VERTICAL CITY: A SOLUTION FOR SUSTAINABLE LIVING

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Preface

The publication of *Vertical City* is very timely, especially in Asia, where many countries are experiencing rapid rural-urban migration. By my estimate, if China, India, and Indonesia were to become as urbanized as the USA in the next 20 to 40 years, China has to build the equivalent of three USAs, India five USAs, and Indonesia more than two USAs. In total, they have to build over 10 USAs. That means that for every building existing in the USA today, these three countries have to collectively build 10 of them.

One may rightly ask, where do we get planners, architects, contractors, and materials to design and construct them? It also leads to the obvious conclusion that these cities must be compact, with high densities and often large populations. Despite their size, China, India, and Indonesia are acutely short of land for both urbanization and agricultural needs.

However, the problem of land shortage may be used to great advantage. As cities are forced to go vertical, compact cities enable more facilities and amenities to be located near homes and help mass transit systems become more viable. If well related to land use pattern, mass transit can move a lot of people quickly, save travel time and energy, alleviate road congestion, and improve the quality of life of many individuals. It would then appear that vertical cities are a good way to go.

But governments, professionals, and citizens have to try hard to make the city work efficiently while designing a beautiful and livable vertical urban environment. I hasten to add that a vertical city must still have parks, amenities, landed properties, etc., to create a rich mosaic of urban milieus and to give people a good spread of environmental choices.

Tiny Singapore faces this challenge even more acutely than large countries. We have just over 700 square kilometers [270 square miles] of land already housing more than 5 million people, with many more to come in the decades ahead. The land mass is limited, but the population growth may be unlimited.

While our government will have to find ways to curb the population increase rate without frustrating economic growth, physical planners have no choice but to plan for high-rises, drawing upon our rather creditable experience accumulated over the last 50 years. We have to walk a tightrope to achieve our multiple goals of being an attractive business center with quality environment and good life.

Let me share with you a few thoughts about how Singapore has turned what was a squatter-ridden city into a modern vertical city over several decades.

In preparing the Singapore Master Plan of 1991, the concept of urban cells (or modules) came in very handy. The city is spatially subdivided into cells at different hierarchical levels. The city of 5.5 million people is first divided into four regions. Each region, with a population of just over 1 million, is about the size of a small city. Each region, in turn, contains about five new towns. Each new town, with a population of around 200,000, accommodates an average of 10 neighborhoods, and each neighborhood is made up of around half a dozen precincts.

With this approach, our planners can assign different densities to different precincts. Gardens, schools, sports fields, lower-density housing, and neighborhood centers are interspersed with high-rise residential precincts so as to moderate the oppressive sensation often associated with extensive areas of tall buildings. This approach seems to have worked. Many visitors to Singapore have commented that our city appears to be less dense than the data suggest.

This leads to a second interesting planning concept used in Singapore: that planners have been able consciously to create an illusion of density, of city size, and of greenness. The juxtaposition of high- and low-rise precincts not only reduces the oppressive sensation of density but gives people an impression that the city is larger than its real size. By locating parks and green buffers strategically, our city appears much greener than the actual amount of green areas used.

But we have to face the fact that high-rise buildings are buildings with handicaps—of heavy dependency on elevators, of being divorced from the ground, of losing one's own identity in a big building, and so on. As early as the 1970s and 1980s, we attempted to identify the handicaps, or shortcomings, of high-rise living, and we did our level best to overcome them through clever site planning and design solutions.

The Housing and Development Board has attained a fair measure of success. Singapore's residents are happy, crime rate is low, and community spirit is strong. An important benefit of our high-rise public housing is that since 1985, Singapore has become a city with no squatters, no homeless people, no poverty ghettos, and no ethnic enclaves. With 82 percent of the people living in public housing flats, Singapore is now a city where 93 percent of the total population owns their own homes, and where the satisfaction level among public housing residents has been 95 percent in the last two decades. Clearly, it is possible to create a vertical city with a quality environment if one were to understand the challenges and were committed to overcome them with creative methodologies.

The last point I would like to make is that planning a city is like assembling a piece of industrial design, such as a car. Whether it is a city or a car, the planner-designer must understand the needs of the people in order to make it simple, user-friendly, comfortable, and convenient to use. In the case of a car, the engine must function like a dream.

Similarly, a city planner must know intimately all the various parts required to complete the urban machine. Only then can he or she assemble them into a perfectly functioning whole. Further, given two cars with the same ease of driving and the same perfect engine, a buyer will choose the car with the more beautiful body design. Likewise, a more beautiful city will attract investments and talent.

This book raises the need to seek new urban forms to tackle vertical cities. It is indeed necessary, as cities in the modern world are facing challenges not previously experienced.

Liu Thai Ker

For Liu Thai Ker's biography, please refer to *Planning* in Section 3.

Foreword

The word "sustainability," in reference to man's relationship to Nature, brings to mind powerful notions of coexistence, balance, and harmony—terms more closely associated with Eastern philosophies than those of the West. In an agrarian society whose existence is so closely tied to the ebb and flow of nature, there would be no peace of mind—or tranquility, if you will—until people learn to bend with the unpredictable forces of Nature, taking heart in the knowledge that rain will follow the drought, feast will follow famine, yang will follow yin.

Similarly, in the early days of Western civilization man saw himself at the mercy of Nature. Nature was too immense, too powerful, too mysterious to grasp; the primary focus was on survival. People planted crops and tended flocks and as the seasons passed, they either reaped and sheared or starved and froze to death. However, with the advancement of science came the conviction that human determination enabled by technology could conquer Nature. This led to the draining of wetlands, clearing of forests, damming of rivers, widespread plowing of open plains, and the building of highways and cities.

Early on in human history, the Ten Commandments served as a guide for man's behavior toward his fellow man; warnings foretold the eventual end of the Earth as punishment for people's indiscretion and inhumanity. But it could not possibly have been imagined that it was within man's capacity to destroy his own universe—either quickly by nuclear warfare or slowly by the wasteful habits of billions of mindless individuals consuming Nature's limited resources, polluting the soil that we depend on for food, the water we drink, the air we breathe. They did not envision the dire consequences that would lead to global warming and another ice age, nor anticipate the depletion of the earth's protective ozone layer thereby allowing the bombardment of life on earth by cancer and mutation-causing ultraviolet radiation.

Had the ancients foreseen the potentiality of man's destruction of Nature, there might well have been an Eleventh Commandment: "Thou shall not waste!" It is precisely this concern over waste that motivated Kenneth King to undertake this book.

Kenneth King is a New York–based Chinese-American architect who was born in Shanghai and has for the last thirty-plus years traveled frequently between the United States and China. He has been an eyewitness to the East's astonishing urbanization with its blinding pace of construction of new buildings, towns, and unstemmed sprawl; he has also watched the irreplaceable loss of farmland. He has heard the many ardent public endorsements of sustainability and has observed the often less evident results. Like many familiar with pre-modern China, he was left to wonder what had happened to those steadfast values that once guided one of humanity's oldest civilizations. Could it be that they were reflections of a slower agrarian society and that they must now make way for the demands of a faster, less patient world? What will be the paradigms that will guide modern China forward?

To better understand the complex forces at work, and to examine whether the course currently taken is inevitable or whether there might be more prudent alternatives, it was determined that the most constructive approach would be to write a book. It is hoped that the results of this exercise will generate discussion among interested readers, thereby sparking new ideas and possibilities for the future. It was in this context that I, also a Chinese-American architect with a half-century of experience working in the East, was called in to help. The hope was that our collective views and shared personal and professional insights would add resonance to the exploration.

It is important to understand that we coauthor this book as concerned observers with no pretext of being experts. Instead, for authoritative insights, we interviewed a wide range of academicians, practicing architects and urban planners, building technology specialists, and experts in such related areas as life safety, community development, land use, and, of course, sustainability.

New York is the largest, safest, and most racially and ethnically diverse city in the United States. It is also the greenest, with some 27,000 acres [10,925 hectares] devoted to public parks and a mobility rate of 82 percent on public transit, bicycles, and on foot. If New York were an independent state, it would rank lowest in per capita energy use.

The further we ventured, the more we learned about the enormity and complexity of the field, and the far-reaching significance of our investigation. Each conversation opened new possibilities, new experts to consult. Ultimately we had to draw our research to a close, even though there were many other experts we would like to have engaged. We hope that this book, however incomplete, may nonetheless make a contribution to the raising of awareness, and to stimulating the kind of discussion, argument, and debate that is essential to bring about change.

Kellogg H. Wong

For Kellogg Wong's biography, please refer to the Appendix.

A Personal Note

I am an urban dweller. I was born and raised in Shanghai, after which I lived in Hong Kong for three years and then in London for five before settling in New York in 1960. Since the late 1970s when China opened to the world, I've pretty much split my days between Shanghai and Manhattan. Along the way I've spent a good deal of time in Paris, Zurich, and Pacific Rim cities like Kuching and Kota Kinabulu in Malaysia, Kuala Lumpur, Seoul, Singapore, and Tokyo, not to mention Beijing, Tianjin, Taipei, and a host of other large—and growing—Chinese cities.

What I like about cities is their efficiency and adjacencies and the sheer convenience of being able to move around on foot or public transit, quickly and inexpensively, without ever having to own a car. I like the rich variety, interest, and excitement—the fun—of city life, and the opportunities for social interaction in restaurants, concerts, parks, or in spontaneous exchanges on the street rather than being isolated in a car, wasting and polluting precious hours while commuting back and forth to work, pulling into a driveway, and disappearing into a single-family house sealed off behind a tidy green lawn and white picket fence. From an environmental perspective, the American dream is a petrol-dependent nightmare.

I'm sure there are people who would disagree with me, particularly in the United States, where, dating back to Thomas Jefferson, there's been widespread misapprehension about cities as centers of unhealthiness and vice. Many environmentalists reinforce this anti-urban bias. Cities, they say, are the greatest energy consumers and the greatest polluters on Earth. It's true. Cities currently cover only about three percent of the planet yet they devour the lion's share of its natural resources and emit about eighty percent of global carbon dioxide and significant amounts of other greenhouse gases.

But by the yardstick of the individual, the picture is very different. The per capita energy use of dense cities like New York is significantly lower than elsewhere in the country; it might come as a surprise that the highest per capita consumption is in the wide open plains of Wyoming. Typical New Yorkers consume far less electricity and gasoline and use far less water than their suburban counterparts. They occupy less land, produce less waste, produce lower noxious emissions, and in general inflict less damage on the environment. Clearly at this point in our imperiled ecology, we need to learn the lessons that such cities can teach.

Given the unprecedented urbanization taking place in China and other developing countries, the need is urgent. If China, for example, keeps on building sprawling new cities to accommodate the massive migration that is expected to continue for the next thirty years, there won't be enough land to grow food. There won't be enough water or other resources. And if, with their new found wealth, people continue to buy cars in record numbers, the ecoconsequences will be calamitous, not just for China but for the world.

We no longer have the luxury of thinking about such problems, least of all about their solutions, in isolated terms. This is a war—a battle for survival—that will not be won in small uncoordinated skirmishes. It is not just an issue of per capita usages but of global stewardship, reduction, conservation, and commitment.

It is neither reasonable, nor possible, to try to stop human energy consumption. But we can use our resources more intelligently, more sustainably. We have the knowledge and the wherewithal. And, with the right leadership, we have the ability to succeed. We need to revisit familiar patterns and determine whether they are valid or are actually destructive and merely sanctioned by habit. We must understand and embrace the need for change and give full rein to our imagination so that we may benefit from new and emerging technologies and creative ideas.

For years I toyed with the notion of setting forth my ideas in a book. Ironically, my most altruistic and lofty aspirations were unleashed by the grim urban reality of bumper-to-bumper full-stop traffic. What could possibly be the problem, I wondered in the back seat of a taxi. It turned out that service crews were making an underground repair. The roadbed had to be opened and excavated, the utility repaired, and then the street resurfaced with heavy equipment. The entire operation

Utility repairs disrupt traffic in midtown Manhattan, creating delays, pollution, and safety risks for pedestrians and motorists.

took days, while the repair itself required just over an hour. The inconvenience and cost, the exasperation, the lost time, and the idling pollution of so many cars for such a long period all struck me as so destructive and unnecessary. There just has to be a better way! This incident was the seed that launched my quest to eliminate as much as possible the urban problems that we've inherited, to find a better way to accommodate human needs, and to design a modern sustainable city.

