Green Buildings and Communities

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The Problem and Opportunity

The design and construction of buildings are critical to our energy future and to the quality of human life. The average North American spends 90% of the time indoors, 5% in vehicles, and only 5% outdoors[1]. We construct buildings to improve our relationships to family, work, community and place, yet they often do the opposite. The built environment uses 40% of the energy we use[2] and modern so-called energy-efficient, sealed buildings often waste energy, reduce ventilation rates and promote asthma (which has doubled in North America since the 1980s). We exercise less in daily life and use more fossil fuels getting to and from work. Our most serious life challenges today (air and water quality, degraded soils, failing agriculture, the loss of species and habitats, wars over resources, and lost opportunities for our children to thrive) have created a planetary emergency. Green building design and construction means purposefully recreating our built environment as a set of facilities for thriving communities and regenerative ecosystems.

Animals, plants algae, bacteria and fungi adapt to changing ecosystems by moving, dying or evolving; humans have the capacity to creatively adapt our organizations, tools, built environments, and cultures to survive and thrive in the face of adversity. Built environments are not living organisms, yet they are living systems within living neighborhoods, cities, and eco-regions. They are workspaces for humans, animals, plants, fungi, algae and bacteria to creatively interact. Built communities can survive and thrive when they create holistic designs that transcend short-term economics, encourage innovation and maintain healthy (mutually supportive) interactions with the rest of nature.

We will examine current practices and the potential for transforming cities to be sustainably green and humane. There are several projects and promising new proposals that are gaining traction. Integrated processes saved more energy and emissions in all stages of building life. Builders that reduced waste throughout building life cycles while improving living and working conditions for workers and occupants reaped greater rewards for themselves and for their clients. The most successful projects have (1) clarified the who, what, when, where and why of their goals, (2) dynamically captured the visions and needs of stakeholders and (3) encouraged creative innovation to benefit multiple stakeholders in concert.

Multiple Benefits

The benefits of holistic design could include (1) lower net construction costs for builders and developers; (2) a net zero or negative energy and emissions footprints; and (3) lower operating costs, healthcare costs and life-cycle costs for owners, operators and occupants. We have been conditioned to expect such benefits to cost more. Additional benefits with zero or negative cost include improved lighting, air quality, social ambiance, transportation, health,

worker productivity and educational opportunities. These can produce lower taxes, healthcare and insurance costs for citizens and businesses. For example, if Chinese urban planners and builders were to adopt a neighborhood development model like the EcoBlock for 25% of the currently planned 4,000 plus Superblock residential neighborhoods over the next year, they could avoid building thirteen drinking-water plants, eleven wastewater treatment plants, and eight county landfills – resulting in a nine billion dollar construction cost reduction and even greater saving by reducing energy, emission, waste management, and healthcare costs for families, businesses, and public services each year.

Scientific Foundations

Science is routinely misunderstood and misused yet it has proven to be more successful at solving problems than religions, ideologies, governments or common sense. Why is that? The reason science works is that all discoveries and scientific laws are considered to be tentative -- subject to further testing. We study and mimic nature and plan our lives using an incomplete understanding of how nature works but we continue learning as conditions change and that is how we add to our successes. Science works best when it is put into the service of humankind and our ecosystems because serving narrower interests alone causes us to overlook changing "external" variables that can undermine our successes.

How can designers and builders maintain perspective and keep critical variables in view? There are three scientific principles we can apply:

1. Keep the human element primary. We too often forget that our buildings, offices, factories, cities and farms are not ends in themselves or merely money machines. The built environment should support thriving people in relationship with nature.
2. Learn all we can from nature. Scientific knowledge is based on the study of nature. Even while scientists study discreet natural processes in isolation, we know that natural processes never operate in a vacuum. Remember to constantly look for contextual variables that may undermine our goals—including the effects of waste and pollution.
3. Work with natural cycles. Nature re-uses resources in full-cycle processes as recognized in the current Chinese economic development plan. When wastes from each process become feedstocks for others, buildings and communities can maximize health and happiness without wasting but regenerating resources. When we create our built environment to combine the five kingdoms of nature (bacteria, algae, fungi, plants and animals) with the five intelligences of humans (emotional, academic, artistic, ecological and organizational) in holistic communities, we can secure multiple benefits and raise our quality of life.

Popular Understanding of Green Buildings in China and the US

The built environment consumes about 40% of total energy in China and the U.S. and most people in industrial countries spend about 90% of their time inside buildings. We would significantly improve our quality of life by improving our buildings—and we can do it profitably with technologies that already exist by integrating them. However, most current builders lack either awareness of the technologies or the skills to profitably integrate them. Homebuyers and owners also lack awareness of what green building entails and the many benefits it could

provide. Surveys of Chinese and U.S. buyers and owners show they do not think about whole buildings, much less neighborhoods or city planning.

When designing and building, we must remember to educate all stakeholders to share information and skills that can make buildings more effective. In fact, buildings can be designed to teach occupants and operators how to save energy, reduce waste and better support their community. The most productive green buildings would answer the following questions for their users: what does each feature contribute to the whole? How can building occupants and operators generate more benefits at lower costs?

