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## Global Environmental Contextualism

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### Adrian Smith

Adrian Smith, has been a practicing architect for over 40 years. His extraordinary body of work includes some of the world's most recognizable landmark structures, including the Jin Mao Tower in Shanghai, China; Rowes Wharf in Boston, Massachusetts and the Burj Dubai in the United Arab Emirates, soon to be the world's tallest structure.

Adrian's unique design approach emphasizes sensitivity to the physical environment. He considers each project holistically, taking into consideration site orientation, climate and geography, cultural and social influences to create highly sustainable projects that achieve contextualism within the global environment. As one of the world's foremost experts of super tall towers, he recently collaborated with Gordon Gill to design the world's first net Zero-Energy skyscraper, Pearl River Tower, to be built in Guangzhou China. The design harvests the natural forces of wind, sun and geothermal mass, and continues Adrian's tradition of integrating energy efficient systems and technologies into his designs.

Prior to founding Adrian Smith + Gordon Gill Architecture in 2006, Adrian was a Design Partner in the Chicago office of Skidmore, Owings & Merrill from 1980 to 2003 and a Consulting Design Partner from 2004 to 2006.

### Gordon Gill

Gordon Gill directs design teams in the creation of award-winning architecture across the globe. His work emphasizes a holistic approach to design that integrates all project disciplines. The results are performance based designs that work symbiotically with their natural surroundings- contributing to the sustainability of cities, augmenting the built landscape and creating an optimal user experience.

Gordon's work includes the design of civic facilities, large-scale mixed-use developments, city-wide master plans and the world's first net Zero-Energy skyscraper, Pearl River Tower. This landmark project achieves energy independence through the harnessing of natural forces at the building's site, exemplifying Gordon's philosophy that architecture must strike a balance with its global environmental context.

His work has been recognized by the American Institute of Architects, Architectural Record and has been exhibited at the Museum of Contemporary Art in Chicago. Gordon has lectured widely and in the fall of 2007 will begin teaching a design studio at the Art Institute of Chicago. Prior to founding Adrian Smith + Gordon Gill Architecture LLP in 2006, Gordon was an Associate Partner at Skidmore, Owings & Merrill LLP and a Director of Design for VOA Associates.

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### Abstract

Adrian Smith + Gordon Gill Architecture is dedicated to the design of intelligent, energy-efficient and sustainable architecture on an international scale. The firm's design philosophy, 'global environmental contextualism', is predicated on the understanding that everything within the built and natural environment is connected, and that a building's design should stem from an understanding of its role within that context---locally, regionally and globally. Buildings designed in response to their environments will make the best latent value of their site and generate natural, environmentally-friendly energy. This approach, which takes into consideration building orientation, daylighting, generation of wind power, solar absorption, and a site's geothermal properties, represents a fundamental change in the design process, in which form facilitates increased performance. If we design with an understanding of global context, we can create buildings that support healthier lifestyles and respond to the changing needs of the planet and create an enhanced, connected built environment. A network of high-performance buildings could one day result in the creation of zero-energy city blocks, neighborhoods even cities---and serve to promote a new standard for sustainable, responsible lifestyles. In the context of global development, and in a time when entire cities are being designed and built from scratch, these environmental goals are not only attainable, but vital to our survival.

**Keywords:** Zero Energy, High-Performance, Global Environmental Contextualism

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### Introduction

The task of the architect has always been to find a balance between art and science, between performance and beauty. Conventionally, talking about the 'science' of architecture has meant a discussion of building structure and systems, and the effect those elements will have on a building's interior and immediate exterior environments. Traditionally, we have not regarded the 'science' of architecture as something that has a far reaching effect on our neighborhoods, our cities, our planet as a whole.

But we are rapidly approaching a critical juncture in our earth's history. Pollution is threatening our environment, our air quality, our water, our very way of life. Contrary to popular thinking, it is often buildings, not automobiles that are the largest environmental offenders. This is especially true in urban areas, where buildings are responsible for as much as 80% of carbon emissions. The design community must accept responsibility for curbing the dangerous levels of pollution generated by modern buildings, and create a built environment that exists in harmony with the natural world. But we cannot move backwards. We will need to make concessions, but we cannot expect society to operate in a world without modern conveniences and comforts. Instead, we must learn to work within these parameters. The buildings of the 21<sup>st</sup> century must move beyond performing programmatically and aesthetically-and perform efficiently, cleanly, powered by natural energy.

