

**The Triangle of Sustainability:
A Comparative Study of Contemporary Sustainable Architecture in Beijing and Pittsburgh**

by

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Lin Hou, B.Phil

Sustainable architecture is increasingly becoming not only iconic of higher life quality, but also a great tool to reduce energy usage in response to global climate change concerns. More and more, sustainable architecture has diverse foci based on what standards (such as LEED) architects choose. Looking at those standards, and how different architects approach them, it becomes essential to look for similarities and differences.

In 2015 at the United Nations Climate Change Conference, the two largest polluters—America and China—committed themselves to cut CO₂ emissions. In this study I am performing a comparative analysis of two recently designed major buildings in Pittsburgh and Beijing, two top cities in America and China which are developing sustainable architecture in response to similar climate issues: the New Tower in PNC Plaza and the Parkview Green Mall in Beijing.

There are two core questions that I intend to answer by the end of this research project: (1) Why does each building go beyond minimum sustainability standards required in its respective country? (2) What are each project's respective foci in designing their own sustainability solutions? I will first analyze two different standards applied in two case studies—the U.S. LEED (Leadership in Energy and Environmental Design) and China's GB (Evaluation Standard for Green Building). How does each standard address different climate issues and how applicable are they in their respective countries?

In order to make the comparison between these two buildings easier to understand, I will focus on their similarities and differences in five major categories: standards, human use, multi-

functionality, focus of sustainability, and central ventilation. However, the comparison is not limited to these categories. For example, communication and raising public awareness about sustainability is another aspect that I explore. My honors thesis includes a website which contains a short movie and animations ([click here](#) to watch the full version of the movie) to help explain my research project in greater detail.

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1.0 UNDERSTANDING THE ROLES OF SUSTAINABLE ARCHITECTURE

Sustainability has been defined by the United Nations as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”¹

Over the last half century, the understanding of sustainability by citizens, architectural and engineering firms, and local governments has increasingly grown from the limited view of purely cutting industrial pollution and reducing CO2 emissions to more ambitious programs of reversing or neutralizing climate change. One example of this increasing attention to sustainability is the U.S. non-profit organization called Architecture 2030, which is comprised of architectural firms, suppliers, community organizations, and local/state governments who have proposed the 2030 Challenge, in which all new buildings, developments, and major renovations in the U.S. shall be carbon-neutral by 2030.² The organization has received support from the U.S. Department of Energy. Such bold moves by governments, non-profit organizations, and designers have spurred my curiosity about how climate change problems can be addressed through responsible design of the built environment.³

Finding solutions to climate change is becoming an unavoidable responsibility for major countries, such as the U.S. and China, which are also currently the world’s two greatest polluters. Architects around the globe are paying close attention to how these countries solve climate issues

¹ <http://www.un.org/en/ga/president/65/issues/sustdev.shtml>, accessed February 12th, 2017.

² http://architecture2030.org/2030_challenges/2030-challenge/, accessed March 18th, 2017

³ <http://architecture2030.org>, accessed March 18th, 2017.

in order to emulate their approaches. Therefore, it is important to study how the two countries approach and develop their own standards for sustainability. By comparing their approaches towards sustainable architecture, this analysis can be used as a toolkit for other countries that are looking for guidelines of sustainability.

However, because the challenge of climate change is so great, cutting emissions and achieving sustainability will require an all-out effort by all stake-holders. The field of architectural design is contributing to this effort in the area of sustainable architecture. In the United States, architecture consumes 48% of total energy resources, as opposed to the transportation sector, which only accounts for 27% of energy consumption.⁴ Therefore, technological innovation and widespread adoption of sustainable architecture can make a significant impact on the future of sustainability. In this thesis, I compare two recent sustainable buildings in the U.S. and China and investigate the different approaches employed by both developers and architects with regard to sustainable solutions. By doing the comparisons, I aim to highlight three different aspects of sustainable architecture. Perhaps most importantly, I emphasize that sustainable architecture should go beyond simple energy savings and resource management to ultimately inspiring other developers to pursue sustainability and fostering sustainable lifestyles within the community.

In the U.S., there are many sustainable standards such as LEED, the Living Building Challenge, and Life Cycle Assessment (LCA). The most widely used set of sustainability guidelines, LEED (Leadership in Energy and Environmental Design), is more directly related to design strategy towards energy saving and resource conservation in architecture. LEED has four levels—Certified, Silver, Gold, and Platinum. Although it is not a requirement that buildings

⁴ Susan S. Szenasy, “Reflections On Sustainable Design,” Volume 37, Number 1, ix.

have to receive LEED certification, most architectural design firms in the U.S. voluntarily aspire to LEED certification in their projects.⁵ In this thesis, LEED will be the primary U.S. standard used to examine how two recent buildings in Pittsburgh and Beijing have been designed to achieve LEED's sustainable accreditation. In China, some Chinese design firms also follow LEED. More importantly, all Chinese design firms must adhere to minimum government sustainability regulations, which are called GB (Evaluation Standard for Green Building). GB is different from LEED in that it is a governmentally mandated green architectural law. Government plays an essential role here to make sure all new construction in China reaches a minimum sustainable standard. As large developers in China look towards international clientele, LEED has become a more attractive certification than GB.

My methodology for research has been interdisciplinary and multi-sited. In order to gather evidence for this project, I visited both PNC Tower and Parkview Green Mall multiple times, where I was able to observe user behavior and also experience the environment of both buildings in an intimate way. In order to better understand PNC's design and sustainability solutions, I interviewed Angelica Ciranni, the former sustainability analyst at PNC, as well as and the project's primary design architect, Douglas C. Gensler. For Parkview Green Mall, there is a published report which includes many interviews with that project's primary design architect—Winston Shu—and its developer. This report helped me comprehend how the architect's initial ideas evolved and informed me about the major challenges that he faced in designing Parkview Green Mall. I was also able to draw on other resources, such as websites and news articles for my research.

⁵ Ozge Suzer, "A comparative review of environmental concern prioritization: LEED vs other major certification systems," *Journal of Environmental Management* 154 (2015) : 266-83.

Because I want to pass the message of sustainability to a wider audience who may not be familiar with architectural design or sustainable technologies, I have written this essay, which represents one part of my thesis, the other being a website that hosts video and animations of the sustainable components of these buildings. This bi-lingual (Chinese and English) public website explains sustainable architecture to a non-specialist audience. This website is therefore related to my argument that in order to be truly successful, sustainable architecture should not only focus on energy efficiency but also inspire the wider community to make sustainable choices every day. I hope that by visualizing sustainable design in PNC Tower and Parkview Green Mall, I can attract more people's attention to the urgent issue of environmental sustainability.

To compare the ways that Chinese and American architectural firms adhere to and surpass their own nation's sustainable standards, as well as how they interpret sustainability, I have chosen one building from Beijing and one from Pittsburgh. These buildings are Beijing's Parkview Green Mall, which is the first LEED platinum-certified building in China, and the New Tower at PNC Plaza (from now on, PNC Tower) in downtown Pittsburgh, which goes beyond even the highest level of the LEED ranking system. Pittsburgh and Beijing both share a similar history of industrial production and climate—two significant factors for architectural design. Until recently, Pittsburgh was famous for steel production and Beijing largely produced rubber and electrical equipment in the industrial period during the 1960s.⁶ Although both cities are now less focused on industrial production, the lingering effects of this history can be seen in their air quality and also in their regional status vis-à-vis other major cities.

Further, both cities lie along a similar latitude (40 degrees North) and share the same general weather conditions during winter and summer. The average summer temperature is 75 F

⁶ <https://wenku.baidu.com/view/59bb3d1e6bd97f192279e9bd.html>, accessed March 30th, 2017.

for both Beijing and Pittsburgh, with temperatures reaching a high of 81F for Beijing and 80 F for Pittsburgh.⁷ Pollution and air quality are also significant factors in both cities. The latest Air Quality Index is 62 for Pittsburgh and is 98 for Beijing.⁸ Pittsburgh, with a population of 305,000, has 109 LEED-certified buildings, and ranked 12th in the U.S. in 2014 in terms of LEED certification.⁹ Beijing, with 70 times the population of Pittsburgh, has just 140 LEED-certified buildings.¹⁰ What causes this dramatic difference? What specific sustainability challenges present themselves in the two cities? With this in mind, I want to answer two questions: First, why does each building go beyond the minimum sustainability standards of its respective country? Second, what were each project's designers and developers' respective foci in designing their own sustainability solutions?

Before introducing the case studies in these two cities, I present my interpretation of sustainable architecture. Good sustainable architecture is never only about green materials, energy savings, or the installation of the latest technology. In this research study, I think of sustainability from three different perspectives: energy aspects, social aspects, and inspiration and impact. The energy aspect includes the analysis of technologies that are installed in the building to save electricity, heating, and cooling, the provision of green spaces, and water recycling systems. This is the most common understanding of sustainability. The social aspect is the design awareness related to the human context, i.e., the people who ensure the long-term sustainability of the building and its integration within their community. This includes how architects can design the spaces inside and outside the buildings to provide environmentally-friendly areas that will have an impact on other buildings in the community.

⁷ <http://www.usclimatedata.com/climate/pittsburgh/pennsylvania/united-states/uspa3601>, accessed April 11th, 2017.

⁸ https://www.airnow.gov/index.cfm?action=airnow.local_city&cityid=164, accessed April 11th, 2017.

⁹ <http://powersource.post-gazette.com/powersource/consumers-powersource/2015/06/09/As-green-buildings-evolve-latest-survey-ranks-Pittsburgh-in-middle-of-pack/stories/201506090003>, accessed April 10th, 2017.

¹⁰ <http://www.usgbc.org/articles/counting-down-2016-leading-countries-leed>, accessed April 11th, 2017.

