

In this paper, I would like to reflect the issues about digital architecture design and how it effects in sustainable architecture, as well as the design methods I would research in my graduation project. *Digital architecture uses computer modeling, programming, simulation and imaging to create both virtual forms and physical structures. The terminology has also been used to refer to other aspects of architecture that feature digital technologies.*[1] By reading the philosophy thought from Michel Foucault's and Gilles Deleuze, the Parametricism by Patrik Schumacher and the Interactive Architecture by Michael Fox and Miles Kemp and with the large amount of practice in prototypes and real buildings even urban planning, I would consider the digital architecture design will be the focusing point of my architecture study and will play an important role in my graduation design.

Background of Digital Architecture Design

The digital age is one of the greatest transformations of our time which influence numerous aspects of our daily life. But at the same time, it also impact on architecture technological innovation as well as a reconfiguration of the traditional understanding of space. The exploration of digitally architecture design or parametric nonlinear architecture design began from the middle of 1990s. The fundamental theory is from the reinterpretation of Michel Foucault's diagram concept from Gilles Deleuze. For Foucault, the diagram projects a presentation of power and resistance in relation to the particular features of a social field. Deleuze precisely and artfully extends Foucault's reach by mapping his early, middle and late works, within a knowledge-power-subjectivity continuum. Deleuze further explores the diagram, extrapolating beyond the Foucaultian abstract machine givens of a compositional process. How translations relay from content to expression and back, from the visible to the articulable, the receptive to the spontaneous, to arrive at the archive and return to the ineffable, virtual, abstract machine to churn again, is the topological terrain mapped by the diagram.[2] On the other hand, depending on the exploration on the rule of the material world, modern science proposed a new theory - complex systems. Compare to the classical Newtonian mechanics' simple system, the complex system is constituted with a large number of individuals. Each individual has a certain wisdom and strongly coupling with others. They will adjust their behaviors depending on the environmental information. Starling flock, ant colony, human society, economic system and the internet are all have the features of the complex system. Complex systems may exhibit behaviors that are emergent, which is to say that while the results may be sufficiently determined by the activity of the systems' basic constituents, they may have properties that can only be studied at a higher level. For example, the termites in a mound have physiology, biochemistry and biological development that are at one level of analysis, but their social behavior and mound building is a property that emerges from the collection of termites and needs to be analysed at a different level.[3] Based on these researches, the methodology of emergent was being presented. By means of simulating the individuals behaviors and the interaction, the whole system can be emerged through this bottom-up methodology. These behaviors are programmed by the designer in order to address the multiple demands from personal to social, from aesthetic to functional, from emotional to environmental.[4] This core concept of the digitally architecture was emerged when the Philosophy thought of Foucault and Deleuze met the complex system and digital technology.

Background of Interactive Architecture

If the emergent methodology is supposed as a method of generating architecture, then the interactive design is the way to make architecture alive. Interactivity is mentioned in many fields (architecture, industrial design, media art, computer programming, stage installation), which is also supported

increasingly by the development of fundamental technologies (wireless charging, sensor development, augmented reality, artificial intelligence, smart phone popularization). According to Zeynep Gündüz's research in interactive stage performances, "*In relation to my own focus, it is important to be aware that there are at least three different types of digital dance practice created with real-time interactive technology, operating with real-time motion-tracking software, which I suggest it is possible to categorize as: 1) choreographic installations; 2) mixed practices, which combine elements of staged digital dance and choreographic installations; 3) staged digital dance.*"[5] The wide application of interactive technology will not merely let human have much deeper communication with machines but also has possibility to change the mode of human life. As a crucial branch of digital architecture, *the issue of interactive architecture opens with an 'introspective-retrospective' of the field by Michael Fox, a leading contributor to interactive design since the mid-1990s.* [6] At 1998, he set up the Kinetic Design Group in MIT in order to explore the possibilities in interactive architecture. He looks back at interactive architecture and tells a story of 'Catching Up with the Past'. *The past here begins with cyberneticians Norbert Wiener and Gordon Pask and architects Cedric Price and John Frazer, who imagined machines and buildings as living, adaptable organisms in dynamic relationships with their environments.*[7] Recent years, many research groups and individuals explore diverse dimensions and potentials of interactive architecture through building prototypes or real projects. For instance, the Tangible Pixels designed by Jean Nouvel in the facade of Institut du Monde Arabe, Aegis Hyposurface designed by dECOi, as well as the Muscle NSA designed by ONL & Hyperbody. In the field of architecture, the interactivity is generally considered as this definition, "*Interactive Architecture explores the possibilities for dynamic, interactive spaces in which people and buildings engage in a mutual relationship with one other. By connecting the data, stories and experiences that develop through this relationship between buildings and their inhabitants, the built environment becomes an interactive, adaptive and animate entity.*" [8] It talks more about the relationship between people and the building.