### Global Environmental Contextualism: An Integrated Approach

As architects, we feel strongly that performance and efficiency can not come at the expense of aesthetic form or functional excellence. These elements should enhance and improve the building environment. To achieve this, our office utilizes a holistic, integrated design approach that gives equal consideration to all disciplines. The approach requires a comprehensive understanding of each building element and its function within a larger context, within both the built and natural environments.

Developments that have a greater understanding of environmental context will support healthier lifestyles and respond to the changing needs of the planet. Buildings designed in response to their environments will make the best latent value of their site and generate natural, environmentally-friendly energy. This approach, which takes into consideration building orientation, daylighting, generation of wind power, solar absorption, and a site's geothermal properties, represents a fundamental change in the design process, in which form facilitates increased performance. This philosophy, which we've termed 'global environmental contextualism', is predicated on the understanding that everything within the built and natural environment is connected, and that a building's design should stem from an understanding of its role within that context---locally, regionally and globally.

Designing a building that responds to its global environmental context begins with a strong understanding of existing conditions: environmental data, relationship to existing and future developments, the policies in place that support site development. Architecture that responds to each of these specific conditions forms an inextricable connection to its site and relates symbiotically to its environment.

### **Supertall and Super Sustainable**

The densification of cities is evident worldwide. In China, more than 12 million people are expected to move into urban areas every year between now and 2030. In 2015, 3.9 billion people worldwide will be living in cities and over 40 percent will be living in cities of more than 1 million people. In response, cities across the globe are enhancing their infrastructures, resulting in a development boom so concentrated that it has been termed a 'Second Industrial Revolution.' At this critical juncture in the evolution of the urban area, cities have a unique opportunity to assert themselves as centers of healthy living.

Cities are inherently more sustainable than suburban areas. Cities can accommodate more people on less land, reduce commute times and roadway infrastructure, and encourage the use of public transportation. An April 2007 study conducted by New York City's Office of Long-Term Planning and Sustainability noted that per-capita carbon emissions of New Yorkers less than one-third those of the average American. But despite generating less carbon dioxide emissions per capita, cities are still responsible for nearly 80 percent of the carbon emissions worldwide. The major environmental offenders in urban areas are not automobiles, but buildings, which in some cities, account for up to 80 of carbon emissions. The key to creating sustainable cities lies in better planning and design- and a holistic approach that begins at the outset of development.

The supertall tower, arguably the most inherently sustainable structure, is also the cornerstone of the modern city. More than any other structure, skyscrapers serve as landmarks for cities and nations. An iconic presence is the chief reason for the skyscraper's popularity, but is also a large contributor to the structure's sustainability. Supertall buildings are efficient and have minimal impact on the land, making them naturally efficient. But skyscraper design can progress beyond inherent sustainability to create performance-based super sustainable towers. These performance based towers will respond to the changing needs of the planet and generate natural, environmentally friendly energy.

'Global Environmental Contextualism', while a universal concept, is especially applicable to supertall structures. Due to their height, high rise structures act as

'sails' in the wind, disrupting natural patterns and creating harsh localized conditions. To limit this effect, the buildings often 'telescope', reducing their floor plate size as they grow. This sheds wind vortices, reduces loads and improves structural performance. But this approach fails to take advantage of the power of the natural environment. Supertall buildings that are formed to work harmoniously with their environmental context can harness natural energy while simultaneously resolving structural issues and increase performance- by taking advantage of wind acceleration and behavior and other natural power sources.

### **Performance-based design**

A high-performance building is an instrument that maximizes the efficiency and functionality of every building element. In some cases, this means the integration of new technologies and more environmentally friendly materials; in others it involves taking advantage of natural resources. These designs also acknowledge the interaction among building systems as well as between those systems and the natural environment, and seeks to improve each individual system's performance. The key to successful sustainable architecture is to find effective ways to integrate these systems and techniques into building design to create a synergy among the environment, the building, systems and users.