In order to truly make an impact, however, sustainability has to have an inspirational aspect as well. Architects and developers have the responsibility to fully use good models of sustainable architecture to pass on the message of sustainability to the wider community and the city. One or even hundreds of zero-energy buildings will barely make a dent in our grave climate-related problems. Users of sustainable buildings and even those people who simply pass by sustainable architecture should have opportunities to experience the benefit of and learn about sustainable design. Thus, a journey to good sustainable architecture should not end with the building's construction, but needs to continue inspiring other companies, communities, and individuals to pursue sustainability from every aspect. These three aspects of sustainability are equally important in my thesis because they all support one another. Their values create the stable "Triangle" (Figure 1) and architecture cannot be truly sustainable without consideration of all three aspects

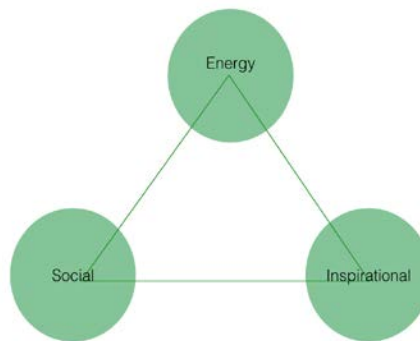


Figure 1: Triangle of Sustainability

In my thesis, I first offer a broad overview of the key debates in sustainable architecture and its development over the years. Then, I compare the two standards of sustainability in the U.S. and China, which are LEED and GB, pointing out the relative merits as well as the shortcomings of each. Then I describe the major sustainability elements of PNC Tower in

Pittsburgh and Parkview Green Mall in Beijing. I proceed by comparing both buildings on the basis of four different concepts: alternative design thinking, sustainability foci, central ventilation systems, and multi-functional spaces (This should not be confused with the aforementioned three different sustainability perspectives). By making comparisons in different categories to find similarities as well as major differences of the sustainable approach of the two buildings, I explore how well they respond to climate issues in their respective contexts. These comparisons reveal overlapping approaches as well as differences to sustainable architecture in the U.S. and China. Finally, I end the thesis by asking what the future of sustainability looks like and how these two buildings fit into new directions of sustainable architecture and urban design.

2.0 LITERATURE REVIEW

The discussions around sustainable architecture as we understand it today have been going on for over 80 years. Sustainability as a concept has attracted attention not only from architects, but also from historians, city planners, and material specialists who have each contributed their specialized knowledge and brought different approaches to sustainable architecture. I illustrate the variety of approaches to sustainability in the following literature review. Although these different interpretations of sustainability come from different fields, each of them has influenced my thesis in some way.

2.1 HISTORICAL DEVELOPMENT OF GREEN ARCHITECTURE

Green architecture first caught people's attention in the 1930s with the sudden awareness of environmental problems such as, drought and soil erosion. Architects used ad-hoc solutions to minimize the climate problems, such as passive cooling structures, reducing charcoal-burning, and on-site water collection. Some examples of such early experiments include the Villa Tugendhat, designed by Mies van der Rohe in 1930, which used a singular solution of passive solar architecture to optimize the internal temperature of the building. Van der Rohe designed the length of overhead shading based on the difference in the sun path between summer and winter so that the building could get less sunlight during the summer and more sunlight during the

winter.¹¹ In our sustainability triangle, this represents an early example of energy resource management.

During the 1950s, architects found that new materials such as “float glass” further increased the transmission of light into buildings and resistance to heat flow.¹² Sustainable architecture then became intimately related with the minimalist “less-is-more” aspects of the modern movement during that period, such as Le Corbusier’s Notre Dame du Haut in France and Buckminster Fuller’s geodesic domes. Until this stage, the interpretation of sustainable architecture by designers was still largely restricted to ecological issues, such as water pollution, nuclear waste, acid rain, and air pollution.¹³ After this stage, which marked the beginning of the widespread awareness of environmental issues, architects began incorporating ecological awareness into architectural design rather than installing features one by one. Phillip J. Tabb and Senem Deviren argue that it is important to see the greening of architecture as an evolutionary process and cyclical ecology rather than simply a fixed set of strategies for a fixed period of time.¹⁴ In other words, the definition of sustainability has changed over time as much as its technology has.

In the 1960s, architects extended their understanding of ecological sustainability to social sustainability and prevailing cultural attitudes. Scholars such as Reyner Banham became more concerned with group behaviors, attitudes, and actions when advocating green building, which is similar to the philosophy concerning human needs which influenced PNC Tower and Parkview Green Mall.¹⁵ The discussions of sustainability also became subsumed within the counter-culture

¹¹ J. Hirš L. Maurerová, “Villa Tugendhat as a Technical Monument - Elements of Passive Solar Architecture,” *GSTF Journal of Engineering Technology (JET)* Vol.3 No.1, July 2014.

¹² A Senem Deviren, Phillip James, “Tabb, Greening of Architecture : A Critical History and Survey of Contemporary Sustainable Architecture and Urban Design,” *Farnham*, (GB: Ashgate, 2014), 6-8.

¹³ Senem, Phillip, *Greening of Architecture*, 29.

¹⁴ Senem, Phillip, *Greening of Architecture*, 2.

¹⁵ Senem, Phillip, *Greening of Architecture*, 32.

movements of the 1960s, such as the “back-to-the-land” movement. Many of the explorations from the 1960s were quite radical, such as Archigram’s proposal for an Instant City—a self-sustaining environment that could migrate from place to place, creating spontaneous urbanism. Understandings of sustainability were further revised during the 1990s, when “the high-tech movement in architecture brought attention back to a focus on building fundamentals and material elements of design—structure, mechanical systems, material systems, fabrication, joinery, and attention to detail.”¹⁶ Architects such as Glenn Murcutt started to test to combine human experience with environmental performance to create habitats that used local materials and ecologically responsible technology in their design.

The relationship between building materials, human behavior, human health, building performance, and avant-garde design became a great concern of sustainable architecture. Architects such as Norman Foster sought to optimize building performance by installing the latest technology and design popularized during the late 1990s and early 2000s, in his famous “Gherkin” or the Swiss Re building in London. More recently in the 2010s, the concept of “sustainable pluralism” has caught the attention of architects. It is a relatively mature comprehension of next-generation green architecture whereby architects need to consider sustainability from multiple perspectives rather than only relying on installing the latest technologies. For example, it has become important to consider the life-cycles of buildings and their materials and the cultural aspects of sustainability alongside the ecological provisions of design. In my thesis, for example, I argue that PNC Tower and Parkview Green Mall represent the latest understanding of sustainability in terms of the Triangle of Sustainability but raise the

¹⁶ Senem, Phillip, *Greening of Architecture*, 100-102.

design for humanity and sustainable technology to a higher level and pass the message of sustainability to the community to inspire citizens to pursue sustainability from every aspect.

2.2 REGIONAL PERSPECTIVES: SUSTAINABLE PRACTICES IN THE U.S. AND CHINA

Susan S. Szenasy's article "Reflections on Sustainable Design" explores the current situation of sustainable architecture in the U.S. Looking at the history of sustainable architecture in the U.S., Szenasy claims that American architects have already shifted their thinking from a purely formal approach to design, working hard to switch from hermetically-sealed glass boxes with frozen air inside, to more environmentally-connected programs, such as Ed Mazria and his long-term advocating of solar design.¹⁷ He is also the founder of Architecture 2030.¹⁸ With the popularization of the LEED system, Szenasy questions whether LEED is helping architects to think more about serious sustainable strategies in design, or just to use LEED as a convenient checklist to get the certification. She also addresses the importance of factoring social sustainability and community design into environmental design so that it can inspire people to pursue sustainability as a lifestyle.

In the article "Green property development practice in China: Costs and barriers," Xiaoling Zhang argues that the main challenge to pursuing sustainable architecture on a large scale in China is the additional cost for all the latest green technologies in China.¹⁹ The author examines the relationship between the promotion of sustainable practices and the additional cost

¹⁷ Susan S. Szenasy, "Reflections on Sustainable Design, MA, METROPOLIS Magazine," Volume 37, 2012.

¹⁸ <http://architecture2030.org/about/leadership/>, accessed March 20th, 2017.

¹⁹ Xiaoling Zhang, Andrew Platten, Liyin Shen, "Green property development practice in China: Costs and barriers," *Building and Environment* 36 (2011), 2156.

of installing green technology in order to find a strategy to improve sustainable architecture in the Chinese market. Zhang believes that implementing a “Green Strategy Plan” will encourage the practice of sustainability in developing projects. She suggests three major steps to achieve this goal. First, the government needs to set a reasonable goal of energy-saving of around 30% for the first few years, with the government providing credits to encourage companies to do so.

Second, the Chinese government needs to develop a special “Sustainability Group” that includes senior managers, planners, engineering and technical departments as well as the financial, human resources, facilities management, and marketing departments of government, to keep companies on track and educate them to pursue sustainability.²⁰ Finally, according to Zhang, governments need to use social media such as websites, TV shows, and Youtube to spread the message of the Green Strategy Plan in order to inspire more people to follow sustainable lifestyles and live in sustainable environments. The architects of PNC Tower and Parkview Green Mall have paid close attention to human factors in design. However, as I later explain, there are still some gaps between their proposed designs and reality.

2.3 PROPOSAL OF FUTURE SUSTAINABLE ARCHITECTURE

The Book “Vertical City: A Solution for Sustainable Living,” by Kenneth King and Kellogg Wong, changes the traditional way of thinking about city planning by proposing a plan for vertical cities with sustainable architecture. The most urgent issue of our times, they suggest, is global warming, which can be mitigated by vertically-oriented design that combines multiple functions into a small architectural footprint. Compared to current horizontal city planning, the

²⁰ Zhang, “Green property development practice in China”, 2159.

vertical city proposed by King and Wong has many potential benefits. By choosing urban density over suburban sprawl, people can give the land back to the planet and reduce vehicle usage. King and Wong set a standard for sustainable architecture, which is closely related to sustainable solutions for carbon emission, usage of natural resources, high-performance technologies, and promoting healthy lifestyles.²¹ Those solutions also overlap with PNC Tower and Parkview Green Mall's sustainable strategies, such as their solar chimney.

