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Quest for the Aesthetics of Sustainability and Sustainable Architecture in the Digital Age

Katalin Puskas Khetani

Independent Research, Kuala Lumpur, Malaysia

E-mail address: katalin@aptiservices.com

Abstract: Architectural styles or architectural aesthetics are very powerful tools for expressing the very core values, customs, emotions, thoughts and philosophies of a culture or society. The emergence of each architectural style was a result of a great shift in humanity's way of life. The reviewed literature suggests that these major shifts in the history of man were caused by technical development and innovations of industrial revolutions. These new incremental technological changes created a human development path that reached a level which is no longer sustainable. Sustainability became possibly the most important motto of our age however, the pronounced sustainable architectural style and aesthetics that would communicate the underpinning philosophies, thoughts, emotions and values is yet to emerge. This article aims to investigate the underlying conditions and factors why sustainability has not yet revealed itself aesthetically as a distinctive architectural style.

Keyword: sustainable architecture, sustainability, aesthetics, style, Alexander Gottlieb Baumgarten, Susanne Langer, sustainable business model, 4IR, Biomimetic, Biomimicry.

1. Introduction

1.1. Sustainability, Architecture and Aesthetics

The most frequently cited definition of sustainable development was coined by the Brundtland Report in 1987 as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development (WCED, 1987)). The architecture of the 20th century and its predecessors were driven by technical change and new technologies. The modernist movements' aim was to gain control over nature by technology, and the minimization of consumption or waste was not amongst the important factors to be considered. (Lee, 2011) The steady rise of consumption arrived to a stage when humanity started to realize that it was no longer sustainable anymore and started with the Stockholm conference in 1972, the Earth Summit in Rio de Janeiro in 1992, followed by the Kyoto Protocol in 1997, the Johannesburg Declaration on Sustainable Development in 2002, and the Paris Agreement in 2016; humanity is now in perpetual search to find solutions for our environmental crises (Singh, 2016). According to the ‘Advancing Net Zero Status Report 2020’, published by the World Green Building Council, the building and construction sector is responsible for a great share of the caused environmental emergency. Buildings consume 36% of the energy produced and are responsible for 39% of global carbon emissions, making it the largest contributing sector to climate change. Glen Hill (Lee, 2011) suggested that technological developments led by the industrial revolution created huge incremental changes in human life styles, and these new life styles made it necessary for

humanity to consume increasing quantities. The advanced life styles and social circumstances created new far-reaching changes in feelings, thoughts, trends and philosophies that manifested in the emergence of new architectural aesthetics. Architectural styles transform from one to another when the underlying philosophical base becomes outdated, exhausted or not relevant anymore. After this, the new style with the underpinning new idea and philosophy will be set free for a time, but as every style it will reach its climax and will lose its flair and meaning and will give its place to new, fresh inventions, ideas and styles (Jones, 1856). As Sir Norman Foster phrased in 2014 “Architecture is an expression of values – the way we build is a reflection of the way we live...every era produces its own vocabulary”. Further to Sir Foster’s approach, architectural styles of different ages can be perceived as a way of communicating our culture via different architectural styles or visual terminologies. In essence, architectural styles or aesthetics has an important role in communicating some sort of innate internal quality or knowledge. Without a definite style or architectural aesthetics, this sort of transfer of knowledge or invisible qualities would not be possible.

The term “aesthetics” was coined by the German philosopher Alexander Gottlieb Baumgarten in the 18th century, originating from the ancient Greek word *αισθητικός* (aisthetikos). In the antique world, this term had a significantly different meaning, which was ‘the ability to receive stimulation to the bodily senses’. According to Baumgarten’s description aesthetics is a “form of knowledge that is gained from that which is sensed”(Lee, 2011). Baumgarten suggested “to bring the critical treatment of the beautiful under rational principles and so to raise its rules to the rank of a science”. Baumgarten formed his philosophy of aesthetics just at the beginning of the first industrial revolution when the development of art as a commercial enterprise resulted in the rise of a ‘nouveau riche’ class across Europe asking for a definition of “good and bad taste, thus good and bad art”. Baumgarten described aesthetics as “the younger sister of logic”, the role of aesthetics for perception or sense cognition according to Baumgarten is the same as what logic does for intellectual cognition. (Miller, 2011). With the reemergence of cognitive theories of art in the 20th century, German-American philosophical Susanne Langer's approach shows significant "family resemblance" to Baumgarten's theory (Gregor, 2015). Further to this, Correia(2019) investigating Langer’s philosophy, argued that the concept of culture gains clarity if we see it as the human mind’s categorization of reality. A culture is like a consistent pattern of thought in action. (Benedict, 1989). Furthermore to this, architectural styles can be considered as parts of these consistent patterns created by the human mind’s categorization of reality.