Improving building performance often benefits from an investigation of latent performance. Efficient design can significantly contribute to the reduction in a building's carbon emissions. By eliminating redundant building structure and technical connections, a building will reduce the total carbon footprint of its structure. In supertall towers, one way to reduce redundant structure is to incorporate a tuned mass damper at the building's top.

Taking advantage of natural resources has also long been a part the architectural practice and has many benefits beyond energy savings. Studies have suggested that exposure and proximity to natural light improves people's mood, health, and well-being. Increasing natural light, incorporating superior views, and providing opportunities for interaction with nature is accomplished through strategic planning at the start of design. Daylighting can be increased through building orientation, reorganization of interior layout, incorporation of light shelves to focus daylight deeper into office spaces, or use of a double wall design to increase window size and visibility while maintaining temperature control and user comfort. It is easy through design to provide access to outdoor spaces or views of vegetation, including plants, gardens, or green roofs, if such space is nearby.

But the demands of today's lifestyles often necessitate greater control over our environment than solely utilizing passive systems such as daylighting or

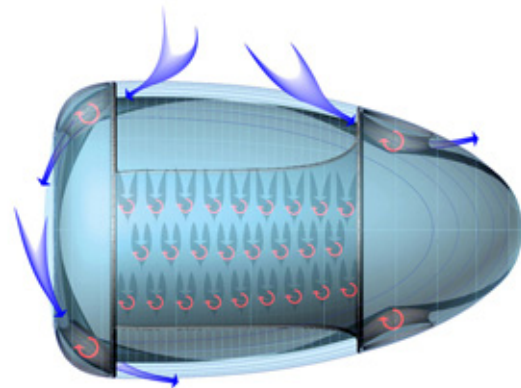
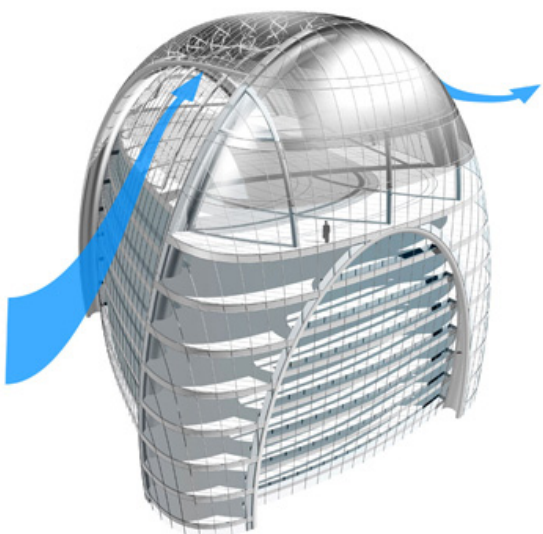
natural ventilation will allow. Advances in engineering allow building ventilation and air-conditioning systems to provide optimal comfort for users while improving indoor air quality. Radiant-slab, chilled-ceiling/beam, and under-floor air systems provide effective ventilation and temperature control while reducing the need for systems that provide substandard air quality and damage both the natural and interior environments. The effect of cleaner, better air on a building's users is widespread, reducing the probability of sick building syndrome, and fostering a healthier environment.

### Clean Technology Tower

The high-performance Clean Technology Tower is an example of a supertall tower based on the principles of global environmental contextualism. The tower is sited and formed to harness natural power on site- but it refines the conventional methods of capturing those natural forces to significantly increase efficiency. Wind turbines are located at the building's corners to capture wind at its highest velocity as it accelerates around the tower. The turbines become increasingly dense as the tower ascends and wind speeds increase. At the apex, where wind speeds are at a maximum, a domed double roof cavity accelerates air, allowing for a large wind farm and the use of negative pressures to ventilate the interior spaces.

The tower also takes advantage of solar patterns, incorporated shading photovoltaic cells on the domed top, which capture the southern sun. Programmatically, the tower is arranged for that office space is located on upper floors, maximizing views and taking advantage of direct natural daylight.