To ameliorate environmental problems, King and Wong propose using clean energy more efficiently and preserving adaptable arable land. Designers also need to employ the latest high-performance technologies, such as high-strength concrete.²² Furthermore, King and Wong emphasize the need to design for humanity, which is analogous to the social aspect of the Triangle of Sustainability. Sustainable architecture should be thoughtfully designed with different usages of spaces that are more accessible to people. What's more, mixed-use architecture is a key method to meet more people's needs within a smaller community, as per the vertical city proposal. It can not only reduce energy from operating, management, and maintenance, but also promote healthier lifestyles. In King and Wong's words, "No slum in vertical cities."²³ In my interpretation, the slum refers to architecture that is neither sustainable nor provides comfortable living spaces. I believe that the world's growing urban population should not be the reason for environmental decline or poor living circumstances.

Jenny Sabin in her article "Transformative Research Practice: Architectural Affordances and Crisis" presents another approach to sustainable architecture. Sabin addresses the importance of key social, environmental, and technological issues that should be considered in sustainable

²¹ Kenneth King and Kellogg Wong, *Vertical City: A Solution For Sustainable Living* (U.S. 2013) 38-41.

²² King, *Vertical City*, 168.

²³ King, *Vertical City*, 69.

building practices. With a focus on the interrelationships among environment, technology, biology, and form, Sabin aimed to test different sustainable models to respond to ecological issues and to design buildings to behave like living organisms in their built environments.²⁴ She argues that architects should rethink how to design environmental sustainability rather than to rely solely on technology. Applying several theories from biology, Sabin proposes the concept of the breathable “skin,” which is an innovative material as well as form that aims to preserve energy in the interior of the building. In this concept, one can think of the walls and windows of a buildings as human skin, which help to maintain our body temperature as well.

As we will see later in this thesis, PNC Tower uses a double-skinned ventilation system, and Parkview Green Mall uses a glass envelope to cover the inside buildings, both of which behave very much like breathable skins. While King and Wong and Sabin propose different approaches to sustainable architecture, they share the idea of focusing on multi-functional thinking towards sustainable solutions. For example, King and Wong propose sky lobbies in the vertical city for shopping, eating, drinking and socializing within one unit of space.²⁵ Sabin, on the other hand, believes that sustainable architecture should consider the environment, technology, biology, and form as a whole instead of separating mechanics from architectural aesthetics.²⁶ In the following section, we will see that this is the approach of sustainability taken in the PNC Tower and Parkview Green Mall.

²⁴ Jenny, Sabin, *Transformative Research Practice: Architectural Affordances and Crisis* (06 Mar 2015), 65.

²⁵ King, *Vertical City*, 102.

²⁶ Sabin, *Transformative Research Practice*, 64.

3.0 SUSTAINABILITY STANDARDS: ENCOURAGING OR RESTRICTING?

3.1 LEED

In order to study the different approaches to sustainable architecture in the U.S and China, it is essential to understand two popular standards in each country—LEED (Leadership in Energy and Environmental Design) and GB (Evaluation Standard for Green Building). LEED is a certification system developed by the U.S. Green Building Council for projects pursuing green design from the stage of planning to operation by earning points in several categories that address sustainability issues. The U.S. Green Building Council is a non-governmental body made of architects, planners, engineers, material scientists, and policy makers. It is an aspirational certification rather than a standard that is mandated or regulated by the U.S. government. The intention of LEED is to change the way people think of architecture, thus improving the experience for the people that inhabit the building as well as responding to global climate issues. In the U.S., architects often encourage their clients to pursue sustainable projects at different levels (depending on their budget flexibility), from incorporating a large water cooling system to smaller interventions, such as using recycled furniture in their design. LEED has eight categories: Location and Transportation (LT), Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental

Quality (EQ), Innovation (In), and Regional Priority (RP).²⁷ It is relatively easy to understand even for a general audience because of the LEED point system. People can easily learn how to get points through LEED system by their guidelines. 40-50 points is certified; 50-60 points is silver; 60-80 points is gold; and 80-100 points is platinum. LEED also has different versions based on the functions of the buildings: New Construction, Core and Shell, Schools, Retail, Data Centers, Warehouses and Distribution Centers, Hospitality and Healthcare.

In “Life-Cycle Thinking and the LEED Rating System: Global Perspective on Building Energy Use and Environmental Impacts,” Melissa Bilec and Sami Al-Ghamadi establish energy models of case studies from over 400 different sites in order to first examine how well LEED and other standards respond to energy and economic performance, and then to determine environmental and human health impacts by using data analysis.²⁸ Rather than only looking at how many points each project gets from LEED, they suggest that it is more important to compare how much the developers spend on annual energy costs by using sustainable architecture, which can vary greatly based on the particular climatic context and different methods or materials used for heating and cooling.

I argue that the Triangle of Sustainability has three angles that are equally important to sustainability. The LEED system focuses most on energy savings but also touches on the social aspect as well. Of LEED’s eight categories, three —LT(16), EA(33), and EQ(16)—are directly related to energy savings. Projects can earn up to 65 points from these three categories, which is already in the range of gold certification. It is important to distinguish different LEED certified projects which get the same points and therefore may have the same LEED ranking, because they

²⁷ U.S. Green Building Council, *LEED Reference Guide for Building Design and Construction* (Washington, DC 2013 Edition).

²⁸ Sami G. Al-Ghamdi and Melissa M. Bilec, “Life-Cycle Thinking and the LEED Rating System: Global Perspective on Building Energy Use and Environmental Impacts,” *Environmental Science & Technology* (2015) 49 (7), 4048.

may get points from different categories. By looking at the categories and their corresponding points, we can understand how different aspects of sustainable buildings have been addressed. According to Bilec and Al-Ghamdi, the LEED system is continually revised to respond to current climate issues, demonstrating that energy savings plays the most important aspect of LEED certification. For example, compared with the LEED version 2.0, the version 4.0 increased the points for Energy and Atmosphere from 25% in 2001 to 32% in 2009.²⁹ From my perspective, however, no matter which level of certification a building earns, all three aspects of the Triangle of Sustainability—energy, social, and inspiration—should be considered equally during the design process.

3.2 GB

Unlike LEED in the U.S., GB in China is a set of government-mandated regulations for construction approval of new buildings. GB contains sophisticated calculation methods for energy, material, air quality, water recycling, and other components, which, to be honest, are not easily understood by the general public. On the other hand, only specialists in the architectural field need to use this standard to check the design in order to get government permission for construction. It would be easier to think of Chinese architectural projects as mathematical problems rather than design projects. This is the chief difference between the U.S. and Chinese systems. Most architects only need to do the calculations to pass the GB standards without thinking too much about their target group of users, the human experience of interacting with the

²⁹ Sami, Bilec, "Life-Cycle Thinking and the LEED Rating System," 4049.

building, or the building performance. Therefore, while GB is a laudable effort at creating and maintaining a minimum standard of sustainability in China, it is also seen by many architects as separate from architectural design and as a mere hurdle to cross rather than an opportunity for cutting-edge design. The problem is that GB regulations on sustainable design take away architects and developers' initiative to pursue the social and inspirational aspects of the Triangle of Sustainability.

The first priority for most firms in China is to get government permission to build their projects, so, due to time limitations, it is important to find solutions by following the rules with only minimal attention to design issues. GB uses a star system (from one to three stars), which is similar to LEED's point system. GB has seven categories: Outdoor Environmental Quality (w1), Energy Savings and Reuse (w2), Water Efficiency (w3), Indoor Environmental Quality (w4), Construction Management (w5), Operation Management (w6), and Innovation (w7). Projects can receive one star certification when they have 50 points, two stars for 60 points, and three stars for 80 points. The minimum requirement for any construction is 40 points. Even more interesting is that GB is a weighted calculation system, which is shown in Table 1 below.³⁰

Table 1: GB Weighted System

		w1	w2	w3	w4	w5	w6	w7
Design Process	Residential Projects	0.21	0.24	0.20	0.17	0.18		
	Public Projects	0.16	0.28	0.18	0.19	0.19		
Construction Process	Residential Projects	0.17	0.19	0.16	0.14	0.14	0.10	0.10
	Public Projects	0.13	0.23	0.14	0.15	0.15	0.10	0.10

³⁰ <http://www.njlsjzw.com/news/show.php?itemid=6190>, accessed March 20th, 2017.

As displayed in the Table, Energy Savings and Reuse (w2) is weighed most heavily, which is analogous to the most weighted category in the LEED system, “Energy and Atmosphere.” In addition to the general GB system in China, each province has its own GB system. These are quite similar in terms of categories and the weighted system, but local GB systems respond more to each province’s local climate and culture. Some cities, have a rich historical and cultural heritage, such as the Qin-era Terra-Cotta Warriors of Xi’an. Because it is seen as extremely important for China to protect this heritage, cultural preservation is included in the point system of GB as well. This corresponds to what I am referring to as the social aspect of sustainability. The GB standards remind people how important Chinese heritage and antiquities are, and we need to protect those historical heritages even as we strive for a better and more sustainable future.

3.3 COMPARISON BETWEEN LEED AND GB

LEED is becoming globally popular and is being used for world-wide projects. Many developers are interested in LEED certification even in China in order to gain an international reputation. Projects such as Shanghai Tower, designed by Gensler and slated for completion in 2018, is the most recent LEED Platinum-Certified building in China.³¹ Also, since awareness of sustainability has increased, developers of office buildings are more willing to pursue LEED certification rather than the GB star system, even if doing so translates into higher rents, because LEED’s reputation often brings in wealthier tenants. Parkview Green Mall, for example, is LEED-certified rather than GB-certified. However, although LEED has been gaining popularity,

³¹ <https://www.gensler.com/projects/shanghai-tower?l=featured>, accessed March 20th, 2017.

GB still plays an essential role from different perspectives. For one, it represents the minimum level of Chinese sustainable architecture and thereby aims to shrink the gap between the top tiers of architecture and the bottom, and it is the government's responsibility to help some existing buildings to meet GB standards.

Both sets of standards address major issues according to their own current climates and economic situations. LEED is more understandable and approachable for the general public, which represents the higher level of sustainable architecture in the U.S. and around the world. GB, on the other hand, represents the minimum standard of construction applied to Chinese architecture. The government provides subsidies to low-income people to maintain the building structure in order to meet the minimum requirements of sustainability to ensure that low income people have better living conditions. Even though LEED represents a higher level of sustainable architecture, and both PNC Tower and Parkview Green Mall are LEED-certified, it is important to understand the current situation in Chinese sustainable architecture, which is that the awareness of pursuing sustainable architecture in China is still driven by Chinese government and not by designers, planners, or developers.