1.2. Industrial Revolutions and Architectural Styles

The 1st industrial revolution started around the mid-18th century, signified by the European 'revivalist' and Eastern influenced styles. The second industrial revolution, which started around 1890, brought with it Art Nouveau and then the Art Deco styles. With the third industrial revolution, the digital era of the 1990’s created the modernist architectural styles. Klaus Schwab, founder and executive chairman of the World Economic Forum, in his book titled *The Fourth Industrial Revolution* (2017) wrote that this new era would be characterized by tremendous social and technological changes and the merging of digital, physical, and biological innovations that will affect all of us in the very core of our life. However, as of today, no overarching architectural style has emerged yet as a medium to communicate the new values. Most probably, this new style will also have its own vocabulary heavily relying on the technical advancement of our age, such as cloud computing, augmented reality (AR), big data, virtual reality (VR), machine learning (ML), artificial intelligence (AI) and other technical achievements of the new digital age (Xu, 2018). However, these advanced technological solutions only provide a platform for communication. The question is what values, culture and philosophies are supposed to be communicated on these channels, to give momentum to a new architectural style to flourish (Lee, 2011)? Sustainability, sustainable design and development are one of the most compelling approaches, receiving global attention of our time. Given the increased interest in this area, it is important to investigate whether sustainability has become an inherent part of the architectural discipline as a whole (Lee, 2011). Can we talk about sustainable architectural style or aesthetics? Furthermore to the above, the important, genuine meaning of sustainability can only be communicated on a large scale via a distinct sustainable architectural style. In contrast to this Glen Hill

(Lee, 2011) mentions that according to contemporary architectural theorists, the current changeable buoyant sequence of styles resulted in the complete loss of meaning and importance of architectural aesthetics. However, this assumption would also result in the loss of opportunity for expression and communication via architecture. In Langer's terminology it would mean that semantic symbols would be reduced to simple physical signals (Correia, 2019). To further elaborate on this question, according to Susan Maxman, the first woman president of the American Institute of Architects and who received national appreciation for her expertise in adoption of the sustainable design principles in her projects has suggested that "sustainable architecture is an approach, an attitude. It should not really even have a label. It should just be architecture." (Guy, 2001)

1.3. Sustainable Architecture - Sustainable Business Models

Three acclaimed professionals, Rem Koolhaas, Peter Eisenman and Wolf Prix were asked if there is such a thing as aesthetics in sustainable architecture today. All three answers were no to this question. Jauslin (Lee, 2011) argues the conclusion that can be drawn from the three most prominent professionals in the field of architecture is that, as of today, there is no consensus on what the possibilities of sustainable architectural aesthetics are or whether they exist at all. Contrary to several ambitious and enthusiastic attempts of architectural professionals, a distinctive sustainable architectural style has not yet emerged up to the present day. Knowles (Lee, 2011) suggests that often the expression of sustainability or sustainable design is just the last add-ons, extra additional supplementary items annexed at the very end of the design process following all the other design considerations. Sustainability should be given great importance from the very beginning of the project conception phase and they should be an integral part of the design considerations all throughout the project phases (Lee, 2011).

Interestingly, studies regarding sustainable business models showed very similar results. For the successful operation of a business, it is imperative to identify the key factors such as sources of revenue, the intended customer base, products, and details of financing, this is called a business model. As Osterwalder's phrased it "a business model describes the rationale of how an organization creates, delivers and captures value" (Fielt, 2013). Although sustainable business models recognize the importance of sustainability and, therefore the new sustainable approach that emerged is the so-called triple bottom line approach (social, environmental and economic considerations), still these do not represent a truly integral part of these models. Geissdoerfer (2018) in his article provided a comprehensive review of the sustainable business model literature. Their conclusion was that what all these papers have in common was that the sustainable business models were purely a modification of the traditional business models. The only difference was that certain characteristics, goals or concepts were added to the already existing models in order to comply with their sustainable business goals. Thus, sustainability considerations and business model innovation are often not well integrated, with sustainability being treated as an add-on rather than as a core source of value.