The building's orientation, form and the incorporation of specific building systems increases utilization of natural resources, provides comfort and clean energy to the space.



(Images 1-4: Clean Technology Tower, © Adrian Smith + Gordon Gill Architecture)

### Elphinstone Mills Development

The Elphinstone Mills complex in downtown Mumbai, harnesses energy from the wind and successfully incorporates the natural landscape into the building's interior. The client's stated goal for the project was to achieve a LEED Platinum standard.

The building was oriented to minimize solar gain on site, decreasing the heating effect of direct sunlight. From the entrance, the building appears to be a tower

“overcome with green”, as garden spaces and vegetation are incorporated throughout. The green vertical surfaces and garden spaces have a cooling effect on the tower, reducing the heat island effect and orchestrating the creation of ‘garden rooms’. The parking garage drop-off, which can be seen from the building entrance, is covered in a planted screen, likening it to a vertical garden space.

Every floor of the 60-story tower features outdoor terraces and multi-story garden atria, which had both environmental and financial advantages for the building. The incorporation of garden spaces resulted in an interior workspace that was fully integrated with the exterior environment. The terraces and atriums increased natural light in the tower, while the overhangs of each outdoor terrace provided shade for the space below. The design also increased natural ventilation and natural cooling. The atria work in concert with a central stack, facilitating cross ventilation and air flow between from the terraces and balconies and the central atrium. The atrium can be configured to direct air through the building and into units on the opposing side of the tower. Air flow into the central atrium takes advantage of the stack effect and the air’s motion up the atrium. Wind turbines are located centrally within the atrium to harness the natural energy from the air.

A local policy in Mumbai provided an increased incentive for developers to increase outdoor space in new projects. In Mumbai, outdoor space in a building is an “FSI free area”, meaning a developer is able to add rentable outdoor space without that space contributing to the approved FSI total. AS+GG took advantage of this unique policy to maximize the outdoor space in the building, which decreased the building’s environmental impact. While the policy was not drafted to increase building sustainability, AS+GG was able to creatively use the local policy to the building’s advantage.



(Images 5-6; Elphinstone Mills © Adrian Smith + Gordon Gill Architecture)

### Eco-Footprint

The eco-logical footprint analysis compares our consumption of natural resources with the Earth’s ability to generate them. Every material item or energy consumed is produced by a certain amount of land in one of more eco-systems. The eco-footprint analysis demonstrates conceptually “how many planet Earths” it takes to support an individual’s lifestyle.

The average eco-footprint in the United States hovers just under 10 (REF: State of the Environment Report 2007, produced by the Western Australian Government), meaning it would take the resources of 10 planet earths to support the energy and materials consumed by the average American. The worldwide average is closer to “2”, with many Latin American, Asian and African countries off-setting the significantly higher consumption rates of countries in North America, Europe and the Middle East. While an eco-footprint of “2” is certainly a vast improvement over the US average, it still indicates that the world’s population is consuming the earth’s energy at twice the rate of the planet’s production.

AS+GG is currently working on a project with an eco-footprint of “1”. The project, a residential mixed-use complex, was developed using an integrated design approach, and understanding of the building in its most reduced form and a comprehensive understanding of local, regional and global contexts.



(Images 7-8; Elphinstone Mills © Adrian Smith + Gordon Gill Architecture)

To achieve an eco-footprint of “1” for this mixed-use residential development, AS+GG defined a series of goals for the project:

#### *Reducing Travel Impact*

To reduce travel impact, the project was located in a dense urban area. Densely populated urban areas are known to be inherently more sustainable than suburban areas because they encourage more efficient land-use and infrastructure, and are accessible by public transport. In fact, simply doubling the density in an area can cut private transportation by 20-30%. Residential heating requirements are also affected: the differences in heating consumption between grouped and free-standing housing developments can be as much as 50%. In addition to being more efficient, high density communities have been shown to become more community oriented, livable places.

#### *Reduce Food Choice Impact*

To reduce food choice impact, the building was designed to accommodate on-site food production in working gardens, to encourage the consumption of locally grown foods. On-site composting and potting sheds are also provided for residents.

