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Reflection paper

INFLATABLE DIGITAL PLAYGROUND

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My graduation studio experiments with new technology relevant to architecture. Typical for the Robotic Building studio is choosing one new technology relevant to architecture, for example, construction technology, for which the technical properties are then analyzed in order to find the innovative application of the material in architecture. Another important aspect is combining the design and production stages into one coherent process, so that modern design methods are reflected in production. The important part of that research process are workshops organized in the studio every few months. I had the pleasure to participate in one of such workshops under the supervision of Henriette Bier, Arwin Hidding, and Vera Laszlo in autumn 2019. I was accompanied by two other Robotic Building Studio students, Yongyi Wu, Thierry Syriani, who are also currently working on their Master Thesis. Thanks to the workshop at the beginning of the graduation studio, where I have been a system designer and its recipient at the same time I was able to realize the nature of the interactions. Geomatics courses and Computer Science lectures that I attended last year were a great complement to my studies. It allowed me to gain experience in using various data structures and apply the acquired knowledge in computational design for the needs of my project.

As a topic, I decided to deal with kinetic reconfiguring architecture, which caused quite unexpected results for me. In retrospect, I see that my project has several aspects that can be reduced to three concepts: interactive architecture, pneumatic architecture, and abandoned architecture. Below I will try to describe these aspects and the path that led to them.

One of the leading concepts for my research from the very beginning was kinetic architecture. Quite a narrow field of architecture and certainly not its mainstream, but which has had many interesting examples over history. Already Vitruvius included a chapter on machines in his ten books on architecture. The main feature of the kinetic architecture is its evolution in time and adaptation to changing conditions and needs. An iconic example is the Rietveld's Schröder House in Utrecht was created over a century ago, and despite the passage of time, the ideas that shaped it remain fresh, inspirational, and still kind of avant-garde. Today, Ritveld's approach has been used by many. One of the most striking examples is the Gary's Chang Domestic transformer. In Hong Kong and Utrecht, the key feature is the ability of the rooms to reconfigure by changing the location of the partition walls and furniture so that the function of the room evolves over time.

These projects, although presenting an innovative approach in creating space, have used moving elements, which was not a novelty in itself (if you look at sliding walls in traditional Japanese architecture). Nowadays, however, new possibilities appear which are often given as a sign of the upcoming or already ongoing 4th Industrial revolution. Thanks to robotics and the new generation of materials, it is possible that architectural elements not only change their location but also could update themselves over time. Programmable or so-called 4D materials allow objects to change shape due to temperature, sunlight, or current flow. Similarly, increasingly cheaper, smaller, and more common robotics solutions allow complete reconfiguration of objects. Programmable materials, although very promising, are only in the early stages of development and their application requires extensive knowledge of materials science. Exploring the potential of a new generation of materials and increasingly sophisticated mechanisms and robots in architecture would not make sense without having a specialized knowledge of mechatronics or materials science and without the possibility of conducting research by constant prototyping. Although these and similar technologies did not become the subject of my master's thesis design, they remained a great inspiration throughout the year of study.

The dream of reconfiguring architecture has accompanied me from the very beginning to the present moment. However, the pragmatic desire to benefit from a functional reconfiguration of space, so clear in Schröder House and Domestic transformer, wasn't my main motivation in exploring this unusual architecture. I search for this motivation in my first semester at TU Delft, when I joined The Why Factory studio, created by Winy Mass. In this studio, over the years many projects have been created that had the ambition to create a vision of the world that could reconfigure at the level of the smallest components that build architectural objects or even at the molecular level. This would guarantee many practical benefits to be able to shape matter freely, but no pragmatism gave rise to the studies of t?f. Reconfigurability is not the property of inanimate matter. This is a feature observed in living organisms and rather not in individual beings but rather in communities, clusters of organisms, or entire incredibly complex ecosystems.

