing the construction sector. There, he was a member of the group that drafted the Sustainable Development Framework for London, which led an initiative to create a voluntary code of practice for sustainable planning, design, and construction of London's built environment. For the last decade or so, Peter has been dedicated to overthrowing the notion that urbanization is inevitably the fast track to environmental collapse. Specifically, he is fighting to ensure that a growing number of the world's mega cities, and the associated mega projects, embrace sustainability principles from the outset. From 2004 to 2008 he was project director for the Dongtan Eco-City project near Shanghai, a project that has recently stalled. Over the last five years, Peter Head has lectured all over the world on sustainable development and the transformation of cities. He gave the 2008–9 Brunel Lecture Series for the Institution of Civil Engineers, titled "Entering the Ecological Age," which he presented in twenty countries. The Brunel Lecture looked, in detail, as to whether there is a model that would enable 9 billion people to live sustainably on Earth in 2050. It asked which policies and investments would be needed to achieve this and whether it could be done without damaging the economy. In focusing on this ecological transition Peter developed retrofit scenarios for existing buildings.

Steffen Lehmann met with Peter Head at the IGBC Conference in Singapore in October 2009 (where they were both speakers) that discussed the world crises caused by climate change, food and water shortages, and resource constraint problems. Steffen asked Peter what the planner's and engineer's role will be in the cities' transformation to sustainable urbanism. Particularly, how such urban concepts and technologies could be scaled to fit the world's most populous country, China?

Here are excerpts from their conversation.

KEYWORDS

ecological age, rapid urbanization, China, decarbonizing energy supply

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Steffen Lehmann (SL): Peter, with the economical and financial crisis it has become obvious that our industrial model of economic development is failing and we quickly need to move towards a new model based on efficient use of renewable resources and materials. I would like to talk with you about the challenges of designing sustainability at the scale of the city district; for instance, how can we best address the broader requirements for a transformation of existing cities, city districts, and their energy landscape?

Peter Head (PH): A significant paradigm shift in architecture, urban planning, and engineering is required, and has started to happen, with the aim being to achieve a fair distribution of resources and to encourage a reduction in non-renewable resource consumption. To make real progress, we need to think on the level of the entire city and of complete systems. The main parts of such a holistic approach are food, energy, water, and raw materials. Especially important is to include food production as part of a harmonious ecological development. The answer for water is probably in energy, because if we have enough energy we can desalinate water. We need strategies based on "smart responsive simplicity." By this, I mean we should keep systems simple, instead of building more and more complex systems; for instance, to use small distributed, decentralized systems, rather than large central ones. This includes collecting energy from the building and district scale, where every building itself produces the energy it requires to operate and feeding surplus energy into the grid, and also, generating energy from waste and reducing energy used in transport and water supply. The solar energy feed-in tariff, which was introduced by Germany, allows every citizen to produce his own energy, and has been a great success story. This policy is about to get replicated and adapted by fifty other countries.

SL: It needs a dramatic rethink and a different approach to town planning and urban design. I imagine we will probably see more buildings that are simpler and more generic, less specific, to make them more flexible and to integrate newly-developed systems easier. Technology and design are now drivers for any modern economy. It is particularly exciting to think of the domain of sustainable technology and design as an emerging force rather than an established, already defined practice. Given that you are involved in projects from London to Shanghai to Mumbai, how do you feel about exporting this know-how globally? How is the office driving the design of masterplanning projects, especially sustainable developments for China?

PH: Arup has always been active globally. In China, the ecological footprint is currently growing at a rate of around 3 percent annually, which means finding an extra 90 mill. hectares of new land each year. The situation in China is quite unique, and the Chinese people are now beginning to embrace a fundamentally different paradigm in urban devel-

FIGURE 1. Conversation between Peter Head and Steffen Lehmann, Singapore, Oct. 2009.

opment, one which starts to reduce this unsustainable demand. Quite apart from the demographic and environmental pressures, there are commercial incentives, too. They are also saying that if we get it right, we can sell this success, with its urban solutions and technology, to the rest of the world. Every year for the next twenty years it is estimated that up to 10 million people will move from China's countryside to its urban areas. This unprecedented rural–urban migration is placing huge demands on existing cities. To accommodate the new urban population, the Chinese Government plans to build over 50 new cities by 2020. China's leaders recognize the environmental consequences of such growth and have placed an emphasis on economic development based on social harmony, environmental protection, and energy conservation. The volume of people is so large that there is no one answer for how to accommodate them in a sustainable way; however, we are now working on several initiatives with the Chinese Government, private developers, and research institutes that will form part of the solution.