1.4. Architectural approaches to sustainability

Sustainability appears in every industry, sector and almost all aspects of our life. Consequently, sustainable development and design is a very large fragmented area involving several interdisciplinary topics, with vested often contradicting interests of multitudes of stakeholders. There are myriad of possible ways and theories to sustainability and without attempting to give a complete picture, the author introduced three pairs of seemingly contradicting sustainability approaches, which could be an exemplary indication of why a distinctive sustainable architectural aesthetic or style has not yet emerged.

(i)Technophilia versus Technophobia (Techno-sceptic) divide. One potential angle to approach this subject is via the two most significant tendencies of sustainable development and design, the technophile and techno-sceptic approach. For the supporters of the technophile approach, the sustainable future is based on hightec building specifications and high technology solutions that are built into the very core of our everyday life. The technophiles believe that humans will only change their behavior if it involves economic benefits. Therefore, humans need some sort of guidance or help to choose and behave in an 'expected',

sustainable way. (Brand 2013). This approach is often associated with renewable energy such as PV panels, solar thermal collectors, wind turbines, heat pumps and sometimes called gadget architecture or eco-bling by critics. (Lee, 2011).

The supporters of the techno-sceptic approach believe that essentially human behavior, culture, values and attitudes should be changed for a sustainable future and then this would change everything else around them. The techno-sceptic design concept is the so-called passive design approach. These design principles accommodate the natural rules and climatic conditions of the setting, such as the orientation of the façade, the depth of the plan, the building shape, natural ventilation, free cooling and free solar heating. In indigenous cultures, this passive design concept is an integral part of their architecture and has evolved over thousands of years. Although the passive building design, eco-design or vernacular architectural design is already pointing to this techno-sceptic architectural style direction, Sauerbruch and Hutton in their article 'What does Sustainability Look Like' address architect to create a completely new marked architectural style that promotes this paradigm shift based on the change of human lifestyles. (Lee, 2011).

(ii) Holistic versus Prescriptive divide. According to the overall large holistic approach described by Banham in his book titled 'The Architecture of the Well-tempered Environment' (1984) is that the three main strategies of ecological thinking, such as conservation (the reduction of resources and materials and the minimalisation of waste), efficiency (efficiency and longer life span of electric and heating appliances and other machineries) and regeneration (the regeneration of natural resources) should be incorporated into the architectural design process in order to achieve sustainability design goals. Lee (2011) emphasizes that one of the major problems of our current architectural approach is that the large overarching holistic ideas and principles suggested by Banham are completely missing from the conception and design phases. Lee argues, that instead of a comprehensive approach, there is often a belief that sustainability can be achieved by complying with certain prescriptive measures, rules and regulations, benchmarking or ticking boxes in forms. The WEF 'Shaping the Future of Construction: A Breakthrough in Mindset and Technology' (2016) report and the 4IR described by Klaus Schwab also talks about the necessity of a holistic approach to the entire design-build-operate life cycle, but this holistic approach puts the emphasis on a bit different topics. In light of the 4IR Lillehagen (2015) in their article 'Holistic Design for Continuous Innovation and Sustainable Knowledge bases' describes a slightly different picture of the key activities that are necessary for this approach. Although this article is not specifically for architects or construction professionals (as the 4IR is driven by IT and manufacturing sectors), it summarizes ideas of the 4IR that are valid for all industries. They state that 4IR will necessitate new concepts, agile approaches, holistic design, new business models, and sustainable knowledge base methods. Innovation, learning and collaborative networking will have a key importance. They argue that the present systems and knowledge bases are not able to support and deal with the growing complexity and the impacts of change.

Opposite the holistic design principles, the more technically oriented approach places great emphasis on green building rating systems (GBRSs) such as LEED, BREEAM and sustainability assessment frameworks. There are several types of analytical tools, metrics and frameworks to evaluate the achieved level of sustainability. The goal of these frameworks, metrics and tools is to assess the scale of the project's environmental impact. These green building rating tools all have their different approaches based on categories such as planning and design, construction, operation and maintenance, renovation, and demolition phases. These rating tools can also vary based on the type of buildings they are applied to. For this approach, frameworks and assessment systems provide a very important and indispensable tool to create more sustainable buildings.