#### *Reduce Domestic Water Use*

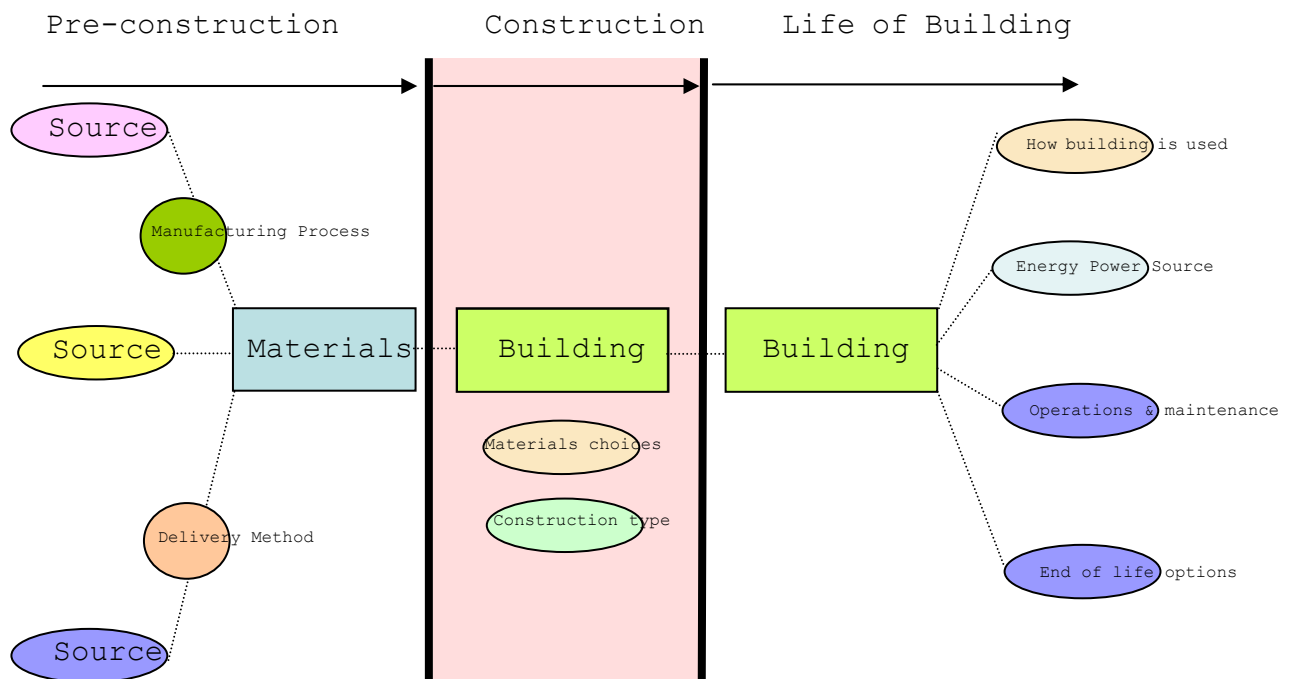
To reduce domestic water use, water reducing fixtures intended to reduce personal water consumption were incorporated into the design. Systems for rainwater collection and on-site water treatment were also included.

#### *Reduce Energy Consumption*

To reduce energy consumption, a number of sustainable features were incorporated into the building, including geothermal systems, thermal massing, solar hot water, passive shading, radiant heating and cooling systems, and energy efficient appliances and lighting. The project also uses biomass fuel and is designed to take full advantage of natural light.

But to create a development with a true eco-footprint of “1” it is necessary to re-evaluate and potentially expand to design. An eco-footprint measures impact and carbon emissions over the entire lifecycle of a building- not just during construction. What happens after building construction is completed and a building is occupied is crucial: how the building is used, how it influences the lives of its users.

Evaluating a building based on these criteria is not common within architectural practice, and represents the expanding sphere of design’s influence. Designing with an eye toward achieving a certain eco-footprint requires architects to go beyond simply designing environments and begin to influence the lives that are lived within those environments. While it is impossible to exact control over how a building’s inhabitants live their lives, as designers we can create buildings to promote and encourage sustainable activities.