Therefore, reconfiguration is often a testament to the presence of life. And maybe the revival of architecture is the hidden goal of kinetic architecture. In the visions present in fantasy literature, sci-fi film, and fairy tales, we often deal with the personification of inanimate objects. The desire to see a part of ourselves in the world around us seems to be a natural human feature. In fairy tales, dreams of some objects can speak to us and even reach out a helping hand. Bringing matter to life, and enabling communication and interaction between ourselves, at least in my case, proved to be one of the main motivations to undertake the search for innovation in architecture

I did not expect that the material that would allow imitating living organisms would be air. Inflatables were suggested to me by my tutor Henriette Bier. For most people, they have a fairly infantile character and are associated mainly with inflatable castles, relaxing by the water or sex toys, but to my surprise, it quickly turned out that although inflatables, which are not in the area of interest of most architects, due to avant-garde environments and the most talented architects have made extraordinary history over the past five decades.

In the 1960s, inflated transparent coatings were used by architects such as Frank Lloyd Wright or the Coop Himmelb(l)au, Archigram, Haus-Rucker-Co and Utopia groups as manifestos calling for the construction of a different kind of city and a new social organization on the wave of a new counterculture. They allowed architects to dream of a new type of mobile homes, workplaces, or entire cities. Suddenly the main obstacle to the free shaping of architecture, mass, and weight evaporated, and the main building material became air. At the 1970 Expo in Osaka, the US pavilion without any supports extended over a distance of 139 meters. Architects such as Buckminister Fuller and Frei Otto then considered enclosing huge surfaces under a thin layer of material, thus creating new ecosystems. The transparent layer of plastic defined a completely new type of border that the architect sets out between the space he creates and the external environment, this border has never been so thin and enigmatic before. Since the 1960s, many spaces have been created, such as Pillow Ant Farm Group, inflatables from Anish Kapoor, Oase No. 7 project by Haus-Rucker-Co, or Dreamspace from Maurice Agis, adapting to external conditions and creating unprecedented spaces affecting all senses. Such varied designs affecting their users in so many ways and stimulating the imagination of so many world-class architects were undoubtedly one of the most interesting architectural innovations of the second half of the 20th century.

A short but rich history proves that pneumatic architecture has nothing to do with infantility. The fact is that it has often made dreams come true. Over the past 50 years, inflatables have been used by architects to realize their dreams of construction of unprecedented flexible and light forms. In addition,

after a thousand years of dreams of flying, it was the inflatables which allowed human species to soar into the air in hot air balloons. In the twentieth century, they allowed the construction of airships and even walking on the moon in a NASA inflatable suit.

In recent years, another application for pneumatics has appeared, namely soft robotics. As the name suggests, this involves creating robots without elements typical for mechatronics and using only air compartments, pumps, and valves. The principle itself is very simple and it allowed me to create prototypes of interactive touch-sensitive objects by using a pressure sensor and responding to the presence of people nearby thanks to the use of a supersonic sensor. The construction of prototypes using open software and open hardware of the Arduino boards was for me an incredibly informative experience, during which I gained the basics of programming in C ++ and electronics. However, I must write that my prototypes, although satisfactory, mainly present the potential of using electronics in shaping responsive architecture. However, I didn't spend much time prototyping models that would allow me to better understand the physical properties of materials. However, I remain an optimist and I hope that soon (despite the limitations related to the COVID-19 epidemic) I will be able to develop models providing feedback on this matter.

After gaining knowledge about the various types of possible interactions between the user and the object, after gaining experience in simulating and prototyping and after the final choice to use air as the main building material of my responsive objects, I just had to choose the location of the project. Inflatables, if they are not located in an open space, fill in any form of their surroundings, creating a kind of relationship between the volume and the surroundings. This is analogous to the relationship between the user and his environment, here an inflatable object. Pneumatic architecture is usually a temporary architecture, created for a specific function and sometimes even for the needs of only a single event. As I noticed, it stands in complete contrast to the empty structures often being the heritage of the industrial age. Blown architecture stands in sharp contrast to the functionless post-industrial architecture. Unlike, for example, monuments of the Middle Ages, such as churches, castles, and palaces, which are usually associated with specific figures or historical events, post-industrial structures are usually not associated with any specific event and thus do not appear in public awareness as an important place. Their numbers and universality only increase anonymity. Referring to Aldo Rossi, it can be said that pneumatic architecture can become a function following the permanent form of abandoned structures. Ultimately, my proposal was located at the train depot in Wrocław, Poland. There are a lot of such halls and other abandoned structures all over the world and there is a lack of funds for their development, therefore it can be assumed that the location chosen by me serves only as an example and the project could very well be implemented in most facilities of similar typology.