(iii) 4IR's Prefabrication, modular construction versus Biomimetic, Biomimicry, 'back to nature' approach. The 4th Industrial Revolution (4IR) is about to bring immense changes, disrupting technologies and also vast opportunities to all industries and sectors. According to a report by the WEF (2016), while other industries have accepted these tremendous changes over the last few decades, the engineering and

construction sector has been reluctant about fully embrace these opportunities. Further to this, the WEF report suggests that the extensive use of standardized, modularized and prefabricated construction methodologies would be one of the potential ways to give a significant boost to this industry. They argue that component standardization could bring many benefits, such as a reduction in construction costs, reduced number of interface and tolerance problems, greater certainty over outcomes, reduced maintenance costs for end-users, and more scope for recycling. Modularization could contribute to the advantages of standardization by expanding the possibilities for flexibility and customization. Prefabrication could boost construction efficiency, facilitate better construction process sequencing and reduce weather-related delays. This could reduce the project's delivery times and construction costs relative to traditional construction methods, and also to provide safer working environments. Prefabrication is suitable for a wide variety of project types, ranging from residential housing to large-scale industrial plants.

Opposite to the prefabrication and modular construction approach in the same time, many research studies point to the direction that working together with nature brings surprisingly positive results. An example of this is Knowles' article 'Solar Aesthetic' (Lee, 2011), where he introduces building forms that were modeled based on the sun's path. As he explains, the natural rhythms of solar cycles molded our human civilization for several thousands of years therefore, these are bound to provide a paramount guide for sustainable architecture. In terms of fundamentally new and integrated methodologies, the so-called biomimetic and biomimicry approach are promising vast opportunities. biomimetics combines architecture, arts and biology in order to study and copy living nature. biomimetics is a highly interdisciplinary scientific field involving the understanding of biological functions, structures and principles of various objects found in nature. The four main areas of biomimetics are: (1) SPACE, bioinspired design for space design, (2) BIOSKIN is the research on energy-efficient facade systems of the future. Features such as light transfer and self-shading passive cooling effects are researched based on natural shapes of cacti, begonias or venus flower baskets for example; (3) BIORNAMETICS is the research of patterns from nature that can be used for architecture, the Fibonacci sequence is an example; (4) GrAB (growing as building) takes growth patterns and dynamics from nature and applies them to architecture. This includes, for example, the study of the mold growth pattern and the potential use of this in architecture (Gruber, 2016). Similar to biomimetic architecture, biomimicry is an approach that learns from and mimics the coping mechanisms found in nature to solve human design problems. Biomimicry architecture is a contemporary philosophy of architecture that searches solutions for sustainability in nature, not copying natural forms, but by understanding the rules regulating those forms. As Janine Benyus, founder of the Biomimicry Institute phrased it: "The truth is, natural organisms have managed to do everything we want to do without guzzling fossil fuels, polluting the planet or mortgaging the future". The key philosophy of biomimetic and biomimicry architectural approaches is that the process of evolution that shaped our world over millions of years provides highly refined natural models that should be studied and applied by architects and engineers.

The announced convergence of digital, physical, and biological innovations of the 4th Industrial Revolution are starting to manifest architecturally to a certain extent in the so-called biomimetic or biomimicry approach, and there are very powerful and inspirational initiations from other described architectural approaches too. The question is, if a distinctive collective sustainable architectural style will emerge from all these sometimes contradicting philosophies and design approaches or not. Jausin (Lee, 2011) argues that the cultivation and propagation of the aesthetics of sustainable architecture is imperative, as this is the only way to address the urging issues of climate change and a world population of 7 billion. Frampton (Lee, 2011) argues that sustainability's aesthetics and architectural style should be a key stimulus, inspiration and motivational factor that would help to enable and deepen our understanding of the pressing issues of our world. Figure 1 shows a structured summary of the 3 pairs of most antagonistic approaches to sustainable architecture identified by the author.

Figure 1. Structured summary of the 3 pairs of most antagonistic approaches to sustainable architecture

ARCHITECTURAL APPROACHES TO SUSTAINABILITY			
Scope	Advanced Technology Approach	Natural, Organic Approach	Scale
Attitude to Technology	Technophilia <i>Eco-bling</i> <i>Gadget Architecture</i>	Technophobia <i>For example: Vernacular architecture, eco-design and passive design</i>	From detailed, smaller scale approach....
Design Concept Perspective	Prescriptive <i>Great emphasis on BREEAM, LEED, etc. analytical tools and frameworks</i>	Holistic <i>3 key principles: Conservation, Efficiency and Regeneration</i>	...to...
Theoretical Background of the Approach	4IR (4th Industrial Revolution) <i>Standardized, modularized and prefabricated construction</i>	Biomimetics Biomimicry	...Large scale comprehensive theories

