Integrated Energy Design of the Building Envelope

This thesis describes the outcome of the PhD project Integrated energy design of the building envelope carried out through a combination of scientific dissemination reported through peer-reviewed journals and a wide range of affiliated projects involved in at an architectural firm. The research project analysed how the implementation of technical knowledge early in the building design process can quantify the effect of a building’s façades on its energy efficiency and indoor climate and thereby facilitate a more qualified design development.

The project was structured in the following way: 1) the importance of integrating knowledge in the early stages of design, and how it can be done; 2) understanding the façade’s typology; and 3) the complex notion of comfort.

The project touched not only on the technical capabilities and requirements governing façade design, but also the process by which it takes place. This was done by applying the methodology of Integrated Energy Design (IED) and analysing its applicability in the design of façades. A major part of the project was an actual engagement in the architectural process to test out incorporating a consciousness about energy and comfort as part of a more holistic performance evaluation.

The research project illustrates the great potential in taking passive properties into account through a geometrical optimisation inherent in the development of the architectural concept. It demonstrates that integration of technical knowledge at the early stages of design not only can qualify the geometrical processing, but also facilitate the design development of the façade. Thereby a more holistic performance optimisation can be obtained through parameters such as overall façade geometry and orientation, functional organisation, room height and depth, façade layout, window geometry and transparency, design of the window aperture, etc. Through the wide range of affiliated project involved in at the architectural firm over the course of this project, this approach resulted in building designs with an energy demand at least 25% below the minimum requirements while simultaneously maintaining high-quality indoor climate and architectural quality.

One cardinal finding from the project is that by applying engineering knowledge in a supportive way in what is usually considered the realm of architects, common ground can be established. This can ensure the full utilisation of both the inherent aesthetic qualities and the potential for improvements in energy efficiency that combine to enrich the architectural concept. True architecture should represent a holistic performance evaluation and therefore be seen as the common goal for all the professional disciplines involved in the building design process. This project also illustrates the importance of understanding the interdisciplinary collaboration between engineers and architects. Contrary to the traditional notion that the building’s performance is determined by the architect’s first sketch on a napkin, to a great extent it is already determined by the building’s context and the building programme. This places great responsibilities on the shoulders of both engineers and architects in the critical first phases of design.

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