However, both sets of standards need improvement. LEED has a reference book for how to earn points to reach Certified, Silver, Gold, or Platinum level, but the points in different categories should not be treated equally in my opinion. Currently developers can improve their LEED rating by simply adding a certain number of green spaces, but for projects to achieve a Platinum rating, architects need to design carefully by adding the latest technology, such as a passive ventilation system and active chilled beam system. This underscores the usefulness of the GB system's weighted calculation, which not only gives credits based on different categories,

but also weights these credits. This weighed system is particularly unique because it considers different phases of the design and construction process separately. Thus, the points are treated differently for different functional projects to make them more individualized and to make certification more valuable.

GB, although enforced by Chinese government regulations, needs to be renewed very often to continue improving its commitment to reducing CO₂ emissions, which the Chinese government made at the 2015 Paris Environmental Conference. However, it takes a very long time to write each new version because the government has more specific regulations applied to different areas in China, which makes the process of getting permissions even longer.

In China, a number of climate problems, such as the air quality in winter, are still caused by industrial pollution. While the government has made major strides in reducing and even closing polluting industries in order to improve the living environment, this is only the very first stage of the solution towards sustainability. However, during the winter in northern China, burning coal is often the only way that people can generate heat, which is why cities like Beijing, which is the northeast of China, suffer from a polluted haze. The way that the field of architecture can address this problem is by trying to inspire and encourage more potential developers to pursue sustainability. This is why the inspirational aspect of the Triangle of Sustainability is as important as the energy and social aspects. One single example of architecture with the latest and most innovative technology and even zero-energy consumption will not help address climate issues unless the community, the cities, and whole countries are further inspired by it. In the following section, I show how PNC Tower and Parkview Green Mall are setting a new bar for sustainable design in the U.S. and China; I also consider how they

may or may not be inspiring a wider community to embrace sustainable choices for their lifestyles and environments.

GB certification happens in two stages. The first is the design phase where the buildings receive the minimum GB rating based on the design strategies. After one year of completion, the building performance is checked and then the rating is granted based on whether they fulfill the requirements of GB. This is considered the operational phase of the GB. LEED certification, on the other hand, can be received directly after the completion of the building based on the modeled energy efficiency of the building. This is the shortcoming of LEED as often buildings overestimate the energy savings and sustainable aspects of their design.³² Even though GB is more stringent in checking if the building truly meets the requirements, the developers only receive government subsidies one year after the completion.³³ This is not an attractive incentive for the developers who want to pursue sustainable design. This may be one reason that Chinese developers decide to pursue LEED rather than GB system.

³² Yang Zhou, "Comparison of Chinese Green Building Standard with Western Green Building Standards," *Bachelor of Science Thesis EGI 2014*, KTH Industrial Engineering and Management, 5-10.

³³ Zhou, 14-15.

4.0 SUSTAINABLE ARCHITECTURE IN PITTSBURGH AND BEIJING

Once an urban leader in the Industrial Revolution, Pittsburgh successfully evolved into a post-modern city with some iconic and sustainable buildings. Today, most of the city's green buildings are built along the Allegheny and Monongahela Rivers.³⁴ However, Pittsburgh has a longer history of pioneering and showcasing the latest trends of architectural design. For example, during the late nineteenth century, the city represented the many faces of modern architecture with buildings such as H.H. Richardson's Allegheny County Jail and Courthouse, completed in 1888. High modernism is evidenced in buildings such as the IBM building, designed by Curtis and Davis, completed in 1962-1964 and the U.S. Steel Building, designed by Harrison, Abramovitz, and Abbe, completed in 1970.³⁵ Phillip Johnson's Pittsburgh Plate Glass building, completed in 1981, remains a classic example of architectural postmodernism in the city.³⁶ In the past few decades, increasing numbers of LEED-certified projects have been built in Pittsburgh. Some LEED Platinum buildings, such as the David Lawrence Convention Center, which was built in 2003 in the downtown area, and the Center for Sustainable Landscapes (an extension to the Phipps Conservatory and Botanical Gardens), completed in 2012, are significant symbols of Pittsburgh's green design.³⁷ By adding PNC Tower to the impressive skyline of

³⁴ <http://www.ncarb.org/~media/Files/PDF/Direct-Connection/2008-1/8-116SeeHowPittsburghsGoneGreen.pdf>, accessed March 23rd, 2017.

³⁵ <http://www.winthropgh.com/properties/36>, accessed March 24th, 2017.

³⁶ Franklin Toker, *Pittsburgh: A new portrait*, (PA: University of Pittsburgh Press, 2009), 20-25.

³⁷ <http://www.usgbc.org>, accessed March 23rd, 2017.

Pittsburgh, PNC Tower is making a bold statement about sustainability as the most important issue in architecture today.

Beijing, the economic and cultural centre of China, has embraced a lot of innovative and green projects for the past 20 years. The Chinese government has recently put a lot of effort into building public projects that are green and inspiring. Projects such as Galaxy SOHO in Beijing, designed by Zaha Hadid and completed in 2012, the National Stadium, aka Bird's Nest, designed by Herzog and de Meuron, and the Water Cube, designed by PTW Architects for the 2008 Olympics, are also examples of avant-garde sustainable design.³⁸ They represent how innovative sustainable architecture can be in the present day. As the capital of China, Beijing takes the initiative in building sustainable architecture, which creates a huge impact on surrounding second-tier cities and encourages them to adopt sustainable architecture.

³⁸ <http://webecoist.momtastic.com/2012/06/25/green-china-13-examples-of-innovative-eco-architecture/>, accessed March 28th, 2017.

5.0 NEW TOWER AT PNC PLAZA VS PARKVIEW GREEN MALL

5.1 PNC TOWER

5.1.1 PNC Tower: The Company's Philosophy

The banking company PNC has been pursuing sustainable design for a long time, and more than 270 PNC projects have been credited to LEED certifications.³⁹ The New Tower at PNC (Figure 2) in particular goes beyond the LEED system since the developers did not want to limit themselves to a single standard, but challenged themselves to use all the latest technologies to build the greenest skyscraper possible, and significantly, to build a better working environment for their employees. Also, by pursuing the highest level of sustainability in PNC Tower, the developers hope to have a positive impact on their employers as well as other companies in the community.⁴⁰

³⁹ Joann Gonchar, "Let the Fresh Air In. Tower at PNC Plaza, Gensler. A Tower Offers an Alternative to the Hermetically Sealed Glass Box," *Architectural Record* vol. 200, issue 10 (October 2012): 100.

⁴⁰ <http://du.gensler.com/vol4/pnc/>, accessed April 2nd, 2017.

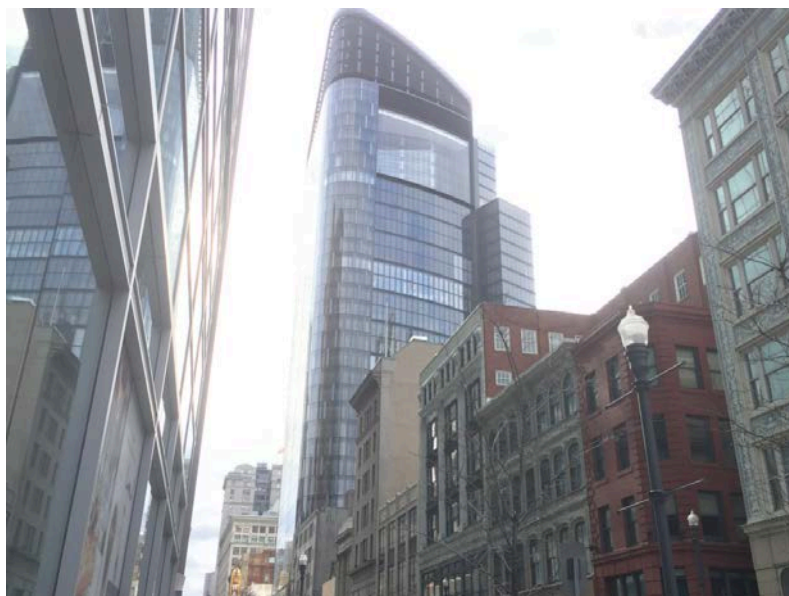


Figure 2: New Tower at PNC Plaza

This 33-story tower, accommodating 2000-3000 employees, was designed by the Gensler company and completed in October 2015. Gensler, a well-known architecture firm, has been working with PNC for a number of years. The major goal was to provide employees with a more environmentally-friendly and comfortable working area, and to inspire the employees and communities to pursue sustainable practices as well. This was a huge challenge for both the PNC company and Gensler because they did not have a perfect sustainable commercial model to follow. Because PNC's clients wanted to have the greenest skyscraper in the world, Gensler's architects even travelled around the world to conduct research to build a green skyscraper for PNC. Even since the building was built, PNC still maintains a team of energy analysts who work to improve the building's performance in water recycling, paper recycling, natural ventilation usage, and other areas.⁴¹ Indeed, it is not normal for a bank company to have a

⁴¹ <https://www.thetoweratpncplaza.com/>, accessed April 3rd, 2017.

department that solely works on the building's energy performance, but these data are extremely helpful for improving building performance.

5.1.2 PNC Tower: Community Design

Gensler architects designed PNC Tower based on three pillars: community builders, workplace innovators, and energy conservation. The major concept of PNC Tower is closely related to the social aspect of sustainability, i.e., building a workplace inside PNC Tower, which creates a sense of innovative workplace community and uses the tower to inspire the urban community.⁴² These two types of “communities” have very different meanings. First, “community” is a design strategy in which architects wanted employees from different departments to communicate with each other more. They achieved this by incorporating one small “neighborhood/kitchen” on every other floor in the building.

The connectivity between floors blurs the traditional separation of different departments. Architects designed a kitchen on alternate floors to attract people to come together to have better communication. Also, on the 28th floor of the tower, there is a five-story “park in the sky” with a wonderful view of downtown Pittsburgh.⁴³ PNC company hopes that their employees can use these “community” areas to reduce their daily work pressure and improve their productivity while also creating a community in their workplace.