Chinese and U.S. Building Energy Consumption

Studies by researchers at Tsinghua University[3] have revealed some valuable comparisons. Chinese buildings generally use less energy than U.S. buildings, which use more than most countries (on average). Among Chinese and U.S. buildings, the least efficient proves to be those with automated central HVAC systems because the heating and cooling systems fight each other. Buildings with windows that do not open are less efficient than others because they take control away from users in each room, tend to re-circulate bad air, and do not keep occupants or operators informed of failing components. The recommendations are to use natural ventilation when possible, install smart sensors and controls at key locations to keep people informed and educated on how to enjoy the best performance from their buildings.

Challenges and Opportunities in Design and Building

Carolina Woo and Robert Wise, architects and planners, have directed and designed major commercial projects, neighborhoods and urban developments around the world. They noted that while human innovation and ambition charge forward, we are only now beginning to harness them to develop humane green cities. Technical innovation too often improves some things and then lowers the overall quality of life. There is a need to integrate human innovation to achieve multiple benefits at once. One example of a green retrofit component that can integrate buildings is Green EcoRoofs on large buildings—which are a focus of the Green Roof Legacy Project. Others include LEED retrofits for commercial buildings, many of which saved enough energy in the first year to more than pay for the retrofit (e.g., Adobe Headquarters[4]).

Successful green development projects, designed and directed by Ms. Woo, include: (a) Canary Wharf, London; (b) Saigon South, Ho Chi Minh City; (c) Xin Tian Di, Shanghai (see Figure 1). The first project involved the 1.2 million square meter financial district of Canary Wharf. The project included open spaces, lakes, trees, and a park-like ambiance. The second project, located in Saigon South, focused on a community of 250,000 people in Ho Chi Minh City. The project included a 17-mile rapid transit system and a natural waterway modified for transportation with no new bridges or tunnels. The plan laid the foundation for including more green technologies as the project continues to evolve. Her third project, the "Xin Tian Di" (New Heaven on Earth) redevelopment plan in Shanghai includes 1 million m^2 of mixed-use construction, a man-made lake of recycled water and many people spaces in the middle of its dense urban development. It is beautiful and functional along many dimensions.

The planetary emergency brought on by climate change can serve as an unprecedented opportunity for the construction, design, and building industries. We can survive this emergency

and prosper if our social, cultural and economic systems transition from wasteful industrial development to integral, regenerative, eco-city and eco-region models.

Figure 1. Carolina Woo's Development Projects

Canary Wharf, London

Saigon South,
Ho Chi Minh City

Xin Tian Di, Shanghai

Many cities and regions are adopting the green redevelopment vision. San Jose, CA, USA; Tokyo, Japan; Tianjin Financial City; and the Tianjin Eco-development Zone in East China are among them. The current market includes over 107 cities that have joined the UN Urban Environmental Accords Planning Project.

The global biosphere's carrying capacity is near its limit. What stops us from developing a multidimensional, organically growing, regenerative economy? The real challenge and the solutions are (1) learning to collaborate with people who have different perspectives and (2) learning to integrate technology with education and grass roots innovation. It should not take an outside researcher to discover when HVAC systems are not performing well. Buildings should be designed to teach us how to make them perform well. Yet, it often does take an outsider to see opportunities that insiders routinely overlook. That is a benefit of including diverse perspectives.