We can no longer live our lives without regard to the impact we have on the environment. Nor can we feel self-satisfied in our new Green awareness and determination to curtail or halt environmentally damaging actions. For the sake of our children, it is not enough to settle for doing less that is bad; we must reformulate the equation to make a positive contribution. We have no choice but to turn things around. Why not take the best aspects of human habitation from wherever in the world they might occur, fuel them with imagination to create new possibilities, and develop new paradigms for modern life. That's what this book is all about.

Kenneth S.H. King

For Kenneth King's biography, please refer to the Appendix.

Acknowledgments

This book is the result of a rich harvest from many brilliant colleagues, as well as wise friends and dear family members. There is no way to adequately express my appreciation to this global community for the myriad contributions that helped bring forth this vision for our planetary future. I am in awe of what we have achieved as a group of committed citizens and professionals, and that gives me hope for what humanity can achieve as a whole.

Let me begin by thanking the team whose untiring efforts to coordinate, organize and edit have been the backbone of this effort. At the top of the list is Janet Adams Strong, Ph.D. who went beyond the call of duty to integrate the many parts of this book`s vision from research, interviewing, writing, editing, to managing all the contributors. A challenging task that required great patience and discipline this book could not have happened without her dedicated effort. Across the world our efforts in China were smoothly coordinated by our esteemed friend Dr. Yiguo Zhang along with the professional translation team spear-headed by Dr. Shanshan Chen.

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A heartfelt thanks goes to the accomplished architects, planners, academics, and professional friends who generously shared their knowledge, expertise and time. We began the interviewing process in discussions with good friends in New York, including the distinguished structural engineer. Leslie E. Robertson, and Marvin Mass, the renowned systems engineer, and his learned associate Scott Ceasar, at Cosentini Associates. We continued with our former colleagues from I. M. Pei & Partners:William Pedersen of Kohn Pedersen Fox Associates, curtain wall specialist Robert Heintges of Heintges & Associates, Maria Sevely of FORM | Proforma, and Calvin Tsao & Mckown Architects.

Our research led us to contact, and forge good friendships with, vertical transportation specialist Rick Barker of Barker Mohandas, structural engineer Dennis Poon of Thornton- Tomasetti, and vertical farming pioneer Dickson Despommier, who favored us with an introduction to Gregory Kiss of Kiss + Cathcart. Ajmal Aqtash of form-ula and core. form-ula shared his extensive knowledge of emerging building technologies and similarly put us in touch with his guru, Carl Galioto at HOK. We were enriched by additional meetings with T.J. Gottesdiener of SOM, Ashok Raiji of Arup, and Erich Arcement of Sam Schwartz Engineering, traffic consultants. We followed up, rather late in the book`s development, with Valentine Lehr of Lehr Consultants International and our good friend William Faschan of LERA, both of whom generously contributed to our understanding of the special engineering challenges posed by supertall buildings.

Tall-building research led us inevitably to Chicago, where we had the good fortune to speak with Antony Wood, executive director of the Council on Tall Buildings and Urban Habitat, as well as to Adrian Smith and Gordon Gill, and also to Philip Enquist of SOM. Continuing west, we benefited from conversations with Professor Rhonda Phillips at the sustainability-focused Arizona State University, San Francisco architects Mark and Peter Anderson, and ecocity trailblazer Richard Register. We made a special trip to the University of Maryland at College park to learn about land management in China Professor Chengri Ding, and to Chapel Hill to meet with urbanist and China specialist Thomas J. Campanella at the University of North Carolina. We are happy to acknowledge Professor Campanella`s mentor, and our old friend colleague Tunny Lee, former head of the Department of Urban Studies and Planning at MIT, who we visited in Cambridge, Massachusetts.

Special interest in China brought us to Beijing, Shanghai, and Tianjin to confirm firsthand our growing knowledge bank and to ensure that our long personal experience in China would analytically encompass current conditions. We are especially grateful to the many people who offered assistance, among them Kenneth P. Wong, real estate COO and Director of International Development of The Related Companies in Shanghai, and the prominent architect and urban planner James Jao of J.A.O. Design international in Beijing.

Viewing urbanization in its global contexts prompted us to investigate other BRIC countries (Brazil, Russia, India, and China) until the constraints of time and budget limited our preliminary research to Brazil. We gratefully acknowledge the generosity of the distinguished urban innovator Jaime Lerner, former mayor of Curitiba, and also Alfredo Trinidade from the Secretariat of the Environment, who could not have been more helpful. We appreciated the opportunity to discuss urban planning with architect-professor Bruno Padovano of Faculdade de Arquitetura e Urbanismo da Universidade de Sao Paulo. For a portion of our trip we were fortunate to be guided by the very knowledgeable Flavia Liz Di Paolo. Through her good efforts we were introduced to Jorge Rubies, the leader of Sao Paulo`s grassroots preservation movement, who struggles valiantly every day against the growing casualties of unbridled urbanization.

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SECTION ONE / A CALL FOR A VERTICAL CITY

The world's population, currently 7 billion people, is expected to reach 9 billion by 2050.

8-8-8 Manifesto

8-8-8 MANIFESTO OF NEW URBAN FORM
We advocate the following policies and strategic goals, all interrelated but conveniently grouped in three manageable agendas of eight (8-8-8).

ENVIRONMENTAL

1. **Curb global warming** by every means available. This is an imperative of the first order.

2. **Use clean energy** such as solar, wind, geothermal, and tidal sources, or biomass energy from plant-based materials, all of which can help significantly to alleviate both climate and energy crises.

3. **Localize power sources** in close proximity to end-user consumption in order to prevent significant energy loss through transmission over long distances.

4. **Preserve arable lands.** This antisprawl initiative is one of our greatest concerns, as land lost to development will never be returned.

5. **Conserve clean water**, by means of rainwater capture, evaporative technologies, and the reuse of gray water for nonpotable purposes.

6. **Detoxify air** through indoor and outdoor plantings that recycle exhaled carbon dioxide into life-sustaining oxygen, and purify the atmosphere of airborne pollutants.

7. **Reduce waste through recycling and reuse**, separating compostable matter. Adopting Nature as our model, wherein waste does not exist, our goal is to achieve zero waste. Such an undertaking is possible through coordinated management, applied technologies, and full-spectrum education programs that make clear the positive benefits (and also the negative consequences) of noncompliance.

8. **Localize food production**, utilizing aquaponics and fish ponds for fresher, better-tasting food, discontinuing the use of chemical preservatives and refrigerants, and reducing the pollution and spoilage involved in long-distance shipping.

8-8-8 Manifesto

FORMAL

1. **Maximize density and compactness** for maxmum efficiency in clustered ultra-tall towers.

2. **Limit the project footprint** to 15-minute walkability from one end to the other.

3. **Dedicate the main surface level to car-free pedestrian-friendly use** with easy access to shops, services and outdoor resources for recreation and enjoyment.

4. **Confine passenger vehicles and deliveries** to lower levels of a raised podium for increased safety, reduced pollution and surface congestion, and improved quality of life.

5. **Locate utilities accessibly in order to facilitate secure access** and minimal disruption during maintenance and repair.

6. Provide mass transit for clean, efficient access around the Vertical City, with intermodal l, inks to outlying areas.

7. **Link the towers with sky lobbies for structural stability**, convenience, increased efficiency, and security, and expand opportunities for social interaction in a series of linked town squares in the air.

8. **Use the latest high-performance technologies** to optimize efficiency and sustainability.

8-8-8 Manifesto

SOCIOECONOMIC/POLITICAL

1. **Mix uses to meet essential needs** for employment, housing, education, recreation, health care, and other necessary requirements; optimize the efficiency gains of centralized labor and consumption markets by doing away with long wasteful and polluting commutes between home and work. We endorse the maximum range of services and amenities to enrich individual life experience, ultimately resulting in an invested and creative society that takes full advantage of the unique opportunities afforded.

2. **Reduce operating, management, and maintenance costs** with the Vertical City, allowing more funds to raise standards of living as a whole.

3. **Foster diversity and social inclusiveness** with a wide range of choices in housing and recreation at various economic levels. There are no slums in the Vertical City; every resident will have a decent place to live securely and with dignity, promoting well-being and productivity and ultimately making the Vertical City a better place for everyone.

4. **Maximize the job opportunities and avert misemployment**, which adds little to the common good, by merging economic and environmental concerns and providing green industries and jobs that will benefit the Vertical City and its greater environment.

5. **Nurture democratic and accountable governance** that integrates ecological imperatives in the decision-making and legislative processes, recognizing that human values and environmental well-being are not unrelated to good business policies and economic growth.

6. **Promote healthy lifestyles and individual human development** by active engagement and exercise against obesity, heart disease, and other afflictions related to an overly sedentary existence.

7. **Recognize differences in the social, economic, and ecological conditions of different cities and nations,** allowing each to adapt our basic concepts to their particular needs while moving beyond past—often destructive—processes of economic growth and urbanization.

8. **Challenge leadership in municipal and national governments** to offer incentives that would encourage new ways of thinking and enable the sustainable development of new urban forms.

Industry is the major source of air, soil, and water pollution in the developed world and increasingly in developing countries where modernization depends on rapid industrialization.

Overview

It is estimated that before the development of agriculture, the world's human population did not exceed 15 million. But some 10,000 years ago, as Neolithic man moved away from hunting and gathering toward planting and husbandry, the relative security of settled life and reliable food supplies led to increased productivity and growth. Clustered encampments evolved into permanent settlements and, in time, complex cities with developed modes of governance, commerce, building, and transport. Farming and irrigation were advanced by increasingly sophisticated techniques and tools, which gave rise to food surplus and, in turn, fostered a division of labor and social stratification. The diverse machinery of civilization similarly promoted advances in sanitation and public health, with the result that the number of people on Earth has grown almost continuously since the Middle Ages.

The population reached one billion around the start of the nineteenth century. More than another century passed before it climbed to two billion, in 1927. But then, very quickly, the population jumped to three billion in just thirty-three years (1960), with another billion added virtually every decade thereafter: 4 billion in 1974, 5 billion in 1987, 6 billion in 1999, and 7 billion in 2012. Current projections, allowing for a slowing trend, envision 8 billion people by 2030, with the global population reaching 9 billion by 2050.

Statistics like these are typically met with alarm, although they can seem just distant and abstract. The reality is brought home by grim reports that nearly half of today's global population lives in poverty: more than 3 billion people survive on less than US$2.50 per day. Equally troubling is the fact that nearly 870 million people suffer chronic undernourishment, meaning that one out of every eight does not eat enough to get the energy needed for an active life.

The problem is not merely a question of numbers. In fact, some would argue that the growing population is not a root cause of environmental decline but that having so many people just magnifies the negative impact of other key factors, such as the uneven distribution of the world's wealth/land/water, unsound or unimplemented government policies, industrialization, and, hardly least, lifestyle.

In emerging economies, such as India and China, people aspire to living standards set by Europe and North America, where consumption patterns are high and unsustainable. In simple terms, it boils down to more people wanting—demanding—more goods, using more resources, and producing more waste. With a world population of more than seven billion and their need for food, water, housing, energy, clothing, electronics, and other consumer products, the strain on the environment is enormous.

Throughout history humans have shaped their physical environment for better or, frequently, worse, unaware of the long-term consequences of their actions. We have destroyed natural diversity by single-crop farming, brought about the extinction of entire species, scarred the land, polluted water supplies, and caused erosion and deforestation. Early on, people would simply move from exhausted sites to richer, more fertile areas. But the past couple of centuries have brought about a behavioral sea change as modern developments have greatly increased our control over the environment and our ability to exploit the planet's resources.

