Reflection

This reflection concentrates on motivation and attitude as well as challenges and restrictions towards this research project and the gained results.

This research is divided into two main parts; Looking into the thin glass for façade application, and at the same time, exploring for smart materials as an actuator for the system. The aim of both parts is to investigate new materials and using them as a new function. Each part has its own challenges and constraints.

Thin Glass

Nowadays, Ultra-thin glass is regularly used in the electronics industry and practically non-existent in architecture. On the other hand, there is a lack of existing research studies and information on the thin glass, especially on material properties. This aspect is one of the main constraints which made us spend too much time looking for a possible reference material.

The other issue is to find the most suitable software for accurate structural simulations. Since the thin glass panel is considered to be adaptive and deflected by the smart actuator, the force for moving the panel should be exactly calculated in order to find a correct number of wires needed as an actuator. This part is so important because if the calculated force is wrong and the wires are asked to exert too much force, they will completely lose their shape memory effect. In this research, first we used Grasshopper to analyze but the results were not satisfying since Grasshopper is not a proper software for non- linear analysis in the shell structures. As an alternative to Grasshopper, we chose Abaqus software which is commonly used for crash simulation. There is the unavailability of tutorials of the software in the faculty of architecture as the software is so professional. So it took me time to learn the software by the online tutorial and get the right results.

Smart Material

The first phase of the research study is to find a type of smart material with enough potential as an actuator for the panel. This process has been done paralleled to exploring information for thin glass. For selecting the most suitable smart material, several materials were considered. The main obstacle is that most of them are new, and nobody is sure about the feasibility of them in practice. In theory, they might have the capability to move the glass, but in practice, sometimes you get different results. As an example, the Bimetals from Wickeder group in Germany have a very high thermal force in theory, but in practice, they are so fragile and not usable as an actuator.

In the second phase, the Shape memory alloy has been chosen for further analysis. Shape memory alloy could be produced in three different types of one way SMA, two way SMA and Flexinol in the market. The two-way shape memory alloy seemed to have a lot of potential for this study at the beginning, but it turned out to have some limitations. Mainly, training the material is needed, which needs specific equipment such as a furnace to heat up the material to approximately 500°C. Because of the lack of equipment and also time, we considered Flexinol for further analysis. Although Flexinol has only linear movement, it saved lots of time as it didn't need annealing.

The third phase is to test Flexinol. One of the main limits is providing electricity and the power supply. The selected diameter wire needs 4 A/second, and finding a power supply with high current was time-consuming and challenging. On the other side, applying a high current especially in case of using more than one wire for just moving a very thin glass does not seem so logical. An alternative to this approach is to apply a lower current in a longer duration to save electricity. The problem with this approach is that the wire does not work in a lower current and a longer span of time. Unfortunately, there is no research study on this material and its application in different current and voltage with different reaction time. So, everything had to be tested carefully in order to find the optimum performance of the wire.