Counter Argument

Regarding to the nonstandard digital architecture or parametric design, some views argue that the so-called nonstandard digital architecture or parametric design is just a kind of fashion, it is indeed fashionable in recent years, but it is not about the essence of architecture, architecture should talk more about social concern, space quality, practicability etc. Besides, some people think that the digitally driven architecture is just a computational technique.

Indeed, the computational technique plays a significant role in the digitally driven architecture or parametric design, but it is not only about techniques, it impacts the way we thinking about architecture and the method we research about architecture. Moreover, with the digital technology, the architects can explore more deep about social concern, space quality, practicability etc. For example, sustainability is a very important issue in computational design, and it is heavily involved into the social problems. In addition, within digitally architecture, architects can use computational technique to calculate the quality of spaces, for instants the quality in temperature, illumination, noise effect etc. Architects can adjust the design to increase the space quality relying on the calculation results.

Background of Sustainable Architecture

In the field of sustainable architecture, "*sustainable architecture seeks to minimize the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy, and development space. Sustainable architecture uses a conscious approach to energy and ecological*

conservation in the design of the built environment. [9] It is often considered as sustainable energy use (heating& cooling system, ventilation), renewable energy generation(solar panels, wind turbines, heat pumps) as well as using sustainable building materials.

Interactive Sustainability

After introducing the concept of interactivity and digital technology into the sustainable architecture, the new kind of opportunities will appear in environment friendly building climate control and energy consumption. In my opinion, the opportunities exist both in global and local aspects. From the local perspective, the development of architecture interactive components have been increased significantly recent years. With the growing of fundamental interactive technology, the interactive architecture components has great potential in dealing with the environment friendly building climatic issues and the integration with architecture design. For instance, the Reichstag dome designed by Norman Forster, of which the sun-shading system component is interactive with the sunlight. As well as the Institute du Monde Arabe designed by Jean Nouvel, the window components are interactive with the sunlight and controlling the indoor climate, at the same time present the typical Arab patterns. These cases show that combing interactivity and digital technology has a great potential in environmental friendly architecture climate ecology as well as the energy consumption. For my own research, I will mainly focus on the opportunity lies on the global perspective. In the 1:1 prototype workshop of hyperbody, it had shown that interactivity and digital design method have a great potential in sustainable architecture and the new mode of spatial occupation in a global perspective. In the project of cloud life of our team, we explored the most efficient use of space and how it effects in environmental aspects. The design of our project is not just a interactive installation or a responsive facade, the interactive system of this project lies in the physical installation and the functional demands of human as well as the spatial usage. This kind of interactive architecture will change the mode of human life in a certain extent and thus effect the energy consumption and the climate issues. The similar mode of thinking will apply to my graduation design project.

Background of Graduation Project

More specific to my graduation project, the site of my project is in the Marconiplein which is a junction with many roads come together and mixed with three stations respectively are bus, tram, and metro station. Meanwhile, the Marconiplein is located at the central of the north boundary of the Nieuw Mathenesse, which is an industrial area that need to be transformed to a residential and small office district. With this changing of the old port area, the population will meet a dramatic increasing, thus the transport infrastructure need to be update in a priority. In the opposite side of Marconiplein of the Nieuw Mathenesse, a project of ferry hub is developing by another hyperbody student. We work individually in our own building project, but we want to explore the possibility of generate an iterative urban pattern which is triggered by the two buildings of transport infrastructure. With the interaction between our two large scale buildings, we want to seek that what kind of urban typology will be generated and emerged, in order to seek a bottom up generative method to increase the efficiency of urban connectivity and decrease the consumption of transport cost. And further to research in what extent can the digital architecture impact the mode of city life.