The First Industrial Revolution began in the mid-eighteenth century when hand power gave way to improved water- and steam-powered machines, and coal largely replaced wood for fuel. Tremendous advances took place in metallurgy, while new agricultural techniques and labor-saving tools yielded bigger crops with less manual labor. Rural workers began to migrate to cities and retrained for new jobs in the belching machine-driven factories that propelled the Industrial Revolution to its next, even more momentous phase.

The steady and widespread development of mechanization and the continuous and prolonged growth of the economy that resulted from the First Industrial Revolution were completely without precedent in human history. Almost no aspect of life was untouched.

The Second Industrial Revolution, which began in the 1830s and spread through Western Europe and the United States and then beyond, depended on chemical breakthroughs, the internal combustion engine, steel, railroads, and the single most important engineering achievement of the twentieth

century: electrification. Electric lighting in factories greatly improved working conditions and productivity, and, at the same time, made possible electric transit, and such burgeoning communications technologies as the telegraphs, telephone, and radio.

Giant corporations, larger than any commercial entity previously known, transformed the marketplace as new organizational systems and efficiencies in automation and assembly lines drove quality up and prices down in a world of increasing commercialism. Mass production consumed huge amounts of natural resources and left behind an equally vast tonnage of toxic and nontoxic waste.

The next phase of the Industrial Revolution started after World War II. In mid-century America, returning soldiers took advantage of government-issued low-cost mortgages to buy new homes in which to raise their families and pursue the American Dream. Post-war prosperity fueled interrelated developments that profoundly changed the country's social and economic patterns, including suburbanization and unchecked sprawl, all made possible by widespread car ownership and vast new highway systems that knitted formerly remote areas together. Inside the home, the invention of television rapidly integrated all facets of American life. After years of depression and war, TV found a receptive audience for all the products and practices that promised a better life.

The great inventions and innovations of the Industrial Revolution are an inseparable part of modern living. As world prosperity has grown, people, especially in developing economies, are purchasing refrigerators, washing machines, and other products previously out of reach, most conspicuously cars, the proud badge of the swelling middle class. Today, the world manufactures more than 60 million cars per year, and the number is rising.

Much of the auto industry's explosive growth is taking place in China and India. (Despite the car-loving American stereotype, ownership in the United States actually declined in 2010 for the first time ever. Indeed, a recent study by the Carnegie Endowment for International Peace revealed that American car ownership is actually among the lowest in the developed world.)

Since the 1980s, or perhaps a little earlier, we have been in the midst of the Information Age. Like the Industrial Revolution that preceded it, this new technological/digital revolution has affected every aspect of life: where and how we live, the way we work, who and what we know, and how we create, conduct business, learn, and communicate.

Remote areas, separate regions, and entire countries are now joined in a global community. Computers, semiconductors, fiber optics, the Internet, and cell phones have all presented unimaginable opportunities for invention, no longer requiring physical presence in a central location, corporate management chains, or even substantial financial investment for a start-up business—just a computer and an idea. The new world order permits collaboration among people thousands of miles apart, instantaneously, fluidly, and efficiently, on equal terms without age, gender, or other bias. Unfortunately, it has also wrought a new form of toxic waste, exacerbated by rapid changes in technology, planned obsolescence, and the eagerness of consumers to possess the latest, most advanced gadgets.

Just as the Industrial Revolution brought about the creation and growth of major cities, and in many cases also their decline, the new information superhighway holds the key to new demographics, new industries, and new urban constructs. Readily at hand are vast stores of formerly inaccessible, or even suppressed, knowledge. People around the globe now have a binding interconnectedness that makes new initiatives for a sustainable future possible—and necessary.

In cities globally, motor vehicles are the single greatest air and noise polluters, whether moving or idling in traffic. Cars contribute to 20–25% of world's greenhouse gas emissions. The National Urban Mobility Report indicates that Americans collectively spent 5.5 billion hours sitting in traffic in 2011, roughly 38 hours per person, each wasting 19 gallons of fuel in the process. Analyzing driving patterns in hundreds of urban areas across the country, researchers at Texas A&M Transportation Institute estimated the total cost of congestion in the United States was $121 billion.

A cell-phone tower disguised as a lonely pine tree in the remote hills of Inner Mongolia. Mobile phones constitute the world's fastest-growing industry, allowing developing countries to leapfrog over former hardware requirements directly to more advanced modern technologies.

Electronic waste constitutes roughly 5%of municipal solid waste, or 20–50 million metric tons globally each year. Only about 13% of e-waste is recycled. The rest is incinerated or dumped in landfills, releasing deadly toxins into the air, soil and water.

Intensive family farming in southern China where narrow paths are woven between rice paddies and other subsistence crops.

United States). As part of a three-pronged strategy to control growth, the Chinese government plans to limit the number of big cities (those with more than 500,000 people). The government intends that the bulk of the ever-increasing urban population be accommodated in medium-sized cities of 200,000 to 500,000 people, and also in small cities with populations of 100,000 to 200,000. From now until 2030, it is estimated that 20,000 to 50,000 new high-rise buildings will be required. That's roughly three to six new skyscrapers each day for the next twenty years.

The unprecedented influx of humanity into cities results in expansion of the existing city limits into the surrounding open spaces, most often into neighboring farmland. In the case of China, which ranks third in total land mass [3,706,580 square miles, or 9,600,000 square kilometers], at an annual rate of 0.5 percent it has already lost 4.85 million hectares [18,430 square miles] of arable land to urbanization, as well as to reforestation and grassland replanting programs, and also natural disasters.

Although China historically suffered widespread famine due to periodic flooding or drought, the country's overall success, for centuries, in being able to feed its population using its own land has been regarded as a modern miracle. Chinese authorities are well aware that the continued loss of farmland will jeopardize the country's ability to continue to do this and, since in China land belongs to the state and collective, they have implemented a policy requiring that any such loss of land be replenished by comparable acreage elsewhere in the country. Additionally, China has set 120 million hectares [296.4 million acres] as the absolute minimum of arable land to be preserved beyond which there can be no further shrinkage, no impingement. That limit, known as the "red line," is dangerously close.

The authors have witnessed China's phenomenal modernization with both fascination and awe. They marvel at the magnitude and quick pace of the nation's transformation but at the same time wonder about its long-term consequences.

Urbanization and the Environment

Before the Industrial Revolution, only 3 percent of the world's population lived in cities. Today, the urban total is 50 percent, and it is expected to climb to 60 percent in the next twenty years. Estimates project that 400 million people will be moving into cities in China alone within the next two to three decades. Indeed, in 2001, Doje Cering, State Minister of Civil Affairs, announced China's intention to build 400 new cities in two decades. According to the Council on Tall Buildings and Urban Habitat, global urbanization is approaching 200,000 people every day, roughly equivalent to all the people in Calcutta added to the world's urban population every month.

Existing planning theory and practices are not adequate to address such a huge influx. The problems are real, very serious, and urgent. Thus far, attempts at resolution have typically involved building higher and more: more towers, more roads, more subways, and so forth. Yet the problems remain. We cannot continue to expand our cities following old precedents. New solutions must be explored and radical new thinking brought to bear in order to make sustainable urban living a viable reality. Luckily the technologies, equipment, and required materials are available, or will soon be within reach. What is needed is the conviction and will to achieve the grand feat. We begin by identifying the most significant problems within interrelated domains.

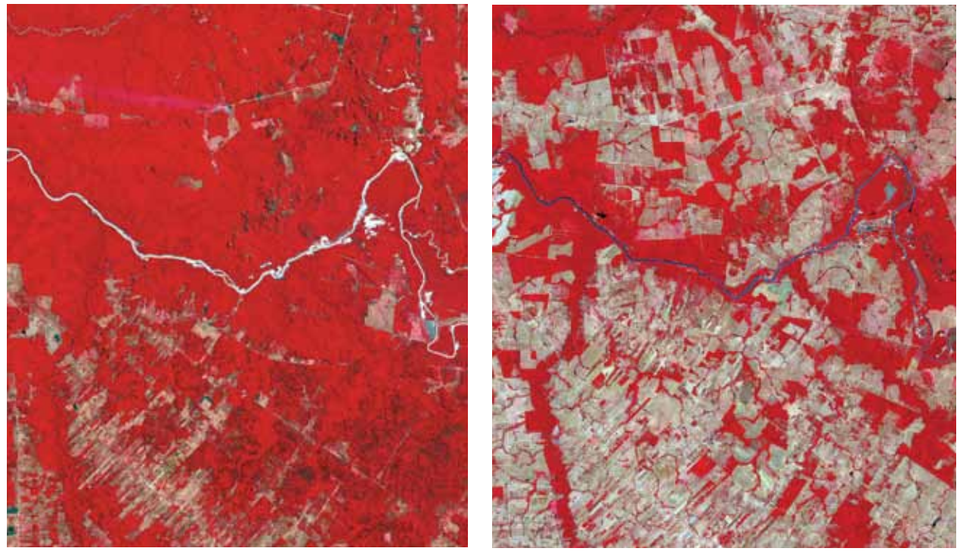
Environmental Impact

As previously stated, the growing human population and its migration into urban centers and newly industrialized rural areas has resulted in unplanned development. Such haphazard expansion invariably occurs at the expense of arable or unspoiled lands in peripheral areas. In the United States, nearly a million acres [approximately 400,000 hectares] of farmland are lost annually. In China, the number is more than double, as every year since the late 1980s some 2.5 million acres [1 million hectares] are gobbled up by development. The continued loss threatens food supply and undermines one of modern China's greatest achievements: feeding its own people following a policy laid out with great public display in 1978, after years of famine and starvation. China now imports roughly 12 percent of its food. As Chen Xiwen, director of the rural affairs policy-making committee of the Chinese Communist Party, explained in early 2012: "During the process of urbanization, we must pay attention to agricultural development… but, of course, we certainly cannot pursue self-sufficiency." Economic growth and modernization take precedence at this stage of China's history.

The loss from development is equally devastating in natural wooded areas and grasslands on the outskirts of cities where fauna and flora, through years of evolution, have achieved a balanced sustainability that is also beneficial to urbanites. Such buffer zones collectively help to protect water and soil from contamination and erosion, break down and absorb pollution, and store and recycle precious nutrients. They further contribute to climate stability, mitigate global warming, and provide habitats for a great many species of wildlife.

Old-growth forests play an especially important role in scrubbing the air by recycling carbon dioxide into oxygen. The often bemoaned but continuing destruction of the rainforest underscores the seriousness of the problem. The rainforest once covered 14 percent of the planet, but it has now been reduced to a mere 6 percent. The 1.2-billion-acre forest is vast by any measure, but it loses more than an acre every second—that's roughly 85,000 acres each day—in the relentless harvesting of timber for construction materials, furniture, and wood-pulp paper. Harrowing estimates project possible depletion in less than 40 years. The consequences are inescapably catastrophic as the rainforest produces 20 percent of the world's oxygen and holds one-fifth of its fresh water and more than half of the world's estimated 10 million species of animals, insects, and plants.

All of this will be destroyed, and with it the loss of still unknown foodstuffs and possible cures for life-threatening diseases. To date, less than 1 percent of the rainforest's growth has been scientifically



Advance Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images from 1992 (left) and 2006 (right) reveal the widespread deforestation taking place in Mato Grosso, Brazil. The tropical rainforest appears in bright red; gray-green areas indicate forest clearance from logging and agriculture; black and dark gray areas pinpoint recent burning.

investigated, yet this tiny sampling has yielded 25 percent of all pharmaceuticals used in the West, including a large portion of today's cancer-fighting drugs.

Recent investigations into the humble aspirin (derived from the bark and leaves of willow trees), the ability to regenerate lost limbs in salamanders, and the production of immense amounts of biofuel from the foam nests of Túngara frogs (a discovery that won the 2011 Earth Award) make it increasingly clear that nature holds the answer to many—some would argue all—of life's questions. Thus, the tragic consequences of man's interventions: the wastes that contaminate water supplies; the insecticides that sterilize the land so that essential microorganisms cannot survive; and the loss of bees as pollinators, bats for insect control, and sharks as cullers of the ocean's weak. The list goes on.