The second “community” refers to the neighborhood of downtown Pittsburgh. PNC wanted the structure to become a sustainability leader and transform the culture of the urban

⁴² Joann Gonchar, “Poppers and Floppers and Porches, Oh, My! Gensler Creates a Building that Breathes for a Client with a Deep Commitment to Sustainability,” *Architectural Record* vol. 203, issue 12 (December 2015): 110-116.

⁴³ <http://www.gensler.com/cities/2015/10/6/the-tower-at-pnc-plaza-a-breath-of-fresh-air.html>, accessed April 3rd, 2017.

community. (Figure 3) PNC holds a lot of community events to welcome other people and companies in the community to learn more about their philosophy of sustainability, such as the Tower Topping Ceremony on June 24th, 2014, and the Tower Opening Ceremony on October 2nd, 2015, to attract people to have more interactions with PNC Tower.⁴⁴ There are a lot of large companies in downtown Pittsburgh, such as PPG, BNY Mellon, Allegheny Technologies, and Alcoa. From the first stages of construction to the opening ceremony, PNC passed on their ideas on sustainability widely through the internet, media, and all the public events in the neighborhoods. The impact of spreading the company's commitment to sustainability is to ultimately inspire other companies in the community to invest in sustainable practices. PNC's architects even declared, "Treat the city well, the city will give back to you eventually."⁴⁵ This indicates that developers and architects pushed the understanding of sustainability in PNC Tower with a great consideration of the relationship between PNC Tower and the community. PNC company expects to inspire other companies in the neighborhoods to pursue sustainability as PNC did to achieve higher goals of sustainable community, and ultimately, for a sustainable city.

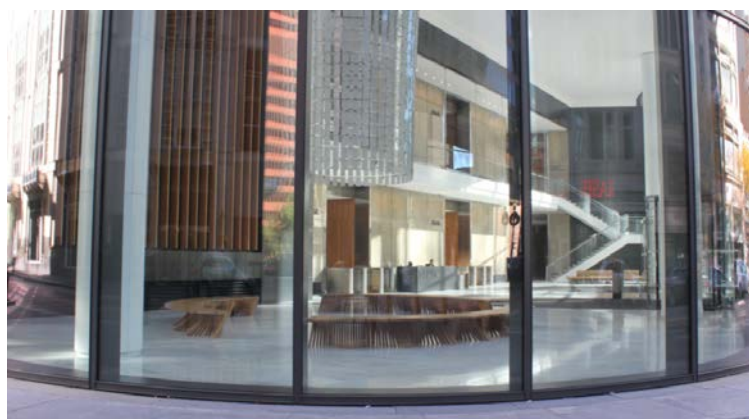


Figure 3: PNC Tower: Lobby View

⁴⁴ <https://www.thetoweratpncplaza.com/#gallery>, accessed March 20th, 2017.

⁴⁵ Phone Interview with Douglas C. Gensler, in June, 2016.

To give back to the community and to serve the people who are passing by the tower, PNC pulled the tower back from the property line to give pedestrians generous public spaces for seating and relaxation. PNC tower is on the corner of Fifth Ave and Wood St., which is a very busy intersection in downtown Pittsburgh. The sidewalks are relatively narrow with a large amount of pedestrian traffic. Thus, the seating areas in front of PNC tower give people a chance to pause and interact with PNC Tower. With the seamless glass that separates the entry lobby from the plaza in particular, people can easily see and access the lobby of the tower.

5.1.3 PNC Tower: Ventilation Technology

The ventilation system is the most impactful element of sustainability in PNC Tower. It has three major components: a double-skin façade (Figure 4), a solar chimney, and return airshafts. These three components work closely together, which allows the tower to be naturally ventilated over 42% of the time in a year.⁴⁶ During the spring and fall, when the air quality, humidity, temperature, and other components meet the building's quality controls from natural ventilation, sensors send a signal to the double-skin façade to open its “poppers”—the exterior metal windows of the double-skin façade—to let the fresh air in. Air is pushed into the filter, located on the lower level of the floor, before it goes into the building. At the same time, the draft of fresh and cool air directs the warm and stale air inside the offices into the air shaft, which is located in the center of the building. When the sun heats the solar chimney, it creates a natural vacuum to draw all the hot air into the air shaft upward and pushes it out of the building. Meanwhile, the sensors, which are located both inside and “outside” of the building, constantly

⁴⁶ https://www.thetoweratpncplaza.com/#tower_talk_blog~blogID=blog1, accessed April 2nd, 2017.

measure the indoor and outdoor environment to control the double-skin façade automatically. The sensors inside the building are designed such that during optimal environmental conditions outside, they provide “good day signals” to employees, who can open the interior layer of the double-skin façade for natural ventilation without mechanical usage. The “outside” sensor is not installed physically, but is linked to local companies who send the simultaneous data on temperature, air quality, wind speed, etc. in the neighborhood to automatically control the “poppers” to open or not.

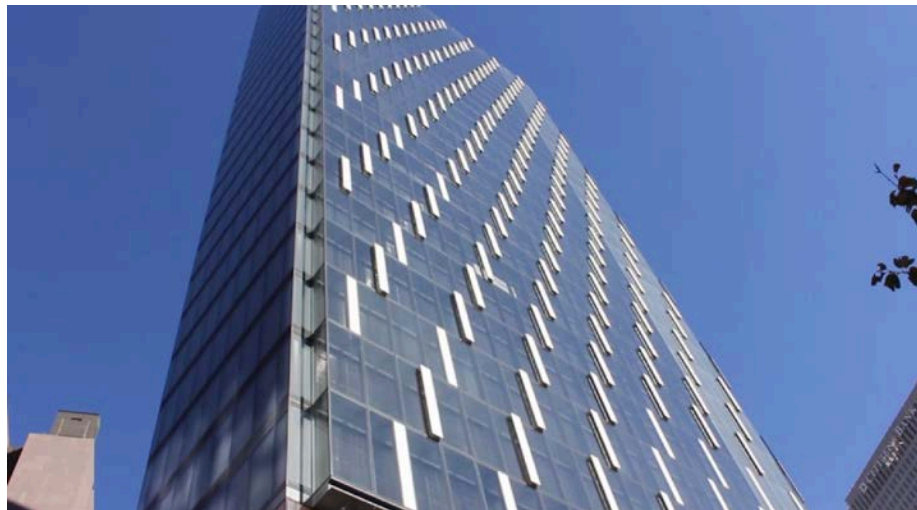


Figure 4: Double Skin Facade

During the summer time, the exterior windows close. The hot air in each floor is pushed into the air shaft and out of the building by a natural vacuum. When the hot air has been pushed out of the building, the fresh air is drawn from the outside into the air handling unit, which is located right below the solar chimney. The air is cooled in the air handling unit before it is pushed down through the central shafts to the active chilled beam into each floor. At the same time, there is a micro-circulation of air currents in each floor. After the fresh and cooled air is pushed into the active chilled beam, which is located in the ceiling, the fresh air is mixed with

the hot air inside of the building the rooms, which is drawn into the active chilled beam as well. After mixing the two kinds of air, the air is then released inside the rooms for cooling. The winter ventilation system is similar to that of the summertime in that the double-skin façade remains closed as well. The fresh air is pre-heated inside the air handling unit. After the hot air is mixed with the cold air in the active chilled beam, it is then released to heat the rooms.

The double-skin façade functions not only for natural ventilation, but also for insulation. During the summer and winter, double-layered windows act as insulation so that the exterior heat and cold only minimally affect the inside temperature. This ventilation system is the major reason for the success of PNC Tower because it helps to reduce mechanical usage. It not only helps save a large amount of energy throughout the year, but also allows all of the office rooms to have a continuous supply of fresh air. What's more, the architects of the PNC Tower used the double-skin façade as a "design language." People can actually see the pattern of poppers with some open and others closed . Because of the sensors located on different parts of the building, different faces of the building react to their environment differently. Therefore, it is very common for people to see different zones of the double-skin façade open and closed. This is very innovative because the building allows people to "read" more information about the weather from the dynamic and constantly changing façade of the building. Thus, PNC performs the inspirational ascent of the Triangle of Sustainability that it uses good models of sustainable architecture to pass on the message of sustainability.

5.1.4 PNC Tower: Other Sustainable Strategies

PNC company also challenges how people traditionally think of water recycling systems. It recycles at least 72% of rain water and waste water for flushing, cooling, and even drinking.⁴⁷ It is a huge challenge, especially in Pittsburgh, since the water quality itself is not always satisfactory. At the same time, recycled water is also used to cool and heat the building. The water is pumped through a mechanical screen to get rid of the contaminants first, and then it is transferred to an oxygenated environment to be treated. After the water is cleaned and disinfected, ozone and chlorine is added into the water to reach a drinkable level.⁴⁸ This water recycling system is a particularly inspiring quality of PNC's philosophy—they always push a little further to improve their sustainability.

PNC Tower also used recycled and local materials for floors, ceilings, interior walls and furniture. One of the other features applied to sustainable technology is the orientation of the tower. It is a very effective method for saving energy. Normally, buildings are built on the city grid. If the city grid is planned well, all of the buildings can gain more sun energy and fewer shaded areas. However, in cities such as Pittsburgh, city planning stems from the early 19th century, when the sun path and sustainability were not major issues for the consideration of a city grid. PNC Tower is not totally parallel to the street, but rather set at an angle. Surprisingly, this simple modification accounts for 50% of the total energy savings of the building's architectural design.⁴⁹ PNC also expects to use 50% of what commercial buildings in terms of overall energy consumption.

⁴⁷ https://www.thetoweratpncplaza.com/#tower_talk_blog~blogID=blog1, accessed March 18th, 2017.

⁴⁸ https://www.thetoweratpncplaza.com/#tower_talk_blog~blogID=blog1, accessed March 18th, 2017.

⁴⁹ Interview with Angelica Ciranni, previous Sustainability Analyst at PNC in June, 2017.