Wanzhuang Eco-City is one such initiative that transforms a number of existing communities into an eco-community. Eco-cities deliver significant, tangible, and measurable environmental, social, and economic gains versus the "business as usual" case for urban development. They demonstrate greater energy efficiency, better land usage, reduced resource consumption, and reduced emissions. We believe that to be truly sustainable, a city must not only be environmentally sustainable, but also be socially, economically, and culturally sustainable, too.

SL: Could you elaborate on the different social and technological strategies you are using for Wanzhuang Eco-City?

PH: The site of Wanzhuang Eco-City is in Hebei Province, 50 kilometers southeast of Beijing and halfway between the nation's capital and the port city of Tianjin. It is close to the city of Langfang, which some have dubbed "China's Silicon Valley" due to its fast developing economy based on computing and technology. The 80 sq km site includes 15 villages with a total existing population of 100,000. The area has been selected by the Chinese Government for development into a city that will accommodate a population of 400,000 people by 2025. We found that geothermal power is available at this location and plan to tap into this wonderful renewable energy resource for a power supply. Prior to our involvement, the plan for the city was a Los Angeles–style grid of roads based on *super blocks*—gated communities on a mammoth scale, typically over one kilometer square, that cause social segregation, encourage car use, and rely on centralized services: electric power lines, sewage treatment plants, sewers, and sanitary water supply. The design swallowed existing villages and would have relied heavily on private cars for transport.

Our masterplan is very different. We argued that the American model is much less useful for China's urbanization compared to the European one, with its compact, mixed-use model. The design proposal begins with the simple proposition of retaining and enhancing existing communities through selective renovation and regeneration. Historic buildings and more organic-shaped street patterns are retained as a footprint for the new city, and the villages are expanded as mixed-use communities that connect with walking, cycling, and public transport to create the city. Jobs will be created for residents in a range of different zones. Expansive historic pear orchards, which are a key feature of the region, will be preserved. We proposed that the standard of living and environmental quality of the existing villages should be improved, as well as them having new opportunities through education and jobs. A community consultation was carried out with villagers to ensure that the project priorities of addressing culture, water transport, and green space were correct. We found that the existing villages in the Wanzhuang area are culturally diverse and could become distinct neighbourhoods. In a cultural workshop with villagers, they expressed the type of cultural spaces the residents would like within Wanzhuang; for example, areas for "pole walking" and public squares for dancing. The aim of these consultations was to encourage local identity and ownership of place.

We gained much experience with the earlier Dongtan Eco-City project, a similar project close to Shanghai, designed for 500,000 people. While this masterplanning project was halted in 2008, it created a large knowledge pool for similar projects in China.

FIGURE 2. Artist's impression of Wanzhuang Eco-City, designed by Arup; the new city is located near Langfang (Hebei Province), China. It's an urban development that is predicted to grow from 100,000 to 400,000 people in the next 15 years, introducing an organic road system instead of a grid of roads. Courtesy Arup, London, 2009.

SL: With such large-scale projects in China or India, I believe it's of prime importance to understand and translate local cultural traditions. Such a careful renewal approach, which you describe, marks a clear change in attitude. Public consultation and grassroots participation, such as running workshops with village leaders to make sure that the planners have the objectives correct from the start to ensure people-sensitive urban design, is a new approach in China. It's about doing things differently. However, I think such strategies are increasingly important for slowing down and harmonizing the negative effects of rapid, high-speed urbanization, which is frequently lacking long-term planning frameworks and guidance for cooperative process. Sustainable design is about holistic approaches and about seeing things, systemically exploring and understanding the variety of solutions that are usually available to any problem. What about the technological strategies for water, energy, and transport in the Wanzhuang project? For instance, in regard to transport-oriented developments close to public transport and mixed-use neighbourhoods, how do you deal with the need for higher density in the urban design?