The critical point is that all living creatures play a strategic role in the biodiversity that sustains the planet as a self-regulating, self-healing organism. The richer the diversity, the greater the strength and resilience. When changes are slow there is opportunity for compensating balances to take place. But with the vast amount of development rapidly taking place around the world, in different topographies and climates, no one really knows the full extent of the damage. As Jaan Suurküla reported in 2004 to Physicians and Scientists for Responsible Application of Science and Technology: "The world's ecosystem has been kept in balance through a very complex and multifaceted interaction between a huge number of species. The rapid extinction rate is therefore likely to precipitate collapse of ecosystems at a global scale."

Urbanization at the expense of farmland and natural greenbelts puts pressure on the environment to a point that is not sustainable. If we continue our development in this direction, there will be irreversible changes in our environment that will drastically affect our health and well-being.

(Left) Logging accounts for about 14 percent of global deforestation. Trees are selectively harvested for exotic woods, but for every tree intentionally felled, some 5–10 others are casualties of the process. Slash-and-burn, (right) among the oldest methods of agriculture, is still widely practiced around the world. It makes previous dense-growth lands available for farming, but contributes to erosion, an increase in greenhouse gas, and the loss of nutrients, natural habitat, and biodiversity.

Soil Degradation

The Earth's natural cover consists of a complex and dynamic ecosystem of minerals, air, water, and organic materials that collectively sustain all of life. It is among our most precious resources, yet roughly half of the world's soil has been lost over the past 150 years, most of it as a result of human actions.

Soil degradation is the loss of nutrients or organic matter or, alternatively, pollution by toxins so that the soil loses its quality and productivity and can no longer be used for growing. The main cause of soil degradation is erosion, whether by weather, wind, water, or gravity, naturally and gradually wearing away the Earth's surface. Human intervention has greatly accelerated the loss, so fertile soil is removed faster than it can be replenished.

Deforestation, logging, and other land-clearing methods, together with overgrazing and irrigation mismanagement, have brought about salinization and desertification. The soil loses its capacity to retain water and nutrients and basically loses its ability to support life. Construction is another factor, as is compaction from heavy equipment, which destroys essential aeration.

The pressures of the growing population have led farmers to use harmful pesticides and fertilizers to increase crop yield. It is estimated that only 20 percent of the additives are actually absorbed by the plants; the rest runs off to erode and poison the ground and water. Intensive tilling also strips away protective ground cover, while single-crop farming and other inappropriate agricultural practices destroy biodiversity.

In urban areas, industrial pollutants and household garbage, especially nonbiodegradable products such as plastics and electronic waste, have reached a crisis stage compared by the World Bank to the severity of climate change; they also contribute to it, as landfills emit more and more methane gas into the air every day. Accurate global data is difficult to compile, as practices in different countries and regions vary widely, but since the amount of solid waste increases with economic development and urbanization, the environmental and human health risks will undoubtedly grow. Municipal solid waste is expected to double by 2025.

Top: Pollution (gray) is readily distinguished from white clouds in this satellite photo of China's southeast coast. Cars, industry, construction, and coal-burning power plants all contribute to poor air quality, exacerbated by the mountains to the west, which trap air pollution in place. Bottom left: Volcanoes emit sulphur dioxide and other pollutants that cause hazardous vog (volcanic smog) and acid rain. Bottom right: The environmental benefit of e-vehicles has been challenged since their manufacturers can emit more toxic waste than factories producing gasoline-fueled cars. The question is even bigger in China, where 75% of electricity is generated by coal-burning power plants.

Air Pollution

Although developed countries have made major advances in the reduction of air pollution, it remains at dangerously high levels in developing countries, where the necessary capital investment to combat it is not available and where regulatory standards, if they exist, are difficult to enforce. As many as two million people die each year from the effects of air pollution.

Major causes of air pollution include the burning of "dirty" fuels like coal and oil in power plants and factories. Coal burning for home cooking and heating contributes to the smoke and soot, whose severity and duration are affected by local climate and topography. Agricultural spraying and dusting, slash-and-burn land clearing, and—critically—airborne construction dusts are also major causes. Air pollution will remain a serious problem as long as feverish urbanization continues, releasing dangerous particulates into the air.

By far, most air pollution in urban areas comes from traffic, both from diesel-fueled heavy transport and from ever-growing numbers of passenger vehicles. In developing countries the problem is exacerbated by the large number of older vehicles on the road. In addition, vehicle maintenance is poor, and leaded fuels are still used in some cases. Auto exhaust is especially dangerous to human health because it is emitted close to the ground where people, children in particular, are most directly exposed. The disastrous effects of lead on childhood health and development spurred the development of catalytic converters and the global phase-out of lead from gasoline (only eleven countries still use leaded gas and just three use it exclusively).

By 2035 the total number of passenger vehicles on the road is expected to double to a staggering 1.7 billion, much of the explosive growth taking place in China and India. Beyond sheer numbers, part of the reason for traffic problems is failed or nonexistent urban planning. Network carrying capabilities are often grossly overestimated as a result of inadequate administrative and legislative controls, financial resources, and the technical skills to deal with such enormous problems. Walking, biking, and public transit in compact "Smart Cities" would seem to hold the solution.

Water

Water is indispensable for life—for drinking, cooking, agriculture, sanitation, the manufacture of such diverse products as clothing and nuclear reactors, and, in general, for the health of every living thing on Earth. By and large, the amount of water on the planet has remained fairly constant over time as precipitation has recycled naturally through freeze-thaw, drainage, and evaporation back into the air, endlessly repeating the process.

The problem comes with climate change and the increased population. According to the United Nations, water use per person grew at double the rate of population increase over the last century. The rate is even higher in China and India, where water use has increased tenfold in the last 50 years. Simply put, more people are competing for limited freshwater resources, and they are depleting the supply faster than it can be replenished. Consumption is already unsustainable, and the situation is getting worse.

Freshwater use is expected to grow by 40 percent over the next two decades, largely driven by the blistering pace of urbanization and economic development. As living standards increase, so does water consumption for improved sanitation and indoor plumbing—flush toilets, sinks, showers, washing machines, dishwashers, and other luxury appliances. Economic growth also brings a change in diet as rice and tofu give way to meat; a traditional bowl of rice requires roughly 550 liters of water for its full production cycle compared to 2,200 liters for a meal with beef.

Agriculture consumes by far the greatest amount of freshwater, the world average being 70 percent, and 84 percent in Asia. And given the growing population, more will be needed. As farmers, with increasing sophistication, turned away from dependence on rainfall and surface water, they took to irrigating rivers, streams, and lakes. They also dug wells to access groundwater in natural aquifers some 20 to 30 feet below the surface. With industrialization came new means for pumping more and deeper, to the degree that aquifers have been drained beyond their renewable capacity. The situation has been likened to making repeated withdrawals from a bank account without keeping up with deposits.

The problem is compounded by the inefficiencies of irrigation through evaporation and runoff, leading to erosion, the leeching of nutrients from the soil, and pollution from pesticides and fertilizers. The disposal of animal waste also poses serious environmental concerns, as it spreads dangerous organisms into the waterways. In agricultural areas near cities, farming has to compete for freshwater

Although recycling programs are growing, it is estimated that some 80 percent of water and other bottles are simply thrown away. Glass bottles take thousands of years to decompose; petroleum-based plastics begin the process after roughly 450 years, but never fully biodegrade. The widespread discharge of often undisclosed and frequently hazardous chemicals into water supplies can lead to irreversible environmental damage. Developing countries are inclined to regard industrial waste as the necessary price of progress, too difficult and costly to combat in the throes of modernization.

with domestic and industrial uses. Especially in developing countries, farmers have no choice but to use groundwater quite possibly contaminated by human waste; heavy metals and chemical discharge from municipal dumps and leaking infrastructure; and antibiotics, bacteria, viruses, and other pathogens from hospital waste. The tainted water presents significant health hazards as people consume the fouled crops. Toxic runoff, untreated sewage, and solid wastes similarly poison lakes, streams, rivers, and coastal waters, with devastating consequences for fish, and other forms of aquatic and human life.

Water pollution is a crisis of epic proportions. Not surprisingly, it is worst in developing countries, where treatment facilities, to the degree they exist, are most often inadequate and where proper sanitation is not always possible or its importance is not understood. According to the United Nations Environmental Program, "[I]n developing countries, rivers downstream from major cities are little cleaner than open sewers." Fully 80 percent of all patients in such areas are hospitalized because of waterborne diseases.

Although Earth is a water—rich planet—some 70 percent is covered by water, most of it is ocean-based. High cost puts desalinization beyond the reach of most countries. Natural supplies of freshwater are remote and inaccessible, trapped in polar caps or permanent ice. Humans therefore have access to less than 1 percent. Moreover, the supply is not evenly distributed around the world, nor is it dependably available throughout the year. Drought in one area contrasts starkly with monsoons, flooding, or higher sea levels in others. Too much water is just as crippling as too little. Climate change compounds the problem.

As freshwater demands increase and supplies decrease, questions about water usage intensify. The World Bank has identified water management and food production as pressing global concerns. Conservation and better agricultural and industrial practices are increasingly important, as are decisions about what to grow, and how and where to grow it. Sustainable measures such as rain capture, drip irrigation, reclamation, waterless toilets, and other new technologies can all help. The overall reduction of pollution and waste, along with enlightened governance, will be required as never before.

- There are urgent needs for adequate housing, public transit, and infrastructure. Power generation, water supply, sanitation, and waste disposal must be appropriately, and quickly, addressed. A greater number of urban dwellers demand increased food supplies, and all the production, shipping, and distribution systems required. In all of this, responsible planning is essential to prevent arbitrary or otherwise misguided decision making and to ensure the health and well-being of city residents. Top-notch professionals and creative minds need to collectively address issues of design and environmental control. Special care needs to be taken in new developments and start-up cities, as there will be no mature trees to mitigate the heat island effects caused by impermeable paved surfaces and buildings.

The challenges and sheer physical toll of recent urban migrations are daunting. Yet it is essential that important matters not be shunted to the side by urgency and expedient solutions. We need to be sure that we don't surrender our arable lands and open spaces—once gone, they will never be reclaimed—and we need to protect the purity of our air, soil, and water. We need to make sure that through the lethal combination of climate change and man's hostile actions we don't destroy the physical world, and all hope for the future along with it. Rapid urbanization is proceeding at full throttle with no immediate end in sight. So the question is how best to maximize the opportunities presented for massive change in a way that will ensure a healthier, more sustainable life.

The Brundtland Commission, officially the World Commission on Environment and Development, was created by the United Nations in 1983 to raise public awareness and encourage multinational cooperation. It defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The American Institute of Architects states the case for sustainability more narrowly, and grimly, as "the ability of society to continue to function into the future without being forced into decline through exhaustion or overloading of the key resources on which the system depends."

Despite convincing evidence that grows daily, some continue to deny climate change, just as others, in the face of irreversible damage, continue to charge ahead, wantonly ravaging the rainforests or discharging toxins into the atmosphere. Still others, whether as a result of ignorance, lethargy, politics, or greed, are criminally negligent in the consumption of Earth's natural resources, depleting supplies at a rate that far outpaces their capacity to be replenished. It makes no sense. We are attacking and killing the living systems of which we ourselves are part and upon which our very survival depends.

