

Reflection

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Thesis title: Adaptive Façade Design for the Regulation of Visual Comfort

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The conclusion of this graduation project results in a product, but also more generally it can serve as guideline on how to reduce the energy demand of an office building and at the same time increase the level of visual comfort, by applying specific design strategies and adaptive technologies. In particular, the research is the answer to multiple questions and problems that have been observed before and during the research process. Specifically, it started with the aim for searching the future trends of the adaptive envelopes under the request of the façade construction company Rollocate Group[®] and, consequently, to integrate this concept in their product with the aim for improving their technological innovation and to connect the company with potential architects' demand.

Researching adaptive facades, made clear that this concept has the benefit of taking advantage of the outdoor conditions with a bigger potential compared with static solutions. Therefore, the adaptive solution was the first requirement for the final design. Moreover, during the research phase, it was clear that these solutions have a big potential in the improvement of the visual comfort because they can relate with the daylight that is the most variable external condition that influences the visual comfort. Regulating this parameter could imply a higher level of comfort into the indoor space and at the same time a

reduction of energy for electrical lighting. Furthermore, during the research process it was clear that the solar control that influences the daylight management has also an influence on the thermal balance of the indoor space. In particular, the problem that was observed is that in many cases the adaptive (and static) solutions that regulate these two parameters usually coincide without optimizing both the factors at the same time. Therefore, the next important step, that represents the innovative aspect of the design, was to decide to obtain a unique product with the ability of regulating the solar radiation with two independent layers, each of them with a different purpose: visual and thermal control. In particular, the former aspect has a higher relevance on the project because one of the further purposes was to achieve the visual comfort of an indoor office environment by increasing the amount of daylight, reducing discomfort and maintaining the view to the outside. Moreover, a research on the façade composition and control of the adaptivity has been done to reach the optimal solution with the conclusion that the other two important strategies are to divide the façade in areas with different visual comfort goals, and to control the indoor environment with the use of sensors.

The result obtained at the end of this process is a fully glazed façade subdivided in areas, each of them composed by two layers of smart glass and

precisely one of Liquid Crystal that controls the visual comfort and a layer of Cholesteric Liquid Crystal that regulates the solar heat gain. The two layers work independently from each other and from the adjacent panels and respond to the input received from the outdoor conditions and respectively from the daylight glare perception and the indoor air temperature. The design has been validated by the simulation with a result that meets the expectations. However, the method has some limitations due to the fact that the smart glazing is a technology that has a limited flexibility in the simulation software and its properties and control strategies are not easy to manipulate. Because of this reason, two different simulations had to be done, each of them for a different type of comfort and therefore a unique and more precise result could not be achieved. Unfortunately, the result obtained in the research is mainly theoretical. It is founded on research and studies of existing products, but also on techniques that are still under development. The concept that has been followed is an idealized product that meets some challenges in practice, like the precise control of the different portions of the solar spectrum, the realization of the concept with a small amount of layers of glass and the high cost. These aspects are obstacles in the present because of the technology development level. However, it is solvable in the future and therefore the application of it is a matter of time. This can be compared with the development of the PV panels that, as other products, were not an affordable technology at the beginning, but are currently common applications.

The improvement of daylight into the indoor space and the reduction of energy demand both for lighting and cooling have an economical, environmental and social impact. Apart from

reducing the energy demand, further aspects that contribute in the environmental and economic sustainability are the systems that take advantage of the outdoor environmental conditions to increment the indoor comfort and that the product demands a low amount of electrical energy that can eventually be taken from a green source. The product would have the potential to be autonomous by the integration of PV cells in the window frame. However, this system would be more expensive than connect the façade to a separate PV panel. Furthermore, because the system requires just the application of two coatings, a further consequence is the reduction of materials and maintenance of a traditional shading system. Because of the simplicity of the technology, it is possible to apply the system as a retrofitting solution, applying the coating to existing windows, reducing the waste of the old windows. From the social point of view, the product offers the possibility to increase the level of daylight maintaining transparency and therefore connection to the outside. The quality of daylight and the view are two elements that have a big impact on the users both from a physical and psychological point of view and they help creating a pleasant work environment that reduces the stress and increases the productivity.

The advantage of this solution is the high technological performances with a little impact on the facade and almost no restrictions for the architect. Moreover, the standard solution offered to Rollecate, can become a standard product of the company, but according to the architect's requirement it can be customized with different sizes, shapes and colours, increasing the design freedom of the architect.

In conclusion, the goal of applying the future

trends of adaptive technologies to improve the visual comfort and decrease the energy consumption for lighting, heating and cooling has been achieved with the realization of a product that improves the environmental, economic and social impact of a building and covers the responsibility of building technology, in connecting a construction companies with architectural needs, technology with comfort, and, functionality with aesthetics.