PH: To determine the best relationship between population density, land value, building density, water management, transport models, and so on, is always very difficult. For instance, water scarcity is a serious concern in neighbouring Langfang, and we have, therefore, suggested a range of methods for reclaiming and distributing water for drinking and non-drinking (grey water) use. Drinking water will be harnessed from underground reserves, and

non-potable water will be made available through the treatment and recycling of alternative sources of water. This water will also be used to recharge the underground reserves. By recycling all the existing waste water from the area and recycling it as grey water, there will be enough water to irrigate the farmland for the first time. This, in turn, will increase food yield. In the landscaping, we reintroduce techniques from the past, slopes which cause erosion and water run-off will be replaced by terracing. The flat surfaces contain and soak away rainfall. Water will be harnessed in the existing canal network, but significant improvements have first to be made to the currently polluted network. In addition, we propose that a new water and waste management system be incorporated into the canal network, including new pedestrian paths for improved access, and tree planting schemes to improve shading and reduce water evaporation.

In terms of transport, the Government has proposed a new high-speed rail link that passes through adjacent Langfang. The site is intersected by an existing freight and passenger railway linking Beijing and Tianjin. We are suggesting a new electric public bus or tram network linking all the villages to Langfang and this new high-speed rail station. A network of direct paths will connect the villages to encourage walking and cycling, and the city centre will be a dedicated pedestrian zone. Cars will have to follow protracted routes along the canals in order to avoid crossing the pear orchards and the cycling and pedestrian paths. Fossil fuel vehicles will be restricted and a programme of extending the use of cleaner vehicle technologies will be promoted. Social infrastructure such as schools, offices, medical centres, and shops will be spread throughout the city to reduce the need to travel and to minimize use of private cars. In regard to density, despite the compact planning, we provide a large amount of green space. Historic pear orchards and poplar forests will be retained and enhanced to become an expansive city park stretching all the way to Langfang town centre. The new park defines the limits of each development area around the villages and reinforces the city edges with high density development. These city parks will provide additional visual and physical amenity to residents living along its edges, thereby increasing its value. Efficient public transport is crucial, as it means better economic growth and a healthier city. By the way, the city state of Singapore is a good example of this. Transport energy in Singapore is really low, and the government continuously invests a relatively large 3 percent of its GDP annually into the public transport system. Singapore is also on the way to becoming a great model for new eco-mobility, as an island state with 5 million people can move more quickly to introduce and implement new policies compared to larger countries.

SL: The fossil-fuel powered energy and transportation systems that currently support our cities must be rapidly turned into systems that supply cities with renewable energy. If we look at infrastructure, we find that cities are always planned and built in direct relationship to their urban infrastructure systems. Transforming our urban environments through better integrated infrastructure and land-use planning will be vital in making the transition to sustainable city districts. Talking about systems, I know you are very interested in *biomimicry* principles, as defined by Janine Benyus, and others.

PH: Yes, nature teaches us some important lessons; for instance: to use waste as a resource; to optimize not maximize; and to use local resources and materials. These are all great principles, which can be applied to urban design, such as looking at circular rather than linear systems. It's not about copying or imitating nature, but about understanding the principles and applying them abstractly. This is performance-led design. I have already described the principle of collecting and using energy efficiently in buildings, but there is also the matter of information: whereby people can live a more sustainable lifestyle through having access to real time information on things like public transport and local services.

SL: In order to reduce car-dependency, many cities have taken action: from Barcelona to Vancouver, from Curitiba to Copenhagen, cities everywhere have adapted robust models, where walking and cycling is made more pleasant and is well supported by an interlinked public space network. The concept of "cities of short distances" is about new ways of connecting buildings and precincts to each other that makes better use of existing infrastructure and moves living

spaces closer to where we work, closer to transport nodes and community facilities. What do you think will be the effect of the electric car on urban design?