Humanity is at a critical juncture if there is any hope of moving forward. According to Al Gore in his Pulitzer Prize–winning book *Earth in the Balance*, "[W]e now face the

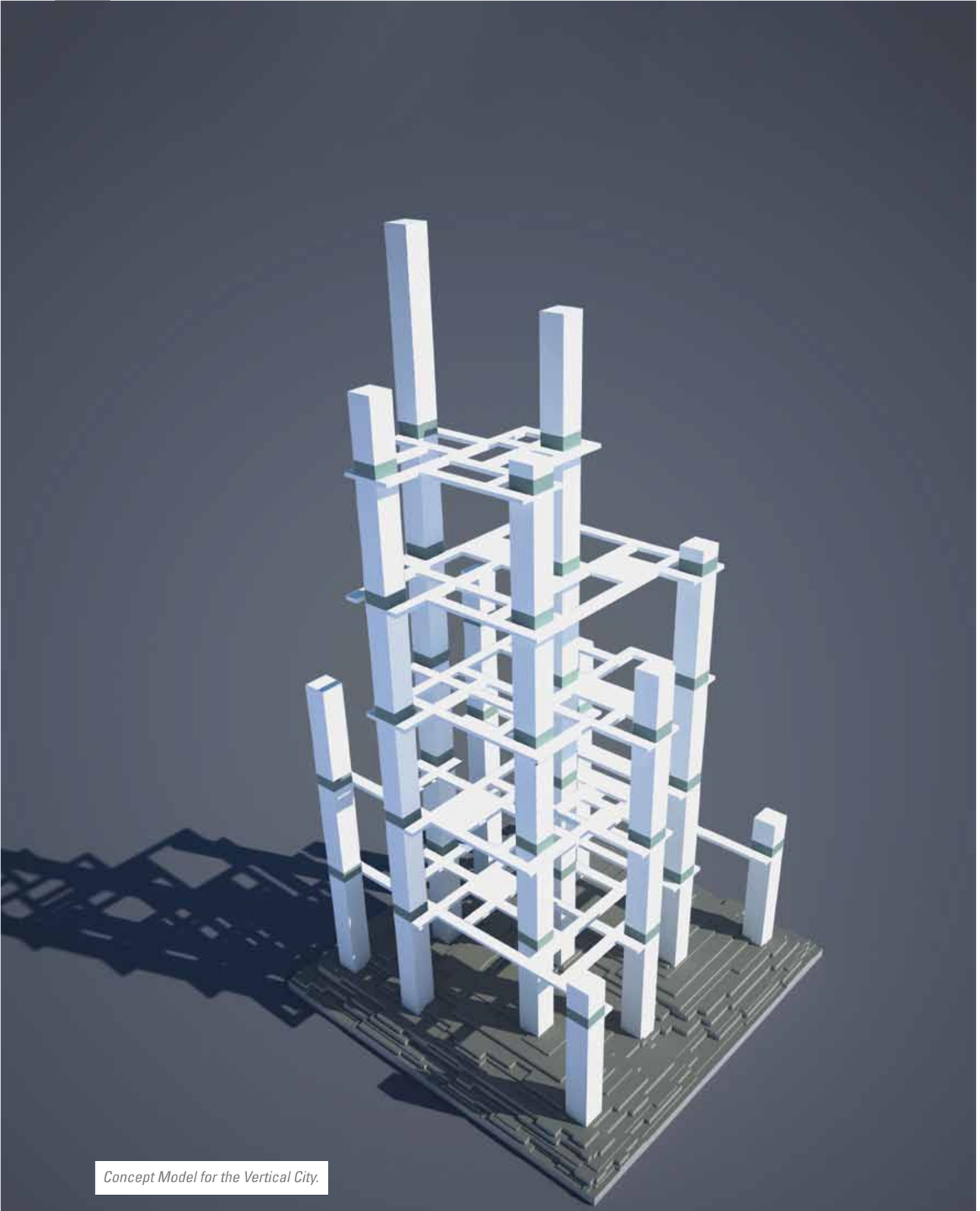
prospect of a global civil war between those who refuse to consider the consequences of civilization's relentless advance and those who refuse to be silent partners in the destruction." It is in this context that the authors have determined to speak up.

If today's urban problems can be likened to an illness, the therapies prescribed to date have targeted only the symptoms without treating the long-term systemic problems or their root causes. Isolated attempts to alleviate traffic, pollution, waste, and other urban growing pains have sometimes triggered undesirable or harmful side effects. Perhaps even worse, they can provide false hope about having found a cure for conditions that remain incurable if combatted only by traditional means. As decades of attempts at local remedies have made clear, a more holistic approach is required. Cities still suffer the same problems, only bigger, more serious, and increasingly debilitating.

We offer in this book an alternative urban form that incorporates the basic principles of sustainability as its starting point. In presenting this theoretical construct we have not addressed the many essential particulars of actual construction, least of all a complete inventory of technical solutions, although we do believe that society already has, or will have very soon, the technical means for implementation. Ours is but one approach to urban living. By perfecting the key ideas behind our prototype through trial-and-error testing and analysis, and by applying the lessons learned, we believe that this could well be the beginning of a new era of truly sustainable development.

Our actions are guided by firm convictions, what we call our 8-8-8 Manifesto of New Urban Form (Page 3), which recognizes the critical importance of cities for the future. By 2050, it is projected that 8 of every 10 people will be urbanites. And since cities are the growing focus of human activity and the heart of developed and developing nations worldwide, it is in cities that crucial environmental, social, and economic battles will be fought and won, or lost. There is no cause that is more deserving of our attention, and certainly none more important in outcome. We thus feel compelled to set forth our vision for a sustainable future as a first step in advancing a solution to contemporary urban problems. We do so with a boldness befitting humanity's highest aspirations and an evocative image capable of stirring its soul.

In 1979, the Pearl River Delta was largely undeveloped (top). The region has been radically transformed by paved roads, industry, and urbanization (all of which appear gray in the lower false-color satellite photo from 2003). Development has also caused a decline in rainfall, since the built environment prevents water retention in the soil, leading to less humidity and therefore less precipitation.



Concept Model for the Vertical City.

Vision for a Vertical City

The vision of a new Vertical City inspired by the above Manifesto calls for a shift away from the current piecemeal urban planning approach that is rooted in the environmentally harmful, energy inefficient, and unsustainable post–World War II mentality of cheap fossil fuel, car ownership, and single-family suburban homes. It is a call for a new paradigm to address the urgent problems of unprecedented human population totals and tidal waves of rural migration into cities.

The solution lies in the optimization of population densities by implementing the theory of a Vertical City, that is, high-capacity, high-efficiency ultra-tall buildings occupying a relatively small car-free, pedestrian-friendly parcel of land. Within this footprint are all the self-sustaining features of infrastructure, buildings, facilities, and services necessary for improving the living, working, cultural, entertainment, sports, recreation, and leisure qualities of life for residents.

In our mind's eye, the Vertical City starts with a raised multilevel podium. Service vehicles and privately owned cars are relegated to circulation and parking on the ground level below so that the surface of the podium, the main level of the Vertical City, is reserved exclusively for pedestrians and bicycles.

Within the podium, the first level above the ground is reserved for utilities and services, housing the infrastructure for water, sewer, and electrical lines together with mechanical, treatment, and storage plants, and equipment.

Located on the top of the podium are the main ("Street") entrances to all buildings. Included is a low (6- to 10-story) enclosed mall-like megabuilding or, alternatively, a more recognizable street pattern of multiple buildings arrayed around outdoor street corridors. Focusing the whole is the namesake of the Vertical City: vertical towers of various heights (one kilometer? one mile?). The towers are connected approximately every 100 floors, at each elevator-transfer sky lobby, or as may be dictated by requirements for structural stability. Elevated horizontal pedestrian bridges facilitate movement between towers.

The sky lobbies together with their bracing/bridge connections-extended sky lobbies, as it were,comprise vertical "village centers." These will be natural gathering places for shopping, eating, drinking, or socializing. Local artists, craftspeople, performers, and street vendors will display their skills or wares here. More energetic occupants may opt for a workout in the Vertical City's numerous swimming pools and fitness centers, or perhaps take a casual stroll, jog, skateboard, or cycle through the extensive network of landscaped extended sky lobbies, vest-pocket parks, and outdoor gardens.

Surrounding the Vertical City are open farmlands, which serve as a buffer between existing urban centers and future Vertical Cities. The greenbelts will be of sufficient size for growing vegetables and fruits and will also house fisheries to provide residents with a nutritious local source of food.

A Vision of Vertical City: illustrations by Reinhard Roy

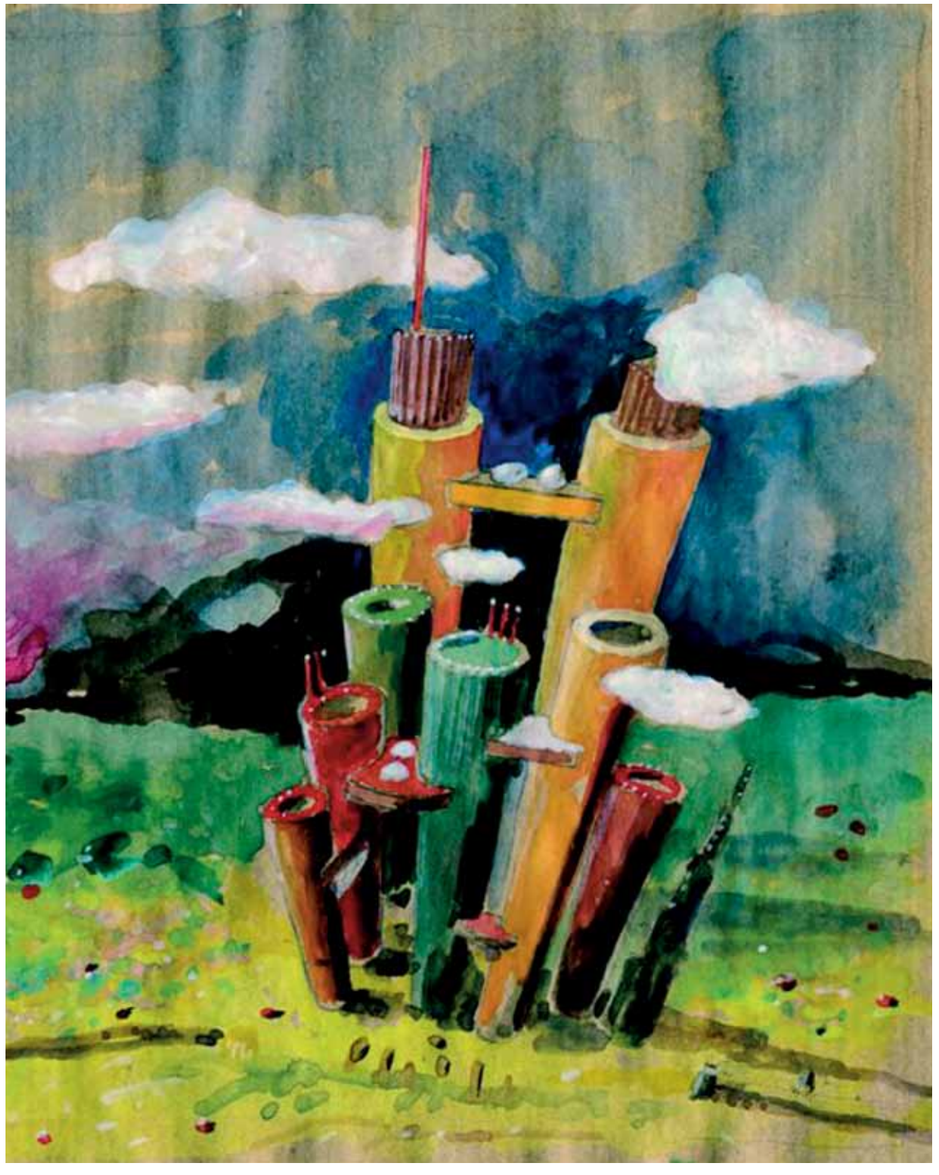
This artwork is about a visionary project of future cities. With my experience as an artist and designer, I have created this work as an adviser to the authors. My connection to this project is my friend and New York architect, Kenneth King.

Like the designation already says, it is about a concept which cannot be associated with conventional urban planning. It concerns the concept of a city which must include the necessary functions and complexities which allow for sustainable living within a community, as well as incorporating all of the technical and social components.

This answer must also consider our problems of the uncontrolled growth to this day of mankind and the effects connected with it on the world as a whole.