Personal Research Methods

My research methods for the graduation project will follow the steps below.

The first step would be the research in morphological emergence. It will be based on the studio of hyperbody's morphogenomics research strand which represents a novel information integrated generative design method for developing context oriented performative morphologies. The first step would be developing informatics based on a network through a series of analysis about multiple aspects of factors, for instants, climatology, sociology, urbanology, etc. Then the data steam and the most vital parameters would be collected from site surrounding factors, like sunlight, acoustic problem, the pollution of air, soil, and water, and carbon emission and so forth, as well as social context, the appeals of local people, aesthetic and functional demands. As extracting the steam and parameters from the informatics, specific computational explorations would take place simultaneously. It would be explored by two aspects, swarm behavior and genetic algorithm. All these two manipulations are base on bottom-up methodologies, they regard the analysis based informatics as inputs of the generative systems. As the informatics changes, the systematic based emergent morphology will change simultaneously. In this phase of genetic algorithm, which is crucially to explore multiple algorithms such as L-system, Particle System, Cellular Automata and so forth. Combine this systematic thinking and methods into the accurate site, then to utilize these input parameters to set up my own system standards. Define the exact rule of each parameter and the relationship between them. And also set the suitable logical relationships between different systems in different levels of the whole systematic architecture. By combining the systems together, driving by certain parameters, to see how the architecture or urban pattern can be emergent in accordance with the demands from personal to social, from aesthetic to functional and from emotional to ecological.

Apply these digital design thinking into the concept of interactivity would be my second step. We will program certain amount of functions and each function with certain area by the data we get from the urban informatics. Pack these functions into the blank urban site by the agents system we developed. In this system, functions manifest as circle agents with different scales depending on their areas. There is attraction force between some agents, for instance, commercial agents are attracted by residential agents. But at the same time, there is also separation force between agents, for instance, commercial agents are separated by each other. Different agents have various strength of attraction or separation force. Based on this urban functional packing, the basic urban network will appear. Urban transport simulating will take place on this urban network. By using the ant algorithm simulation, agents comes from the existing urban area into the architecture site, forming the basic architecture topology. Then the agents will pass through the urban network in attracting by the opposite building. Simultaneously, each segment of the urban network will calculate the amount of agents who pass through it. Depend on this data to define the hierarchy of the urban roads. With this bottom up digital method, the urban pattern is generated by the interactivity of the two transport hubs, in order to increase connectivity, effectivity, rationality and decrease the consumptions in transport cost. It will introduce a new relationship between architecture with urban and social operation as well as human life.

The final step I would focus on the research of interactive architecture and the interactive technology study. In this phase of interactive design, the real projects and installations are crucially to be analyzed. Studying the technology and meanings behind these nomenclatures - kinetic, adaptive, responsive, intelligent, interactive, and so forth, in order to find the rational aspect of interactive and meaningful environments of the architecture. *The progressive integration of networked, interactive devices into the physical environment is implying a transformation not only in the operation and use of built environments*

but also a change in their physical configuration, and therefore, their design.[10] As well as my first step exploration of morphological emergent algorithm, interactive architecture also set a wide range of notions, such as interactive built environments, real-time changing multi-player installations, interactive design and fabrication etc. My central research agenda on interactive architecture would specifically focus on the building physicality interactive with the climatic issues. The building would interactive with the climatic factors in order to regulate both inside and outside environments. On the other hand, physicality interactive with the climatic issues also has potential synergy effects between environmental regulating and energy saving and generating. The physicality interactive architecture would require the further research on material, mechanical movement device, indoor& outdoor climate, human psychology etc.

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