5.1.5 PNC Tower: Social and Cultural Factors

Similar to “multi-functional spaces,” the concept of “Hierarchy Spaces” is based on human behavior. On each floor of PNC Tower, there are three levels of spaces based on what people may need to do during their work hours: the community area, the working area, and the meeting area. The community area is the most public area because it is closer to the double-skin façade. The working area is around the double-skin façade as well, but the density of working space is higher, which creates an innovative working area. The meeting area, the most secluded space, with a limited approach to the double skin façade, is in the middle of the tower. It is also easier to understand the “Hierarchy Spaces” by looking at circulation patterns on each floor. From the floor plan, the community area has an open plan with nearly no barrier to impede circulation, whereas the meeting area has only one entry/exit for each room.

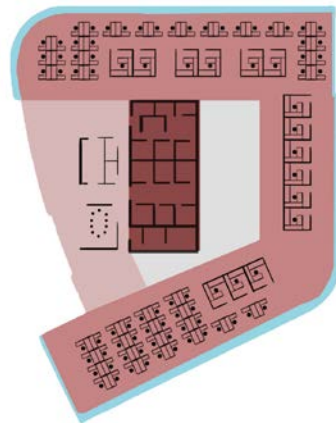


Figure 5: PNC Tower Color Coded Floor Plan

This innovative working area and the arrangement of space allows PNC employees to maximize the use of the double-skin façade. For example, during the spring and autumn, when

the sensors inside the building are green, which indicates that the air quality is good enough for natural ventilation, employees themselves can open the interior panels and step out on to the catwalk to stretch their legs and get some fresh air. PNC believes that improving employees' working environments will give the company the biggest returns in the future. The company conducted surveys which indicated that 70% of the employees felt proud of their company and were inspired by its sustainable and beautiful design.⁵⁰ This also reflects the social aspect of the Triangle of Sustainability: architects designed the spaces based on what those employees want to do during their work time.

5.2 PARKVIEW GREEN MALL

5.2.1 Parkview Green Mall: Introduction on Parkview Family

Parkview Green Mall (Figure 6) is owned by a company called “the family of the Parkview Group”, which was originally established in Taiwan in the 1950s. The company has mainly focused on infrastructure projects such as airports, railroads, and dams. The first proposal considered by the Parkview family for the Parkview Mall site was a residential/office building as it was a relatively dense residential area.⁵¹ In Beijing, different urban zones are defined by their primary functions. Thus, it would have been easier for the developers to make a profit if they built a residential project in a residential area. After they acquired permission from the government for the construction of such a residential/office building, the Parkview Group

⁵⁰ Interview with Angelica Ciranni, previous Sustainability Analyst at PNC in June, 2017.

⁵¹ <http://www.parkviewgreen.com/cn/about/parkview-group-1/>, accessed April 2nd, 2017.

changed their minds because they saw an opportunity to create a long-term family business based on sustainability that could inspire other companies in Beijing.⁵² The family believed that addressing urban complexes and building sustainable architecture could be the future of a successful city. Also, because of fast-paced modern work and life in contemporary China, the family wanted to design a building that would fulfill people's daily needs within a tight radius.⁵³



Figure 6: Parkview Green Mall

However, the project faced huge and unexpected barriers. First, Parkview Green Mall is mainly a commercial building, which includes a shopping mall, office building, hotel, and art gallery as its four major functions.⁵⁴ In recent years, it has become very common in Chinese real estate to build large-scale complexes that go by the acronym of HOPSCA—Hotels, Offices, Parking, Shopping malls, Clubs, and Apartments.⁵⁵ It is a recent investment strategy in China since the industrial period, as such multi-functional spaces bring various users and thereby

⁵² Xiaodi, Zhu, *Winston Shu and Parkview Green*, (ArchiCreation, No.182, January, 2015), 23.

⁵³ Zhu, *Winston Shu and Parkview Green*, 46.

⁵⁴ Zhu, *Winston Shu and Parkview Green*, 82.

⁵⁵ http://usa.chinadaily.com.cn/business/2011-07/11/content_12876408.htm, accessed March 3rd, 2017.

different revenue streams. As previously mentioned, Parkview Green Mall is in a residential area. It became a huge challenge for architects to attract people to come to a residential area to shop. Shu wanted to create this multi-functional space to fulfill people's needs, such as offering different cuisines of the world in the atrium for visitors to rest from shopping while they are in Parkview Green Mall.

Second, since Parkview Green is a multifunctional project, the scale is larger relative to the surrounding buildings. If it was built as a tower, the amount of sunlight received by the lower floors of the building and the noise level of the surrounding neighborhood would be affected, which is against the family's philosophy of creating sustainable architecture that can bring benefit to the entire community. The family of the Parkview Group and the architect, Winston Shu, spent over 10 years on this project from 2000 to 2013 to find solutions.⁵⁶ With their insistence on building an environment for sustainable human living, Parkview Green became the first LEED Platinum-certified project in China.

5.2.2 Parkview Green Mall: Design of “Complexity”

Winston Shu, who graduated from the Architectural Association in London, reconstructed a “micro city” in the Parkview Green Mall. He believes that physical spaces should follow human behavior to meet people's different needs.⁵⁷ He thinks of Parkview Green Mall as a collection of urban complexes, which was its major strategy to attract visitors.⁵⁸ To design and connect each function well, Shu divided the design into four different blocks with different heights, covered by a huge pyramid-shaped glass envelope. With the glass cover, the building can use as much

⁵⁶ Zhu, *Winston Shu and Parkview Green*, 79.

⁵⁷ Zhu, *Winston Shu and Parkview Green*, 33.

⁵⁸ Zhu, *Winston Shu and Parkview Green*, 33.

natural light as possible. At the same time, office and hotel buildings are able to have enough privacy by the division of the internal blocks. Shu also created a semi-outdoor space for the city's public events. This semi-outdoor space (Figure 7) includes two floors below the ground level, but it is still open to the public. This is very unusual because basement areas are usually the most private areas in most buildings. Shu wanted to open this large area to welcome the community.



Figure 7: Semi-Public Space of Parkview Green Mall

While some features of Parkview Green are innovative, this type of complex mall is not new. Developers in mainland China have long tried to mimic a city of malls in southern China, specifically, in Hong Kong.⁵⁹ The malls in Hong Kong are more driven to a high-density, mixed-use community. This is because developers in Hong Kong have tried to respond to the pattern of urban development there so that people can do more without having to use transportation and to

⁵⁹ Stefan AI, *Mall City*, (University of Hawaii Press November, 2016), 5.

achieve the maximum potential from shoppers.⁶⁰ Because of the successful example of the multi-functional mall complex in Hong Kong, Shu employed some similar ideas in the Parkview Green Mall to attract more shoppers as well.



Figure 8: Parkview Green Mall: Atrium

Shu was also inspired by the idea of the traditional “Chinese Garden,” whose beauty is based on the interior’s being hidden by the exterior. From the exterior, people can clearly see the steel structure and the floor layout of the inside, which gives people a feeling of industrial architectural design. However, the inside of the building is a totally different world. It is filled with excitement due to the different themes of artwork and huge sculptures that are placed intentionally within the inside spaces. (Figure 8) Some of the sculptures are mobiles and can move simultaneously with the air flow inside; others are so brightly colored that they catch visitors’ attention; yet others are so large that they create unique spaces surrounding them, for both entertainment and to emulate a “Chinese Garden.” Shu also designed a real indoor garden

⁶⁰ AI, *Mall City*, 4.

on the upper floor of the mall for the public. In the indoor garden, Shu designed a representation of the planets with other artwork as well in order to give people different experiences. By installing different artworks, Shu and the family aimed to attract more young people and give them a chance to engage with local arts and boost local artists' careers. For example, when I visited in August 2016, I saw one sculpture named *Cosmos*, designed by Choi Jeong Hwa and installed on the bridge. Because of its location, *Cosmos* gained a lot of attention from people reading the story behind the sculpture, which represents the idea that "Everything is made by relations in the world but the nature of it is an empty existence."⁶¹ For someone like me, who rarely has the chance to visit museums and art galleries, Parkview Green Mall's temporary installations of sculptures and paintings are one of the main attractions to the mall.

Shu also carefully designed the shopping spaces by dividing them into different sections. There are many threshold spaces between corridors with some paintings on the walls, benches, and sculptures for people to take photos and relax if they do not want to shop. This reduces the "shopping pressure" that customers in China often feel from salespersons and gives visitors opportunities to rest and appreciate the mall for other uses besides shopping. Although in terms of space value and potential profit, developers could have transformed these public areas into shopping spaces to make more profit, the architects and developers' desire was to design spaces based on people's needs when they are in the Parkview Green Mall. By doing so, architects hoped that that would encourage people to come back to the mall.

⁶¹ Image/text from the Site.

5.2.3 Parkview Green Mall: Design Philosophy of a Bridge for the Community

One component that differentiates the Parkview Green Mall from other commercial buildings is an iconic, boldly-colored red bridge. (Figure 9) This bridge was designed for people who may not be using the building for the four primary functions of mall, hotel, art gallery, or offices to connect the two sides of the residential community surrounding the mall, which can save time in extreme weather and also provide pedestrians a chance to interact with the interior of the building. It is very unique in China because the developers spent a lot of money and effort on a feature that is not directly linked to profit-making. But for people's convenience, the family of the Parkview Group insisted on building this bridge for the community. The bridge also represents a good strategy for the company's reputation. People in the community will get a sense of convenience by walking on the bridge every day, but they will also become a free advertisement for the company and its ethics of sustainability. For long-term profits, if the company continues to improve their reputation, they will get more customers, which is economically sustainable as well.



Figure 9: Parkview Green Mall: Bridge

For the people's comfort and entertainment, there are many sculptures on the bridge that connect to the shopping atrium. This provides a comfortable experience that connects people on the bridge to the people in the shopping atrium. The entire bridge is 236 meters long, which is the longest indoor suspension bridge in Asia. Thus, the construction of the bridge was also a huge challenge that the family and Shu faced because of the length of the bridge. Their insistence on designing Parkview Green Mall to serve the community is reminiscent of the PNC architect's belief that if we treat the city well, the city will eventually give back to us. This further connects to the social aspect of the Triangle of Sustainability as well. Good, sustainable architecture always includes design that considers the human context.