Frank Lloyd Wright's Proposed Mile High Building 1956

Artist's Vision of a Vertical City



Artist's Vision of Vertical City

SECTION TWO / NEW MATERIALS AND TECHNOLOGIES

NEW MATERIALS AND TECHNOLOGIES

SECTION THREE / FORUM OF EXPERTS

AN EXPERT APPROACH

ARCHITECTURE

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ANDERSON ANDERSON ARCHITECTURE

T.J. Gottesdiener, SOM/NY

William Pedersen, KPF

Adrian Smith And Gordon Gill,
ADRIAN SMITH + GORDON GILL ARCHITECTURE

Antony Wood, CTBUH

The crest of Jin Mao Tower above Shanghai's endless skyline. The city's population has grown from roughly 11 million in 1980 to almost 24 million in 2012.

An Expert Approach

The problems resulting from rapid urbanization in the United States and China are symptomatic of a growing crisis worldwide; solutions will require the best minds in architecture, urban planning, technology, sociology, environmental sciences, and related fields, all working together in a dynamic cross-disciplinary manner. The required response needs to be simultaneously very large and small, sufficient in scope to address the complex whole and yet flexible enough to appreciate fine-grained individual needs.

In developing this book, we realized that there is no one answer, no single preferred approach. Indeed, there is not even uniform thought about the nature of the problems, least of all about the future of tall buildings or their relationship to the environment. Historically, buildings—particularly big buildings—were erected at the expense of the land, excavating, channeling, diverting, and consuming natural resources in the name of progress. We wondered whether it might be possible to invert the status quo so that instead of despoiling Nature, we somehow build in a way that would actively preserve it.

We came to this challenge with a lifetime of personal and professional experience in architecture. Yet we quickly realized that the scope of our inquiry is so great, the areas of specialization so many, and emerging building technologies so numerous and complex that, responsibly, we could best serve in the capacity of informed and concerned laymen, asking questions rather than supplying answers. We therefore decided to build a forum of expertise by interviewing acknowledged leaders in related fields and to present their thoughts and insights for consideration.

Beginning with the basic premise that tall buildings are the most efficient means of accommodating the unprecedented numbers of people surging into today's cities, we wanted to explore some of the larger issues involved. As New Yorkers, with 9/11 still vivid in our memories, we wanted to know the prognosis for future high-rise buildings. Going further, if increased density is universally accepted as one solution to the challenges of population growth and expanding urbanization, we wanted to explore whether ultra-tall buildings might be a possibility. What are the technical challenges specific to ultra-tall building? Are there recent technological advances that would facilitate ultra-tall construction? What about the sociological implications of living very high up off the ground?

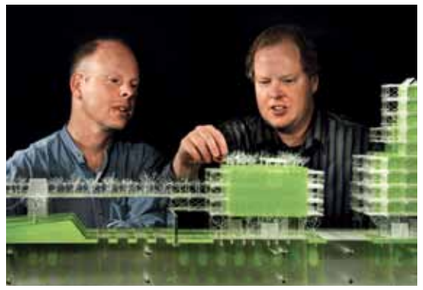
Given our particular interest in China, we were also curious to know from experts currently practicing there how they compare the Eastern work experience to that in the United States. What are the specific challenges? In addition, we wanted to learn about sustainability in China from those with firsthand experience. What are the guidelines? Are they enforced? Which are the greatest hurdles facing China in its effort to solve its urbanization problems?

Each question generated others—not that we ever ended up with definitive answers—that couldn't somehow be expanded or modified by new or different input. We hope, by adjacency between the covers of this book, to provide just such an opportunity and to encourage cross-pollination among disciplines that traditionally have had little overlap. We also hope to generate discussion, deliberation—even disagreement and heated debate—among our readers, as personal engagement is the first step toward taking action.

The ideas expressed in the following interviews are solely those of the experts. They appear here for information purposes only and do not in any way suggest input or endorsement of our proposal for a Vertical City.

Mark and Peter Anderson

ANDERSON ANDERSON ARCHITECTURE,
SAN FRANCISCO



Mark S. T. Anderson, FAIA and Peter C. O. Anderson, FAIA, have broad experience in building design and construction as architects, builders, and educators. In partnership in the firm Anderson Anderson Architecture, the Anderson brothers have designed and constructed numerous building projects in the United States and Asia and have also directed construction technology research projects, exhibitions, and public art installations in the United States, Europe, and Asia. Their work has received many competition prizes and design awards, including three Progressive Architecture Honor Awards; national honors from the American Institute of Architects, the Boston Society of Architects, the American Wood Council; the Emerging Architects honor from the New York Society of Architects; and particular recognition for design work in service to society and the environment, from such groups as the Danish Royal Index Awards, Copenhagen; the Zumtobel Awards, Zurich; and the Holcim Awards, Zurich.

Their drawings, design models, and industry prototypes have been widely exhibited, including at the Venice Biennale of Architecture, the Museum of Modern Art in New York, the Hamburg Museum für Kunst und Gewerbe, the Los Angeles Museum of Art and Design, the San Francisco Museum of Modern Art, the Panama City Museum of Art, and the Danish Design Museum. Their work has appeared frequently in books and professional publications in the United States, Asia, and Europe—including in the journals *Architecture*, and *Architectural Record* (New York), *PLAN* (Milan), Deutsche BauZeitung (Berlin), *Architecture Review* (London), and *L'Industrie delle Costruzioni* (Rome). A monograph on their work, *Anderson Anderson: Architecture and Construction*, was published by Princeton Architectural Press in 2001. A book on their design and construction technology work, *Prefab Prototypes; Site-Specific Design for Off-Site Fabrication*, was published by Princeton Architectural Press in 2007, and nominated for a Royal Institute of British Architects Book Award. A fifty-page retrospective and critical review on their design work was published by *Taiwan Architect*, May 2009.

Mark Anderson is a member of the architecture faculty at the University of California, Berkeley, and an appointed Peer member of the United States Federal Commission for Excellence in Art and Architecture. Peter Anderson is a member of the architecture faculty at the California College of the Arts in San Francisco. Mark and Peter are both Fellows of the American Institute of Architects.

Proposal for Lips Tower in San Francisco, a thirsty urban utility sucking water and solar energy from the sky, winner of the 2012 AIA San Francisco Unbuilt Design Honor Award (Anderson Anderson Architecture, 2011)

Adrian Smith + Gordon Gill

ADRIAN SMITH + GORDON GILL ARCHITECTURE/CHICAGO

Adrian Smith, FAIA, RIBA, Adrian Smith, FAIA, RIBA, has been a practicing architect for 45 years. His philosophy is to engage the history, art, landscape, climate, and indigenous materials of the places where he is designing. His goals are to interpret and honor the societies that his buildings serve; to forge a unique dialogue between culture and place; and to foster a strong connection to the people who see and use his buildings. His contextual approach has produced buildings recognized throughout the world for their beauty, elegance, and subtlety of their cultural references. His work has won more than 110 local, national, and international awards.

Adrian's extraordinary body of work as a designer includes four of the world's current 11 tallest buildings, including Burj Khalifa in Dubai, the world's tallest building; Jin Mao Tower in Shanghai; the Trump International Hotel & Tower in Chicago; and Zifeng Tower in Nanjing, China. Other landmark structures in his portfolio include the Broadgate Tower in London, recently named the Best Tall Building in Europe; and Rowes Wharf, the iconic structure that revitalized Boston's waterfront district.

Most recently, Adrian's portfolio has expanded to include Kingdom Tower, to be the world's tallest building when completed in 2016 in Jeddah, Saudi Arabia; and Wuhan Greenland Center, to be the world's fourth-tallest building when completed the same year in Wuhan, China. Prior to founding Adrian Smith + Gordon Gill Architecture in 2006, Adrian was a design partner at Skidmore, Owings & Merrill and its chairman, 1993–1995. He is the author of two books on his work and co-author (with Gordon Gill) of the newly published *Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan*.

Gordon Gill, AIA, is one of the world's preeminent exponents of performance-based design. His work, which ranges from the world's largest buildings to elements of a single home, is driven by his philosophy that there is a language of performance: a purposeful relationship between design and the performance criteria placed upon the subject.

A founding partner of the award-winning firm of Adrian Smith + Gordon Gill Architecture, Gordon's work includes the design of the world's first net-zero-energy skyscraper, Pearl River Tower (designed at SOM Chicago), and the world's first large-scale positive-energy building, Masdar Headquarters. These landmark projects achieve energy independence by harnessing the power of natural forces on site, striking a balance with their environmental contexts. Gordon has also designed performing arts centers, museums, schools, civic spaces, and urban master plans across the globe.

Gordon's work has been published and exhibited widely in the U.S. and internationally. His designs have repeatedly been recognized by the American Institute of Architects. In 2009, he was selected as Chicago's Best Emerging Architect by the Chicago Reader. Prior to founding AS+GG in 2006, Gordon was an associate partner at Skidmore, Owings & Merrill and a director of design for VOA Associates. Most recently, he co-founded PositivEnergy Practice, a consulting firm that designs and implements energy- and carbon-reduction strategies for clients around the world.

Burj Khalifa at night, Dubai, United Arab Emirates (Adrian Smith + Gordon Gill, 2010)

SECTION THREE / FORUM OF EXPERTS

TECHNOLOGY

Rick Barker,
BARKER MOHANDAS VERTICAL TRANSPORTATION CONSULTING

Marvin Mass and Scott Ceasar, COSENTINI ASSOCIATES

Carl Galioto, HOK

Robert Heintges, HEINTGES & ASSOCIATES

Dennis Poon, THORNTON TOMASETTI

Leslie E. Robertson,
LESLIE E. ROBERTSON STRUCTURAL ENGINEER LLC

Rick Barker

BARKER MOHANDAS/BRISTOL, CT

Rick Barker is involved in most of the work of Barker Mohandas. Prior to co-founding the firm, he was Director of Technical Services at Otis World Headquarters, where his responsibilities included preconstruction services for major projects. He also chaired the Otis product strategy group for dispatching control products and simulation tools, and co-led strategy for the company's tall-building elevator product called Skyway™. He led a major study to improve elevator product energy efficiency, co-led the Otis Odyssey™ system development that integrated elevators and horizontal automated people movers (APMs), and was a key liaison between Otis World HQ and United Technologies Research Center.

Prior to joining Otis, Rick led vertical transportation at Jaros Baum & Bolles Consulting Engineers (JB&B) in New York, and was involved in the company's largest projects at the time. At Westinghouse Elevator (now Schindler) he was involved in the company's largest projects in western New York, and at Delta Elevator in Boston (now Otis) in the company's largest modernization contracts.

Rick has authored papers on super-speed elevators, on an integrated horizontal-vertical transportation system, and on elevators and fire safety for firefighters and disabled persons. He is a member of the National Interest Review Group of the ASME-A17 Safety Code for Elevators and Escalators, and a former member of the A17.1 Emergency Operations Committee and similar NYC and FDNY committees on fire and elevators. He has co-chaired the Vertical and Short-Distance Horizontal Transportation Committee for the Council on Tall Buildings and Urban Habitat, guest lectured at MIT School of Architecture, and was a board member of the Building Owners and Managers Association of Buffalo. Rick Barker is named, singly or jointly, in 24 patents held by Otis.

Dubai, view from the Burj Khalifa during construction (2008)

SECTION THREE / FORUM OF EXPERTS

PLANNING

Erich Arcement, SAM SCHWARTZ ENGINEERING

Thomas J. Campanella, UNIVERSITY OF NORTH CAROLINA

Chengri Ding, UNIVERSITY OF MARYLAND

Philip Enquist, SOM/CHICAGO

James C. Jao, J.A.O. DESIGN INTERNATIONAL

Jaime Lerner, INSTITUTO JAIME LERMER

Liu Thai Ker, RSP ARCHITECTS PLANNERS AND ENGINEERS

Bruno Padovano, UNIVERSIDADE DE SÃO PAULO

Philip Enquist

SOM/CHICAGO

Philip Enquist, FAIA, is leader of the global city design practice of Skidmore, Owings & Merrill LLP (SOM), the world's most highly awarded urban planning group. Phil and his studios have improved the quality and efficiency of city living on five continents by creating location-unique strategic designs that integrate nature and urban density within a framework of future-focused public infrastructure.