2. Methodology

The key concept of this research study was a systematic literature review of the slightly overlooked topic of sustainable architecture. There is a vast amount of information, books and body of knowledge available about almost all other aspects of sustainability, except for the underlying potential for a sustainable architectural style. The primary source of information for this study was a literature review of various articles, books, and websites in the topic area of sustainable architecture, sustainability, aesthetics, style, Alexander Gottlieb Baumgarten, Susanne Langer, sustainable business model, 4IR, biomimetic and biomimicry. The papers selected ranged from the year 1856 to 2020 and originated from several fields such as sustainable architecture and design, history of art and architecture, cultural, business and environmental politics studies. The Google Scholar database was used to collect a complete, exhaustive repository of all the available literature relevant to the research topics. The literature review was conducted on a qualitative basis, adhering to standards for gathering, analyzing, and reporting evidence. The key principle of the systematic literature review, the use of an objective and transparent approach, with minimal bias, was strictly followed.

Due to the fact that the picture painted by the reviewed literature showed a very diverse, fragmented and sometimes contradictory scenery, it was imperative to find a suitable approach to try to show all or as many of these trends and tendencies of the subject as possible. The author decided that one of the plausible and appropriate approaches could be to find and pair the most relevant contradictory concepts and try to structure the paper along these dichotomies. Further to this the author identified the following 3 pairs of most antagonistic approaches to sustainable architecture: (i) Technophilia versus Technophobia divide, (ii) Holistic versus Prescriptive divide, (iii) 4IR Prefabrication- modular versus Biomimetic, Biomimicry, 'back to nature' approach. Although definitely there are multitudes of other ways of approaching this field, and even following our method, there must be more dichotomy pairs to be found in sustainable architecture, the author believes that the presented structure gives relevant insight into the targeted topic, which is the question of the aesthetics of sustainable architecture. Table 1 shows the selected sources of the literature review.

Table 1. Articles selected for research contribution

No.	Author's Name	Title	Year	Source
1.	Attia, S	Modern History of Sustainable Architecture.	2018	Regenerative and Positive Impact Architecture SpringerBriefs in Energy,
2.	Brand, R., & Fischer, J.	Overcoming the technophilia/technophobia split in environmental discourse.	2013	Environmental Politics
3.	Correia, C.	Susanne K. Langer and the Definition of Art.	2019	Eidos. A Journal for Philosophy of Culture
4.	Gebeshuber, I.	Sustainability through Biomimicry: Discovering a World of Solutions Inspired by Nature	2012	First International Conference "Sustainability through Biomimicry:
5.	Geissdoerfer, M., Vladimirova, D., & Evans, S.	Sustainable business model innovation: A review.	2018	Journal of Cleaner Production,
6.	Gregor, M.	Baumgarten's "Aesthetica."	1983	The Review of Metaphysics
7.	Gruber, P.	A Biomimetic Approach to Architecture and Design.	2016	www.grc.nasa.gov
8.	Guy, S., & Farmer, G.	Reinterpreting Sustainable Architecture: The Place of Technology.	2001	Journal of Architectural Education
9.	Lee, S.	Aesthetics of sustainable architecture	2011	Repository.Tudelft.Nl.
10.	WEF in collaboration with The Boston Consulting Group.	Industry Agenda Shaping the Future of Construction A Breakthrough in Mindset and Technology	2016	WEF
11.	Xu, M., Kim, S. H., & David, J. M.	The Fourth Industrial Revolution: Opportunities and Challenges	2018	International Journal of Financial Research

3. Conclusion

Sustainability is one of the most compelling approaches to our time. It is present in every industry, sector and even in our everyday life. Architecture, which is the most important expression tool for human culture, values and philosophies, has not gained enough momentum to give birth to a marked sustainable architectural style. The field is very diverse, fragmented and often contains rather contradictory approaches. However, in this turmoil of searching for a path towards sustainable architecture, there are already very interesting signs of a new beginning. The 4th Industrial Revolution announced the convergence of digital, physical, and biological innovations are starting to manifest architecturally to a certain extent in the so-called biomimetic or biomimicry approach, and there are very powerful and inspirational ideas from other described architectural approaches too. The question is, if a distinctive, collective, sustainable architectural style will emerge from all these sometimes contradicting philosophies and design approaches or not. The cultivation and propagation of the aesthetics of sustainable architecture is imperative, as this is the only way to address the urging issues of climate change and a global population of 7 billion. Sustainability's aesthetics and architectural style should be a key stimulus, inspiration and motivational factor that would help to enable and deepen our understanding of the current pressing issues of our world (Lee, 2011).

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