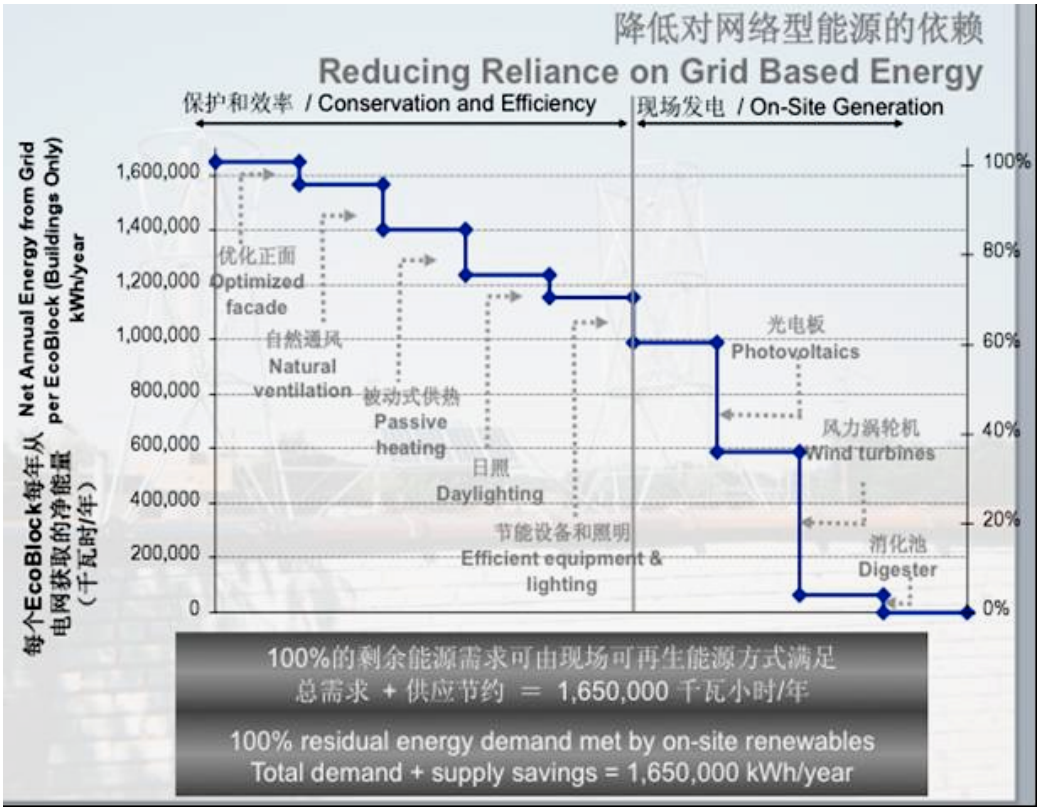
EcoBlocks as Green Neighborhood Design

Another technique for green environmental communities is the EcoBlock design. Harrison Fraker and his team developed this model for neighborhoods to have the look and feel of traditional Chinese architecture but modified to produce a near zero energy and emissions footprint with modern conveniences[5]. This project is designed to demonstrate integrated, regenerative residential and industrial development. One EcoBlock design was completed for the Tianjin Eco-Zone (a Singapore/China joint development project). The Tianjin site has good public transit, plentiful sunlight, and excellent wind resources. It has extensive agricultural land to be integrated as Permaculture. It is on the seacoast and has strong potential for tidal and wave power. The Tianjin Eco-zone is a candidate for a full-scale development of the EcoBlock residential neighborhood model. Once built and functioning well, the EcoBlock will be proposed and locally adapted for cities throughout China.

Why are EcoBlocks needed? At current growth rates, the built area of China will double within 25 years. Traditional construction models create serious problems by wasting resources, preventing agriculture, and degrading the natural environment. However, the EcoBlock model incorporates energy reduction strategies, which include passive solar heating, high performance glazing, shaded walkways, natural ventilation, reflective pavement, natural light, shared plug-in

vehicles, solar water heating, on-site wind power, and rainwater capture. It might even contribute to the energy grid, if it was well planned and connected (see Figure 2).

Figure 2. Energy Demand Reduction and On-site Renewable Energy Generation[6,7]



Since energy efficiency and on-site generation are integrated with battery storage, energy requirements will be met without taking power from the grid.

It should be noted that EcoBlocks are not stand-alone solutions. While they are less dependent on parent cities for utilities, high energy demands from sources other than residential buildings, will require external energy. And when neighbors need more energy, EcoBlocks can share their excess energy. Ecoblocks will be most effective when they are integrated with parent cities and eco-regions even while they remain independent for basic necessities. As cities reap the benefits, they will creatively develop new versions of EcoBlocks. The EcoBlock model could also serve to inspire citizens, designers and students through systems that are not based on buildings, such as communication, shopping, entertainment, education, emergency response, recreation, etc.

Conclusion

When Chinese, American, and international innovators work together to build and improve EcoBlocks, Eco-cities and Eco-regions, we will become continually more integrated

with natural development. As human communities learn to be responsible and regenerative, we can thrive and develop without depleting our ecosystems.

As a scientist, I do not see this as a utopian situation. There will always be problems to solve and improvements to make. However, once we adopt this holistic perspective on buildings as facilities for individual and community development, in partnership with nature, we can more easily build alliances across specialized professions, trades, and cultural diversity to avoid the planetary emergency and severe challenges.

We can educate ourselves to creatively and continually improve our quality of life. Our education systems can transcend the incomplete understanding of green buildings and green living held by current building owners and buyers. We can even utilize our buildings and infrastructures as interactive teaching tools with immediate experiential benefits as well as promote long term economic benefits. We can develop buildings and neighborhoods that generate their own power and convert their own wastes into resources while reducing the need for expensive and wasteful public utilities that use fossil fuels and cause pollution. Modern internet capabilities, smart meters, smart phones, smart appliances, and interactive educational media can enable buildings and utilities to participate in the education process, teaching us, with location based services, to save energy and convert waste into resources while facilitating feedback from users and operators.

As a result of this green building forum we can see that green construction and urban planning can deliver more benefits than simple energy and emissions reductions. They can save money in construction, public utilities, and health care. The key will be to use science, technology, collaborative education and creative innovation in a unified strategy focused on supporting regenerative communities in partnership with nature.

Acknowledgements

This paper is based on a panel presented at the U.S. China Green Energy Conference held in Beijing in November 2008. Panel participants included Wei Zhou, Carolina Woo, Robert Wise, Qingpeng Wei and Harrison Fraker. Their ideas were incorporated into this report. Qingpeng Wei and Yi Jiang of Tsinghua University participated via a presentation by Dr. Wei, and their views are outlined a separate companion article they wrote for this volume comparing U.S. and Chinese building energy use.

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