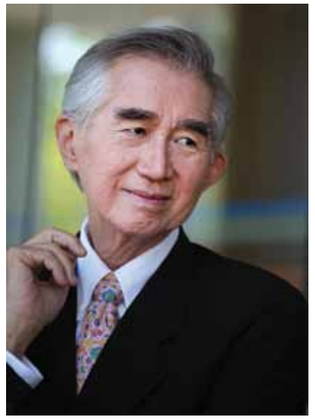
The scale of Phil's design perspective continues to expand from innovating sustainable urban forms that enhance city living with walkable, transit-enabled districts humanized by their natural amenities to rapidly changing urban clusters within regional ecosystems like North America's Great Lakes basin and China's Bohai Rim.

Phil is committed to the profession through one-on-one mentorships, his recent teaching of a studio for architecture and urban design students at Harvard University's Graduate School of Design, and as the Charles Moore Visiting Professor at the University of Michigan's Taubman College of Architecture and Urban Planning.

He was honored with the 2010 Distinguished Alumnus Award from the Architectural Guild of the University of Southern California (USC) School of Architecture for his dedication to strengthening the physical, social, and intellectual infrastructure of cities. The previous year, the *Chicago Tribune* named him and his studio Chicagoans of the Year in Architecture, citing "the city-friendly designs of Phil Enquist."

Philip Enquist passionately believes that the world's explosive growth in cities and population must be managed by humanely bold and holistically sustainable thinking at the national, regional, and metropolitan scale, and that human habitat design will become the alpha design science of the twenty-first century.

Chaoyang North District sustainable plan, Beijing CBD East Expansion Competition, China (SOM/Philip Enquist, 2009)



Liu Thai Ker

RSP ARCHITECTS PLANNERS & ENGINEERS/
SINGAPORE

Dr. Liu Thai Ker, M. Arch., Hon. Sc.D., is an architect-planner. Since 1992, he has been director of RSP Architects Planners & Engineers Pte Ltd., a consulting firm of over 1,000 people, with 11 overseas offices and projects in 17 countries. Dr. Liu is also the chairman of Centre for Liveable Cities, which he founded in 2008.

Dr. Liu has served as adjunct Professor in the School of Design and Environment and the Lee Kuan Yew School of Public Policy at the National University of Singapore. He is also adjunct professor in the College of Humanities, Arts & Social Sciences at Nanyang Technological University. He is a member of several governmental bodies in Singapore, and planning adviser to over 20 cities in China.

As architect-planner and CEO of the Housing & Development Board, 1969–1989, he oversaw the completion of over half a million dwelling units. As CEO and chief planner of Urban Redevelopment Authority, 1989–1992, he spearheaded the major revision of the Singapore Concept Plan and key direction for heritage conservation.

In the cultural arena, Dr. Liu served as the Chairman of the National Arts Council from 1996 to June 2005 and the Singapore Tyler Print Institute from 2000 to 2009. He has served as the chairperson of the External Review Panel, Arts Quality Framework appointed by the Ministry of Education, and a founding member of the board of trustees, Arts & Culture Development Fund, Ministry of Information, Communications and the Arts.

Dr. Liu obtained his Bachelor of Architecture with First Class Honors and University Medal from the University of New South Wales in 1962 and Master in City Planning with Parson's Memorial Medal from Yale University in 1965. He attended INSEAD Advanced Management Program in Paris in 1980. In 1995, he was conferred Doctor of Science honoris causa by the University of New South Wales.

Among his awards are the Public Administration Medal (Gold) 1976, the Meritorious Service Medal 1985, Singapore Institute of Architects Gold Medal, and the Medal of the City of Paris, France in 2001. In 1993, he was given the Second Asian Achievement Award for Outstanding Contributions to Architecture.

Bishan Public Housing New Town, developed in the 1980s and 1990s.

SECTION THREE / FORUM OF EXPERTS

SUSTAINABILITY

Ajmal Aqtash, FORM-ULA, CORE.FORM-ULA

Dickson Despommier, VERTICAL FARM

Gregory Kiss, KISS + CATHCART ARCHITECTS

Ashok Raiji, ARUP

Richard Register, ECOCITY BUILDERS

Maria Sevely, FORM | PRO-FORMA

Dickson Despommier

PROFESSOR EMERITUS AT COLUMBIA UNIVERSITY/NY

Dickson Despommier was born in New Orleans in 1940, and grew up in California before moving to the New York area, where he now lives and works. He has a Ph.D. in microbiology from the University of Notre Dame. For 27 years, he conducted laboratory-based biomedical research at Columbia University with NIH-sponsored support. He is now an emeritus professor.

Professor Despommier has always been interested in the environment and the damage we have caused by the simple act of encroachment. At present, he is engaged in a project whose mission is to produce significant amounts of food crops in tall buildings situated in densely populated urban centers as described in his book *The Vertical Farm: Feeding the World in the 21st Century* (2011). This initiative has grown in acceptance over the last few years to the point of stimulating planners and developers around the world to incorporate vertical farms into their vision for the future city. To date, there are seven up and running in Japan, Korea, Seattle, Chicago, and Vancouver, with many more in the planning stage. The hope is that vertical farming will become commonplace throughout the built environment on a global scale.

Dr. Despommier has received numerous teaching awards (eight Best Teacher of the Year awards at his medical school), and the national American Medical Student Golden Apple Award for Teaching Excellence in 2003. He has published four books, over 80 peer-reviewed scientific papers, and numerous review articles on a wide variety of subjects. He has lectured on the subject of vertical farming at MIT, Harvard, NYU, Cornell, Rutgers, Brigham Young University, and Singularity University, to city agencies in Chicago; New York City; Seattle; Newark, New Jersey; Los Angeles; Seoul, Korea; Amman, Jordan; Beijing, China; Bangalore and Coimbatore, India, and to federal government agencies, including the United Nations, IMF, USDA, and USAID. He has presented at TED, TEDx Chicago, TEDx Bermuda, TEDx Washington, DC, TEDx Engineering Columbia University, and TEDx Youth, PopTech, Ars Electronica, IdeaCity, Monterey Design Conference, Seoul Digital Forum (2008, 2011), the Indian Institute for Architecture annual meeting (2009), and The Colbert Report. Dickson Despommier lives with his wife in Fort Lee, New Jersey.

Sky Farm proposal for Chicago. (Wonwoo Park, 2010)

SECTION THREE / FORUM OF EXPERTS

QUALITY OF LIFE

Rhonda Phillips, ARIZONA STATE UNIVERSITY

Jorge Eduardo Rubies, PRESERVA SÃO PAULO ASSOCIATION

Alfredo Trinidade, SECRETARIAT OF THE ENVIRONMENT

SECTION FOUR / PROPOSAL FOR A VERTICAL CITY

NEW URBAN FORM
DESIGN APPROACH
PROPOSED SCHEMES FOR A VERTICAL CITY
CALL FOR A CHANGE OF LIFESTYLE

New Urban Form

In the previous Overview section, we observed that civilization, as we know it, is at a crisis point brought on by years of disregard for the environment. In our pursuit of a better life for numero uno, we have triggered global warming, the effects of which (for both believers and nonbelievers) are powerfully demonstrated at our very doorsteps: severe weather that is more violent and frequent than that experienced by previous generations; melting polar caps; rising sea levels; drought; and the drying up of ponds and lakes. The list goes on.

The authors, who happen to be of the self-absorbed generation that nurtured neighbors with a "keep up with the Joneses" lifestyle of material consumption and excess, incrementally contributed to the current crisis. We are now confronted by the need to choose between two extremes:

One: Regard the unfolding phenomenon as just a natural cycle of Earth's evolution and assume a wait-and-see complacency while demanding more and more concrete scientific proof that humankind does indeed have a hand in its making. Conclude with resignation that, in any case, it is a problem for

Two: Err on the side of caution and accept the call for immediate action to reverse, reduce, or at least postpone irreversible demise.

As vigorous proponents of the latter course, our response, as outlined in the 8-8-8 Manifesto on page 3, points to the need for a new urban form and the choice of a new lifestyle.

A Suggested Brief for a New Urban Form—A Vertical City

General Description

The Vertical City, as envisioned in the Overview on page 7, makes clear the need to create a new type of self-sustaining, pedestrian-friendly city that will accommodate both a "bedroom community" of 60,000 to 150,000 people and also a "live/work community" with a maximum population of 150,000 to 250,000. To provide facilities that will nurture and reinforce the choice of a new lifestyle, the following must be carefully considered:

Site

Site Selection

In selecting a site, every effort must be made to preserve to the greatest degree possible:
The existing natural landscape as home for native flora and fauna;

Arable land for cultivation of food for local consumption;
Open space for parks and recreation;
Natural greenbelts, or buffer zones, between neighboring communities;
Natural water sources, protected from contamination.

Site Size

For the larger live/work community, dimensions are determined by the maximum distance one can travel comfortably on foot in 10 to 15 minutes.The smaller bedroom community requires a smaller area, but of sufficient size to accommodate shopping and other nonresidential support facilities.

Site Location
The live/work community must be located near transportation routes for connectivity to other cities. The bedroom community requires easy-access rapid transit to employment opportunities in nearby cities (the lures for migration from rural areas).
Site Planning:
Built-on land area is to be mitigated by creating a pedestrian-friendly community. The main level as well as all sky lobbies, reserved exclusively for pedestrians, is segregated from vehicular traffic on a lower level. The main entrance to all buildings is located on the aforementioned pedestrian level. The new Vertical City is to be surrounded by open land for cultivation of produce and operation of a fishery for local food consumption. The open space will also provide a green buffer between other cities.

Horizontal Circulation

Vehicular

Vehicular circulation within the Vertical City is limited to the lower level. To preserve fast-disappearing arable land, all external vehicular traffic to and from the project ideally should be elevated.

Pedestrian

As one of the premier features of the Vertical City, the primary modes of circulation are by foot or bicycle, the maximum distance being that which can be walked in 10 minutes.

Bicycles

Bicycles are encouraged, in dedicated lanes, in conjunction with foot traffic.

Extended Sky Lobbies

Located at vertical intervals of approximately every 100 stories, extended sky lobbies allow pedestrian interconnection among all towers. (See "Towers," below.)

Moving Sidewalks

As necessary, a system of radiating moving sidewalks can be installed along selected heavily traveled routes.

Mass rapid transit

If necessary, consideration will be given in the future to the incorporation of a rapid-transit system in the utility service level below the main pedestrian level. The same transit system will connect the Vertical City to neighboring communities.

Vertical Circulation

In addition to stairs, ramps, and escalators, the towers are served by ropeless high-speed express elevators connecting one sky lobby to another. Transfers to banks of local elevators provide service to individual floors above and below.

Infrastructure

Roads

Since the primary internal circulation mode is by foot on the main podium level, conventional roads are limited in number and relegated to the lower level for service vehicles, privately owned cars and rentels. Highways and rail links to other communities are raised in order to preserve precious arable land.

Services

Service utilities such as electricity, natural gas, water, storm and waste sewers, and related storage tanks, plants, and equipment are located within the podium platform for security and easy access for maintenance and repairs. Such a disposition prevents disruption of activities on the pedestrian level above or the vehicular level below.

Buildings and Structures

Basements

It is believed that with the introduction of the raised podium platform, described below, the cost of basement excavation and construction can be avoided.

First or Grade Level

The lowest level of the podium is located on grade for deliveries and vehicular access and parking.

Podium Platform

A raised podium houses all the services and infrastructure required by the Vertical City. The roof of the podium is the main platform, or "ground" level of the Vertical City, from which the main entrances of all buildings are accessed.