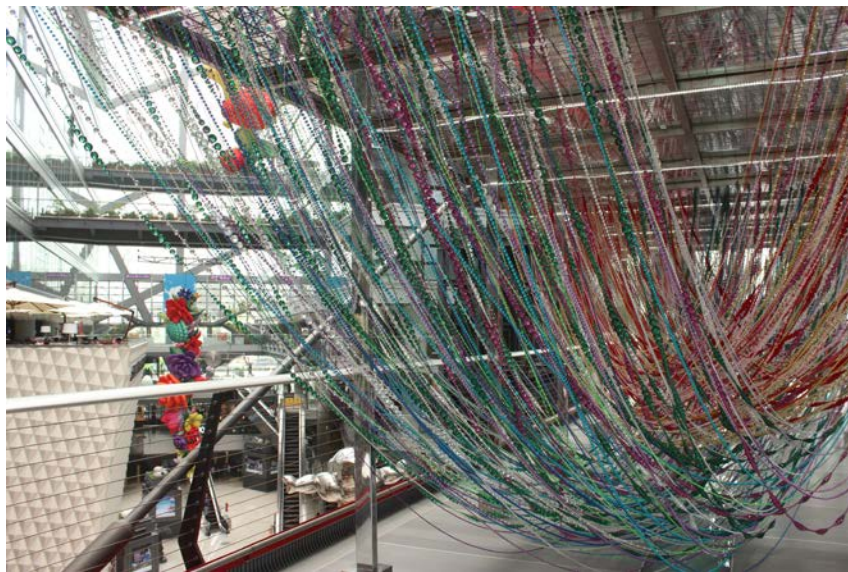


Figure 10: Installation on the Bridge

5.2.4 Parkview Green Mall: A Different Design of Innovative Natural Ventilation

Like PNC Tower, the ventilation system is the major sustainable technology strategy used in the Parkview Green Mall as well. The four blocks of buildings are covered by a glass envelope. This envelope and the interior walls of the four blocks create a double-skin protection as well, which

keeps the inside temperature from gaining or losing too much from the heat and cold. During the spring and autumn, the cold air is drawn in from the lower part of the building in order to bring the warm stale air the central building into the air shafts so that the hot air can be pushed out. Natural ventilation and mechanical ventilation operates at the same time to balance the temperature inside the building since the priority of sustainable design is to keep people in their comfort zone. What is different about PNC's ventilation system is that instead of using a solar pad, Shu designed an indoor garden inside the mall. The plants absorb "hot" carbon dioxide from the building. At the same time, they release "cold" oxygen back into the building. The indoor garden also serves as a buffer from direct radiant heat.

5.2.5 Parkview Green Mall: Other Sustainable Strategies

Looking at the mall's roof, visitors notice that there is a bubble-shaped material attached to the roof, which is called Ethylene Tetra Fluoro Ethylene (ETFE).⁶² This material is a lucid membrane that is extremely light, only 0.22 mm thick and easy to replace. Because of its thinness and transparency, it can transfer 50%-95% energy from sunlight to the inside of the building.⁶³ ETFE is also fireproof, which decreases the potential danger from accidents. ETFE has been used widely in Chinese architecture, most famously in the Water Cube designed by PTW Architects for the 2008 Beijing Olympics, which used ETFE for its entire exterior wall.

Shu changed the orientation of Parkview Green Mall to be not parallel to the city grid, but he also changed the angle of the building to make sure that the surrounding buildings would not be in the shadow of the mall, as well as to maximize the gains from sunlight for the building.

⁶² Amy Wilson, "ETFE Foil: A Guide to Design", *Architen Landrell*, (February, 2013), 1.

⁶³ <https://wenku.baidu.com/view/31f107b6be23482fb5da4c13.html>, accessed in March 3rd, 2017.

The energy report shows that Parkview Green Mall can cut energy expenditures by 13%, 63%, and 80% for summer, spring, and winter, respectively, so the average total energy savings compared to other commercial buildings is 53%.⁶⁴ As with PNC Tower, simply changing the orientation of the building with respect to the sun path and other environmental factors helped with other sustainable technologies to save 50% more energy.

5.2.6 Parkview Green Mall: Social and Cultural Factors

Shopping pressure is becoming an unavoidable factor for Chinese people in deciding whether or not to go to physical stores instead of the internet for shopping. Such pressure exists because salespersons in Chinese retail outlets put enormous pressure on consumers to purchase items in the store. This pressure negatively impacts people's shopping pleasure and makes them feel uncomfortable. It has become a major obstacle for Chinese malls in making profits and meeting their rent since more people have begun shopping online to avoid such social pressure. Because of this, Shu wanted to design a shopping center that could provide a certain level of privacy and comfort for the visitors that would in turn reduce this shopping pressure.

Parkview Green Mall has many “art spaces,” which are aimed to direct people's attention away from stores and advertisements. On the ground floor, which is the atrium, there are a lot of sculptures installed in the most public spaces. This is the space that most people come to during their first visit to the mall. There are also many restaurants and grocery stores along with clothing stores, which attract people who work in the offices or those who stay in the hotel to have lunch and run daily errands. On the upper floors, Shu put many small art galleries with a

⁶⁴ Zhu, *Winston Shu and Parkview Green*, 162.

variety of themes, designed benches to attract people, especially younger groups of people, as they do not have as much ability to afford the luxury goods sold in the mall. Attracting a diverse group of people besides shoppers brings a certain energy to Parkview Green Mall so that people who want to shop can have a better shopping environment, while those who do not want to shop can still feel welcome.

6.0 COMPARISON OF PNC TOWER AND PARKVIEW GREEN MALL

In the following sections, I offer a comparison of PNC Tower and the Parkview Green Mall across four aspects: Alternative Design Thinking, Sustainability Foci, Central Ventilation System, and Multi-functional Spaces.

6.1 ALTERNATIVE DESIGN THINKING

Architects of both PNC Tower and Parkview Green Mall share similar design attitudes about the human context. Architectural design is not about isolated buildings but about how careful design addresses the relationship between a particular building and the community, the city, and its people. The architects of both buildings take very seriously the people who are not the primary users of the building. The architects of PNC Tower, for example, pulled back from the property line to provide generous public space in the busy downtown area. (Figure 11) The architects of Parkview Green Mall, on the other hand, designed the iconic bridge to provide convenience for the pedestrians in the immediate neighborhood.



Figure 11: PNC Tower: Street View

PNC's brand of sustainability and Parkview Green's efforts have raised the rent ceilings, but also, more importantly, it is related to the belief that the developers held towards sustainability. They believed that sustainable architecture could improve work efficiency by providing their employees and customers with a better working environment, thereby inspiring their employees and other companies by interacting with sustainable design in order to pursue a more sustainable lifestyle. One or even a hundred green buildings can help very little towards solving climate problems. Only when a majority of buildings in communities, cities, and countries become sustainable, will architecture be able to really impact environmental issues and make a lasting impact on the planet's ecology.

6.2 SUSTAINABILITY FOCI

Both the PNC and Parkview Green architects understand sustainability from ecological, social, and economic aspects. Since both buildings were certified by the LEED system, it is worthwhile to examine which categories each project received the most points on. PNC Tower's top three

categories were Energy and Atmosphere(25), Sustainable Sites (22), and Indoor Environmental Quality (13).⁶⁵ Parkview Green Mall's top three were also Energy and Atmosphere (36), Sustainable Sites (22), and Indoor Environmental Quality (13).⁶⁶ Thus, for these two buildings, Energy Quality, Sustainable Sites, and Indoor Environmental Quality are the most important components of their sustainability programs. These three categories are more designated to energy saving, which is the main feature of LEED system. This reflects the energy aspects of Triangle of Sustainability that architects and developers still need to pursue energy saving as the primary strategy of sustainability.

It is also important to point out that both architects changed the orientation of their buildings to be off the city grid to maximize the sunlight in order to use more natural resources. Orientation is a very efficient method for saving energy. Sometimes, changing the orientation can improve up to 50% of total energy saving. However, changing the orientation off the city grid may have an impact on the surrounding buildings, such as casting surrounding buildings in perpetual shade. Balancing the building orientation with regulations can become the biggest obstacle for architects and developers. Architects of both PNC Tower and Parkview Green Mall were able to resolve this obstacle and change the buildings' orientations to improve building performance. Also, Shu changed the original plan from original height of the mall from 120 meters tall to 90 meters tall to avoid overhead shading and negative impact on their neighboring buildings.⁶⁷

In terms of energy-saving, although PNC Tower does not have a full energy-saving report yet, PNC Tower architects have estimated that they will be able to save 50% or more energy

⁶⁵ <http://www.usgbc.org/projects/tower-pnc-plaza>, accessed March 15th, 2017.

⁶⁶ Zhu, *Winston Shu and Parkview Green*, 12.

⁶⁷ Zhu, *Winston Shu and Parkview Green*, 67.

compared to the average energy cost of a commercial building.⁶⁸ Parkview Green Mall, on the other hand, has been open for several years. They have energy savings of 13% during the summer, 63% during the spring/autumn, and 80% during the winter, with an average of 50%. Thus, by carefully designing good sustainable architecture, developers can save a great amount of energy and money over the long term.

6.3 CENTRAL VENTILATION SYSTEM

The central ventilation system is the major sustainable energy strategy applied to both buildings. It is designed to bring as much fresh air as possible into the buildings to cool them during the summer and heat them during the winter. In order to keep the temperature still within the human comfort zone, both buildings operate using both natural and mechanical ventilation at the same time during extreme summer and winter conditions, but are designed to only use natural ventilation during the spring and fall. The key to central ventilation is not eliminating mechanical usage completely, but controlling the proportion of both central and mechanical ventilation usage.

There are two major differences between the central ventilation system of PNC Tower and Parkview Green Mall. The first is that PNC uses a heating pad in the solar chimney., whereas Parkview Green uses an indoor garden instead. The concept is the same: when the sun heats the heating pad or indoor garden, the temperature rises in order to push all of the hot air in the building upwards and out of the building. However, the indoor garden (Figure 12) has one

⁶⁸ Interview with Angelica Ciranni, previous Sustainability Analyst at PNC in June, 2017.

extra function, which is to release cool oxygen back to the building since the plants absorb some of the hot carbon dioxide. The second difference between the two buildings is that PNC Tower uses the double-skin façade as part of its architectural language. Open “poppers” on the building indicate that the air quality in the neighborhood is good enough for its use in the interior of the building. The changing façade brings sustainable architecture to a higher level, creating a “readable” building for users and pedestrians, who can actually glean information about the surrounding environment by looking at PNC Tower.