PH: That's an interesting question, as we do not know yet if we will need to build more roads to facilitate a new form of transport. I am convinced that very soon we will see the large-scale roll-out of electric vehicles, and this will have important positive side effects on the urban environment; for instance by reducing air pollution, we will get a quiet and clean environment in the city, which will again deliver us the opportunity to increase natural cross-ventilation of buildings by simply opening the window. This means, that the electric vehicle will enable us to build a city district based on natural ventilation and reducing our air-conditioning dependency, which is all very positive. On the other hand, interconnecting cities and city centres with high speed railway will be the future, combined with a policy for public transport-led urban planning.

SL: Most experts agree that sustainable city planning will play a major role in reducing the negative effects of climate change. In the past few years, this role has been actively debated at all levels, and some experts have expressed a very clear and progressive view of what cities could do to tackle climate change related issues. For instance, it has been suggested that we start with city-wide, urban-scale transformations of existing districts, reengineering and retrofitting the existing building stock to make them energy-efficient buildings. Today, the technology and concepts for holistic solutions are mostly available; however, not much of it has really been taken up so far. In the meantime, some cities have grown considerably and have further increased their ecological footprint. A high percentage of environmental problems are produced by the uncontrolled expansion of cities. How can a more sustainable, more compact form of urban design be achieved? Shouldn't we establish strict growth boundaries and clearly focus on densifying the existing footprint?

PH: New urban-rural linkages need to be considered, where we reconnect the urban-rural resource flows to establish a better rural-urban economy, in order to develop the urban and the rural together. Not enough work has been done in improving the relationship between the urban and its rural hinterland. We will also need to consider the important role of brownfield sites, to stop building on greenfield sites, and focus on densifying the existing city.

There are now a series of so-called eco-city projects under way, which are built on greenfield sites and which are in need of further critical assessment. I am still skeptical of the Masdar Eco-City project outside Abu Dhabi. Will it be a model that can be replicated? Will it attract communities and people to live there? Another much published project is Tianjin Eco-City. Unfortunately, its energy supply is based on a coal-burning power station. The energy generation is, of course, a major aspect and in the case of Tianjin Eco-City this has not been shifted to renewable energy, so it's a limited model. We also have to remember that much of sustainability is ongoing, still evolving, and learning by doing. I agree that we need to put higher density mixed-use developments around existing or new transport hubs in cities and suburbs, so that public transport is more affordable and people can get to work more easily. In some sprawling cities, some suburbs will have to be abandoned.

SL: Sustainability has a long history and there are multiple examples of traditional solutions, in vernacular architecture throughout the world, where passive design principles have been convincingly applied. However, over the last fifty years, with the introduction of mechanical air-conditioning systems and other "techno-fix" solutions, it seems like we have forgotten about the most basic and elementary design concepts. Buildings often do not respond well to their environment, climate, and context. How can we better reintroduce passive design principles into planning and architectural design?

PH: It's important to quantify the effect of these passive design principles to better understand how they can be applied most effectively. The combination of thermal mass and greening of walls, roofs, and surrounding spaces to shade and cool the building are all important techniques that can improve the overall efficiency and working and living environment, and they can be much cheaper and more attractive than current designs.

SL: You mentioned that solving the energy question by de-carbonizing the energy supply and introducing decentralized systems to generate energy and supply water is of prime importance. What about the large solar thermal projects like Desertec, which plan to build gigantic solar fields in the desert to supply energy to Europe?

PH: There is enough solar energy in desert regions to power the entire world's energy needs 10 times over. The issue is, of course, how to get the energy from the desert to the cities. I would think hydrogen is a better solution for some situations, like taking energy from the Australian continent for use in Japan. Ships could transport the hydrogen power stored in cells, and the ships themselves could be powered by hydrogen, transporting the power from places with plenty of sun, such as Africa and Australia, to places of consumption. Africa and Australia could become main producers of hydrogen energy and supply it to large cities in Asia and Europe. However, low conductivity grids and the use of wind, waves, hydro, and stream power will also play their part.

SL: Things are moving quickly now, and it seems important that we keep people engaged in sustainability efforts without overloading them with technical information and causing them to lose interest. Peter, thank you very much for the interesting conversation.