Podium Buildings

Comparatively low support buildings, averaging 6 to 10 stories, house schools, shopping, theaters and cinemas, restaurants, cafés, bars, medical facilities, government agencies and other functions that are not suitably accommodated in the towers. Collectively, the support buildings constitute the Central Business District (CBD) found in all conventional communities. This primary commercial area will be supplemented by smaller shops, stores, and service outlets in tower sky lobbies and extended sky lobbies (described below).

Towers

The iconic towers of the Vertical City are primarily residential, serving both the bedroom and live/work communities. In the latter, the towers also serve, significantly, as centers of employment, housing offices, laboratories, health care, and even certain clean light industries. A limited number of mixed-use towers will serve each community according to market demand.

SECTION FIVE / THEORETICAL APPLICATIONS

-THE VERTICAL CITY
CONCLUSION

Applied Principles of the Vertical City

To test the validity of the principles of the Vertical City against the problems of actual cities, we had first to choose the cities. In doing so, we were sensitive to the fact that residents often resent outsiders who, instead of giving a balanced view of their beloved city, have had the audacity to find fault. Such feelings are understandable and are no different from when we New Yorkers complain to each other about the scarcity of affordable housing, the dearth of taxis when it rains, and the dirty slush after a snowstorm, but resent it when outsiders voice the same complaints. Therefore, we wish to state at the outset that it is not our intention to find fault but to accurately identify certain well-documented situations in selected cities that we believe can find relief in the application of the theories of the Vertical City.

It would be a great injustice not to acknowledge that municipalities throughout the world channel tremendous talent and resources into the identification, evaluation, and resolution of their respective problems. It is beyond our resources to do more than state that in the United States, certainly in cities like Boston, Chicago, New York, Philadelphia, and San Francisco, such leadership exists.

The emphasis of this book thus far has been on halting the universal problem of urban sprawl, in both developed and developing nations. In addition, particularly within developed nations and especially in the United States, there is the growing problem posed by the oldest suburbs. They were highly desirable communities when first established, but with their deteriorating buildings, services, and roads they are now being abandoned for newer homes even farther away from the city center. In going forward, as planners, administrators, and urban theorists address these issues, the principles of the Vertical City for an environmentally conscious, high-density, self-contained, car-free, pedestrian-friendly community are worthy of consideration.

We are aware that complacency is part of human nature, and until the rising sea level is at our very doorsteps, or we have to retreat within the protective shelter of a Buckminster Fuller geodesic dome, mankind will live out its existence following old habits governed by antiquated beliefs, principles, and regulations. There is always hope that, as land disappears, science will enable our survival by tapping into the riches of the sea—that we can somehow mine the layers of fertile ocean floor to cultivate oxygen- and food-producing water plants to compensate for the loss of the rainforests. Others maintain that we have concentrated too much on the negative side of global warming. Why not celebrate the shorter winters and longer growing seasons? Soon we will all be living in one big tropical paradise!

About one thing we are sure: We need to talk!

It is thus that we—brazenly, yes—superimpose images of Vertical Cities on existing cityscapes as a means to generate dialogue and test the air, as it were. We are fully aware that only through a miracle would any of the illustrations come to fruition. On the other hand, if, after making the required adjustments, major or minor, in a location most suitable for the specific conditions, the collective wisdom of just one urban center saw fit to test the validity of the Vertical City's principles, there would be cause for celebration.

Moscow the capital of Russia, was ravaged during the war with Napoleon in 1812. It was gradually rebuilt over the years, but the greatest change came after the breakup of the Soviet Union, in 1991. Since then, rapid development has made Moscow the largest city in Europe, with a population of more than 11 million and some 4 million cars on the road. Infrastructure is stretched to the limit, yet people continue to pour into the city by the thousands. Moscow's population is expected to double in the next 20 years.

To accommodate the expected new arrivals, Moscow planned to expand its physical boundaries toward the southwest in an area about twice the size of the existing capital city, doubling its horizontal footprint. Historically, such lateral expansion has been the norm in most major cities, but it has proved to be unsustainable.

Applying the principles of the Vertical City to Moscow

A series of bedroom communities (each accommodating upward of 150,000 residents) plus live/work communities (each accommodating up to 250,000 residents) within a square footprint of one half mile per side, or roughly .25 square miles [.64 square kilometers], measured against Moscow's current population density of 9,772 persons per square kilometer, would occupy only 2.5 percent of the land, leaving 97.5 percent for agriculture, recreation, and other productive uses. Since the pedestrian-friendly communities are car-free, there is no requirement to build new roads. Every Vertical City constructed would eliminate the use of 90,000 cars.

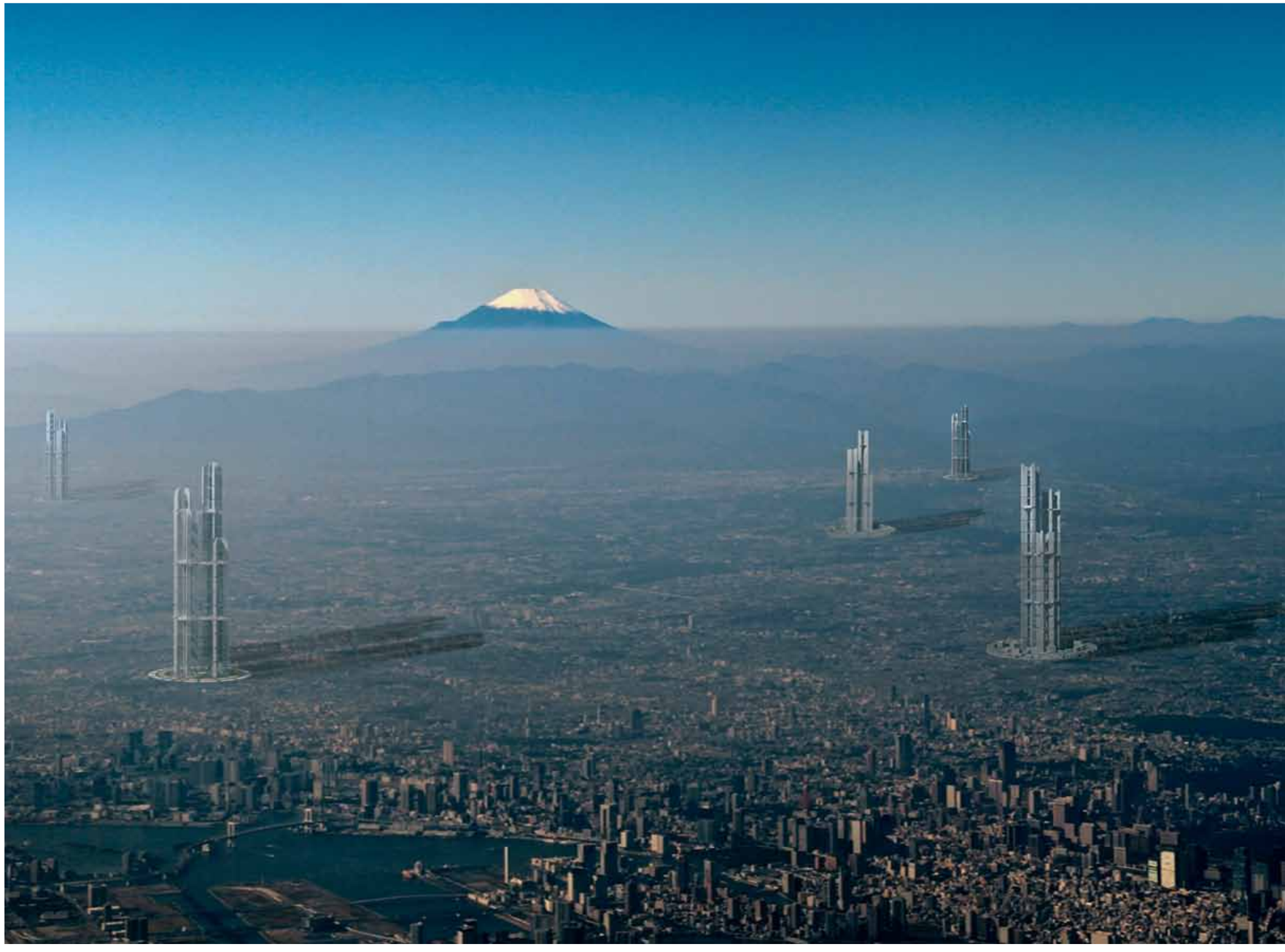
Such an approach would stem the tide of destructive urban sprawl. It would allow Moscow a chance to update its mass transit system and other aging infrastructure while completing its urban renewal efforts in a less hectic fashion than is currently the case.

Moscow

Tokyo, Japan's largest city, is experiencing a population decline as the populace ages and young couples give birth to fewer children. While the city's economy remains robust, it is predicted that by 2100, Tokyo's population will plunge to less than half of its current 13.23 million. Meanwhile, the urban planning objective of metropolitan Tokyo is improvement of the urban infrastructure. The focus is especially on transforming the regional transportation system to create a low-carbon, healthy, and appealing environment that will continue to attract investors and increase Tokyo's international competitiveness. Less predictable are the environmental and economic consequences of the government's reconsideration of a zero-nuclear policy.

Applying the principles of a Vertical City to Tokyo

Replacing sprawling low-density neighborhoods with carefully planned Vertical Cities can help Tokyo solve the problems stemming from its antiquated infrastructure, reduce its energy demands (irrespective of energy sources), and create a healthier, more efficient, and competitive international city of the future.



Tokyo

Conclusion

The world needs no more urgent a wake-up call than the realization that the current global population of 7 billion has the potential to reach 9 or even 10 billion by 2050—less than four decades from now! Such alarming growth forces the question about the point at which Earth will be no longer able to feed such a mass of humanity. Putting political correctness aside, there is an obvious solution: population control/birth control/family planning. Whatever the name, there is a grave need to stabilize growth. Research has shown a direct correlation between education and population control; therefore, we implore experts in related fields—teachers, medical providers, sociologists, religious leadership, politicians, everyone!—to urgently redouble their efforts to find a solution and prevent the unchecked, ever-increasing growth of humanity from dragging us all into the abyss.

We often refer to the delicate balance of nature—exemplified by the need for the perfect mix of temperature, atmosphere, and nutrients in the ooze of the tidal pool—for life as we know it to begin. So too was the delicate mutation of our forbears' DNA to enable us to walk upright, carrying proportionally the largest brain of all Earth's creatures. On the other hand, there is no delicacy in the brutal forces that the universe is capable of when it hurls an asteroid—for instance, Little Ida—a mere 36 miles [58 kilometers] in diameter (about the size of the island of Singapore), for a direct hit on our planet; or when the melting ice caps and ice sheets of the Arctic and Antarctic raise the sea level by some 195 feet [58.5 meters], drowning most of Earth's coastal cities; or when the entire planet is blanketed in mile-thick ice [1.6 kilometers], thereby wiping out mankind—the mankind who unthinkingly continued to tip the balance until it reached a catastrophic slide into oblivion. But in time, perhaps millennia later, spring will return, and nature, being the nurturing mother that she is, will give a wiser mankind another chance.

As architects, we can help point out to men and women across the world that we need desperately to pause and take stock of our actions before steering the course irreversibly in the wrong direction. We need to stop releasing so much carbon dioxide into the atmosphere that we cannot ever recover; killing our streams, rivers, and oceans by the criminal dumping of pollutants; and mindlessly continuing to waste natural resources or otherwise consume more than our fair share of Earth's rapidly diminishing bounty. Some would argue that it's already too late. Before we are forced to live on the ocean atop floating pontoons or aboveground in pods suspended from cables, we need to diligently explore the possibilities of building vertically, not necessarily at mile-high limits, but at sufficient heights that will ensure against losing to urban sprawl yet more arable land, yet another clump of trees, yet another bit of precious nature. We need to reevaluate terrain that is not suitable for farming, previously dry ground now inundated by rising sea levels, and parts of existing cities that lack the critical population mass to rejuvenate itself. By all means, let us start by exploring issues with which we are most familiar and then, reaching beyond our comfort zone, explore all avenues that may—small step by small step—help us find ways to sustain the only habitable planet we know. This book has been one such attempt.