Figure 12: Parkview Green Mall: Indoor Garden

Furthermore, when the air quality is very poor and natural ventilation cannot be used, PNC Tower’s double-skin façade and Parkview Green Mall’s glass envelope serve as a protective insulator from losing energy or gaining too much energy. This relates to Jenny Sabin’s idea of using building materials as a form of “skin” to let buildings breathe and regulate the temperature within a stable range. Both PNC Tower and Parkview Green Mall have multiple-layers of façade, which is the glass envelope coverage, as a protective “skin” to maintain the inside environment in a comfortable range. The ventilation system is a more unique technology

compared to materials/sustainable site design because the system needs separate parts of installations: double skin façade/glass envelop, central shafts, and solar chimney. This is a great sign that architects came up with solutions to continuously bring fresh air to every corner of the building.

6.4 MULTI-FUNCTIONAL SPACES

Due to the urban complexities of modern society, more people want to meet their needs within a limited area. The architects of PNC Tower and Parkview Green Mall used the idea of “multi-functional spaces” from different perspectives to achieve this goal. The target group of people in the design of PNC Tower are PNC’s employees. They will only use the tower during their work hours from 9 am to 5 pm, Monday to Friday. In consideration of what amenities employees may possibly enjoy during their work hours, PNC Tower’s architects designed community areas such as common kitchens on every other floor to facilitate dialogue between different departments.

Parkview Green Mall has another interpretation of “multi-functional spaces” because the target users are of various groups, including shoppers, office workers, hotel guests, and art gallery visitors. (Figure 13) In contrast to the relatively homogenous set of users occupying PNC Tower, the majority of the time, there are very different groups of people in Parkview Green Mall every single day. Thus, finding how to meet the needs of people of different ages, genders, and goals is a major challenge that architect Shu had to think about regarding “multi-functional spaces.” In addition to the fact that Parkview Green Mall has four major functions—gallery, mall, office and hotel—Shu added many other components, such as installations, sculptures, and

the bridge to offer visitors multiple and varied experiences. The key concept of “multi-functional spaces” is to create a more dynamic experience by thinking about how people will react inside of the building by considering the duration, purpose, and target group of visitors, rather than adding more and more functions in limited areas.

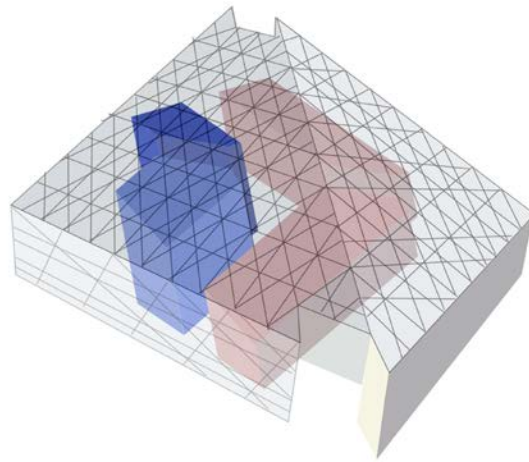


Figure 13: Parkview Green Mall: Multi-functional Spaces

7.0 PNC TOWER AND PARKVIEW GREEN MALL: A CRITIQUE

In this section, I discuss the gap between architects' expectations and reality and offer some specific criticism on these two sustainable buildings. While both buildings are considered success stories of sustainability, they also provide future lessons for even more sustainable design. PNC's double skin façade is designed as a breathable skin to bring fresh air into the building approximately 42% of the year. However, PNC Tower is using regional air sensors and data, which are not located in downtown Pittsburgh, so the data does not correlate to the building's immediate environment. Therefore, it is likely that sometimes the air brought into PNC Tower is polluted or compromised in some other way. Also, the advanced water recycling system that was originally proposed for the building may not be installed after all.⁶⁹ This would mean that several thousands of gallons of waste water would need to be transported offsite from PNC to a water treatment plant, creating wasteful expenditures of energy.

Parkview Green Mall, on the other hand, uses ETFE material to bring more solar energy into the building during the winter. However, ETFE is a fluorine-based plastic, which has environmental costs.⁷⁰ This is something that designers need to think about, as sustainable materials should not have negative environmental impacts in any stage of its life cycle. Also, few people, including the ones who live and work inside of Parkview Green Mall, know that it is a

⁶⁹ Personal Communication.

⁷⁰ <http://www.chinabaike.com/z/shenghuo/kp/2016/0628/5496911.html>, accessed February 25th, 2017.

sustainable building. Thus, Parkview Green Mall does not pass the message of sustainability to others, which is a lost opportunity to educate citizens about the value of sustainability. It is important to emphasize that good sustainable architecture should not end its program of sustainability as soon as construction is finished; it should continue educating other people and corporations to pursue sustainable choices as well as creating more sustainable architecture in the future.

8.0 WHAT IS THE FUTURE OF SUSTAINABLE ARCHITECTURE

As I undertook this comparative research, I kept asking myself, “Which design is better?” This was one of the original questions that I aimed to answer at the beginning stage of my research. PNC Tower and Parkview Green Mall can only be compared from certain perspectives without considering local culture, building types, duration, cost, economic difficulties, governmental regulations, and other influencing factors. It took more than 10 years for Parkview Green Mall to be built, which is not common at all considering the fast pace of urban development in China, and shows the dedication of the developer to their vision of sustainability. Likewise, PNC showed their commitment to sustainability with a 240-million dollar building that provides a state-of-the-art working environment for their employees.⁷¹ Beyond the three aspects of sustainability that I have discussed, there are some other components that I found particularly important when thinking of sustainable architecture today. For example, architects need to consider what the target group of people is for a sustainable project. The wider community may learn from even minimal interactions that they have with sustainable architecture. It is not only limited to the people who use the building, but also includes those who may pass by the building. Also, future generations are another potential target group of people as well, who will inherit the environmental costs that we incur today. Thus, architects and future developers need to consider

⁷¹ https://www.thetoweratpncplaza.com/#fact_sheet, accessed February 24th, 2017.

not just people around the building but also the people in any way affected by its energy expenditures, among other things.

Multi-Functionality is the design strategy used for both buildings. Even though PNC Tower only has one main function, which is as an office area, it is more important to design the spaces by anticipating the potential human behaviors in order to fulfill their needs when they are in the building. The intention of Parkview Green Mall's different functions is driven by different groups of human behaviors as well. Central ventilation has been used as the major cooling/heating system, as well as allowing for the continual supply of fresh air inside the building. However, I prefer PNC Tower's design because architects not only installed the central ventilation in different modes based on the current air quality, but also designed the double-skin façade as part of the architectural language. The double-skin façade is a sign of a readable building, which is an innovative approach for a more computational and sustainable building. As such, PNC Tower acts as a giant billboard for both the company and the cause of sustainability.

Sustainable design is a holistic process that should go beyond just innovative designs for isolated buildings. When I interviewed PNC's sustainability analyst, Angelica Ciranni, she told me that a continuing problem that PNC faced was not just about maintaining the latest sustainable technologies in their workplace, but also persuading senior employees of something as simple as printing on double-sided paper to reduce the daily paper load. Such trivial challenges and choices may seem inconsequential compared to the scale of PNC Tower and the company, but it is the everyday choices of sustainability that will ensure the continuing health of the planet. It goes back to the social aspect of sustainability—the human factor—without which green architecture has little meaning. Both PNC Tower and Parkview Green Mall have installed the latest green technology to optimize the building performance. However, the real challenge is

still how to inspire everyday choices and to change people's lifestyles so that the world moves in a more sustainable direction. Without changing people's mindset, sustainable architecture can make very little impact on our environmental improvement.

The ecological aspect of sustainability can be measured by individual building performance, which could be a guideline for other developers who want to pursue sustainable architecture. The social aspects of sustainability, on the other hand, are much more subtle but equally important to building a sustainable community, city, and arguably, the planet at large. Also, both ecological and social aspects have to be correlated to economic yields so that developers can make long-term profits from investing in sustainable design. This profit is not limited to the financial aspect, but is more related to long-term environmental profit, building performance, human performance, etc.

Architecture is much less meaningful when people are not factored into its design. I will go so far as to say that sustainable architecture itself will not be sustainable if the people inside do not pursue sustainability deliberately and mindfully both when they are within sustainable buildings but also beyond them, in their homes and leisure environments. Architects and developers can and should be encouraged to think carefully about how their sustainable projects can impact occupants, the community, and even the city, since one or even hundreds of green buildings can help very little towards climate problems.

In the end, I want to return to our pressing environmental issues. The 2030 Architectural Challenge gained a lot of attention from architects, firms and governments and raised awareness of sustainability. Besides, at the 2015 Climate Change Conference held in Paris, France, more

than 195 countries pledged to reduce carbon emissions.⁷² This is also a revolutionary event which indicates that pursuing sustainability to improve our environmental problems is an urgent issue that needs global attention and effort. Even though we cannot control what will happen for the future climate, the 2015 Paris Conference was a great sign that the majority of the nations in the world have agreed to help our environment and to ensure its healthy survival for future generations. Recently, the Chinese government recommitted themselves to a pledge made at the 2015 Climate Change Conference and affirmed that they will do everything they can to achieve this goal. Chinese architects need the support of the government to pursue sustainability at a truly meaningful level. Sustainable architecture involvement in the U.S., however, is relatively mature, and states and cities have far more control than the federal government over decisions made at the building level. Thus, the next approach for the U.S. will be to inspire more people to join the group and pass on the message of sustainability to people who do not fully understand what real sustainable architecture is nor how urgent environmental issues are right now, which needs all stakeholders to commit equally and strongly to sustainable lifestyles and practices in every regard.

⁷² <http://www.un.org/sustainabledevelopment/cop21/>. accessed April 14th, 2017.

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