Buildings that have access to public transportation, storage for bicycles or access to hybrid rental cars, such as Zip cars, promote sustainable transport. Vegetable gardens and green space promote the growth and consumption of organically grown foods. Energy saving appliances and fixtures encourage inhabitants to use less water and electricity. While this may appear to be a ‘gray area’ between the life of a building and the lives of its inhabitants, good design has always strived to influence the lives of users. By taking sustainable design to the next level and attempting to influence people’s choices regarding what they eat, drink and how they move around, we are expanding a user’s social conscience and reflecting the 21<sup>st</sup> century lifestyle and culture.

#### *Taking it Further: Holistic Eco-Analysis*

A holistic eco-analysis begins with pre-construction. A full analysis of building materials, including how they are manufactured and delivered to the site is conducted to ensure the most efficient and sustainable materials and transport methods are utilized. During construction, building methods and material choices are monitored. But the most important evaluation comes after construction is completed, over the life of the building. A close evaluation of the building’s use, its energy power sources and procedures for operation and maintenance should be considered.

#### **The Economic Value**

The perception that high-performance architecture always carries a significantly higher price tag is largely

misguided. Numerous studies have demonstrated that sustainable buildings do not require significantly higher capital investment than unsustainable projects. In fact, the average added cost of buildings meeting Leadership in Energy and Environmental Design (LEED) standards over non-LEED structures is calculated to be less than 2 percent if design teams begin with a goal of LEED certification and adopt an integrated design strategy, according to *The Costs and Financial Benefits of Green Buildings*, a 2003 report by Gregory Kats, principal of Capital E, a clean energy consulting firm in Washington, D.C.

In addition, policy initiatives to promote sustainability are on the rise, and many federal and local governments provide tax incentives to help offset larger first costs for green projects. Equally compelling are the decreased life-cycle costs of sustainable buildings: the energy savings provided to building owners over the building’s period of use may be more than enough to recoup initial costs, and in most cases, final costs will be substantially lower than for a traditional building. There are also marketing benefits: as concern about the environment continues to grow, the premium on sustainable, high-performance buildings will rise, so even selling a building after a year or two will be economically advantageous. Finally, a major selling point for potential building tenants are the benefits to the interior environment- reduced toxicity in the air, improved ventilation and overall healthier interior spaces will add to the health and well-being of building users.

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Sustainable design is forcing the development community to change the economic equation typically used to judge building projects. In addition to the baseline economics of a project---the initial incentives and overall life-cycle costs---design and building professionals must also evaluate the value of both an enhanced quality of life and a reduced environmental impact.

The value of energy savings and reduced carbon emissions could be compounded by trading of carbon credits on an exchange such as the Chicago Climate Exchange. By equating energy use to carbon emissions and relating those emissions to current exchange prices, one can begin to quantify a building's positive or negative environmental impact, and subsequently calculate any additional income that will result from reducing this environmental impact. The possibilities for trading and selling carbon credits or saved energy are great.

Once designers and building professionals understand the value of the qualitative elements of sustainable design, they can begin to embrace use of sustainability to add economic value to any building project, regardless of its parameters.

### **The Zero Energy City**

While new, high-performance developments can help lower the carbon footprint of a solitary piece of land, existing low-performance, inefficient buildings will continue to pollute the environment. The development community needs to address existing structures. Incorporating green technologies into these buildings will help curb emissions, but the reality is that some inefficient buildings will be slow to evolve. The next generation of sustainable development must compensate for these large carbon emitters, by naturally generating excess energy.

Positive Energy buildings could one day store or trade energy with neighboring buildings supporting themselves as well as the local community, through efficient distribution of energy to buildings in close proximity. This concept could grow into a network of energy-generating and sustainable buildings, resulting in net zero-energy city blocks, neighborhoods---even cities---and serve to promote a new standard for sustainable, responsible lifestyles. In the context of global development, and in a time when entire cities are being designed and built from scratch, these environmental goals are not only attainable, but vital to our survival.