



**Responsive Building Skin Environmental Efficiency
(An Appraisal using Digital Mock-up)**

A Thesis Submitted to the Architectural Engineering Department
Faculty of Engineering – Alexandria University
In partial fulfillment of the requirements
for the degree of
Doctor of Philosophy
In
Architectural Engineering

By

Mohamed Mahmoud Mohamed Ali Elfakharany

October 2017

ABSTRACT

Innovation in the field of responsive architecture as a whole is depending on the success of that system to respond to different external stimuli, achieving the goal of responsiveness and covering the effort and energy used in the process. Enhanced by the achievement in the field of digital simulation has its great effect on the exploration and the evaluation of such a new trend, enhanced by other technologies such as the linking of GPS data to computer software and the enhancement of the weather data provided to the computer.

The main objective of the thesis is to provide a methodology to help architects examine the possibility of using the responsive building skin in achieving energy efficiency, this methodology depends on the idea of digital simulation in the early stages of the design process.

The research begins by presenting an overview for the main theories and concepts of integrating responsive building skin systems and the benefits from implementing them in different building types explored through various examples. Then it proceeds to explore the lighting design considerations for a specific building type which is educational buildings, then an introduction to the main concepts of energy modeling simulation and the capabilities of the available software and the opportunities they offer.

The thesis proceeds to investigate a number of architectural applications, where the buildings inherit the characteristics of being responsive and interact to different types of stimuli with different types of motion to achieve different goals, mainly energy efficiency. then the research discuss the categorizing of different types of motion and responses achieved by the examples, offering a vocabulary from which architects can explore different ideas and possibilities. The thesis also shows the role of building façade to achieve energy efficiency as a medium separating the inside of the building from the external environment. It also, pays attention to the important role of the responsive building skin in regulating different aspect along the day as they fluctuate in response to external stimuli.

The thesis consequently investigates the main factors to which a responsive façade can respond and alter its form, as a result the research finds that the sun is the main factor affecting the building either directly through light and glare or indirectly through heat and plays a major role in the aspects of human comfort, then the research represents the main hypothesis of the research; by depending on the sun position as the main motive for manipulating the responsive building skin, and assuming that this approach will boost the energy performance of the building.

Then a process for evaluation of the proposed responsive system is discussed, as using a visualization technique then an energy modeling simulation to verify the efficiency of the responsive system. Finally, the thesis attempt to apply the methodology and the evaluation process through the energy modeling simulation on a case study for an educational space in an educational building. Then a set of conclusions and recommendations are proposed for future research fields and related problems and exploring new methodologies to compare them with the proposed in the thesis.
