The Role of Human Factors Engineering in Designing Interactive Metal Facades

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Introduction

The rapid development in modern digital technology has influenced all life aspects; and its impact has reached the arts of architecture and design. As interactivity has been introduced to architectural application; the advanced materials and techniques is redefining the relation between architecture and the physical world; especially in the fields of buildings claddings and facades.

Facades nowadays effectively respond to the internal and external effects of the environment; in what is known as “the intelligent behavior”, which ensures that these facades can react to the different environmental effects through the information fed into it by computer systems.

As every design is adapted to serve the human beings; human considerations are always taken into observance as a main factor that targets the compatibility of these systems with human characteristics, in order to achieve both comfort and ideal performance. Therefore; the inclination to develop a smart metal coating; which is based on the integration of all features conducted by the traditional building facades; in one advanced and compound cover, is a fulfillment of human factors engineering objectives, which are to study the human characteristics; and design an environment suitable for working and living; that respond to these characteristics.

Because the façade is the first indication to the nature of any building; designing an interactive metal façade, that respond to the environmental effects; and comply with the considerations of human factors engineering; in terms of adapting to the needs of the building users; is considered a fulfillment of the successful artistic and functional design.

Therefore; this research discusses the role of human factors engineering in supporting the process of designing interactive metal façade, through an analytical inductive method.

Problem

The problem of this research emerges from the following points:

- The insufficiency of utilizing the human factors engineering in designing interactive metal facades.
- The need to develop a proposed design methodology, to create interactive metal facades that conform to the characteristics of human factors engineering.

DOI: 10.12816/mjaf.2019.13077.1175

Objectives

1- To emphasize the importance of human factors engineering; as a design determinant of the expressive and functional formation aspects; in designing interactive metal façades.
2- To develop a design methodology based on the utilization of human factors engineering, to design interactive metal facades.

Methodology

The research adopts the analytical inductive method.

The research aspects

In order to achieve its objectives; the research was based on the following aspects:

First aspect: The general features of interactive metal facades

In the case of designing interactive metal facades; modern interactive architecture tends towards substituting new design values that are compatible with the demands of this era; the era of renewed knowledge and digital informative environment that controls this knowledge. In short; it is trending to abolish the traditional Euclidean principles, and shifting towards formative formulations to design interactive facades that defy the laws of gravity, and are full with dynamic contortions and deviations, in order to immediately respond to the demands of the user, with an instant responsiveness between its design elements to any effects; whether internal or external.

One of the kinetic interactive systems in designing metal facades is the technique of interfaces, which controls the season and the transformation between the internal and external climate. This technique is based on improving the idea of using a double-layered glass, by adding another layer of rough-surfaced glass to create an air gap and adding solar control elements; such as breakers and mobile air curtains; to respond to the environmental effects, by which the air flow can be controlled from upside or downside. Through exposure to the air, a simple pressure is created inside this air gap that allows the opening motion of the air curtains sheets to dispose the exhaust air, so that warm air can replace it, afterwards; the sheets regress to close autonomously.

There are four levels of interactive systems used in designing interactive metal facades: passive systems, reactive systems, autonomous systems and agent systems.

In both passive and reactive systems, the system responses to the environment are like a reflex procedure to the effects; while the environmental inputs/effects in the autonomous and agent systems go through several fixed evaluations; against the required outputs; in order to transform the objective of the interactive design from designing the behavior itself, to designing the process that lead to the required behavior. In this case, the desired outputs are part of the inputs; so the system can evaluate the ideal performance and execute it to reach the desired behavior.

Second aspect: The reflection of human factors engineering on designing interactive metal facades

The human factors engineering is one of the sciences that were developed in response to the human need to design and develop products for the human beings through the available techniques. This branch of knowledge includes both engineering and cognitive psychology, as

on one hand; engineering is concerned with anthropometry and the working environment, while on the other hand; the cognitive psychology is concerned with studying the human behavior in light of the internal psychological and mental processes that drive humans to a certain behavior; human factors engineering is also called “ergonomics” in some countries.
The relation between the human factors and interactive metal facades design is based on the correlated effect of both of them. The human factors is concerned with defining the negative impact on the human being and how to avoid it; while the process of designing interactive metal facades focuses on achieving a changing reaction that is based on the type and size of the effect, thus; the need to create responses consistent with the human beings, that achieve their comfort inside the establishment; in which the façade is the first element and protective cover.

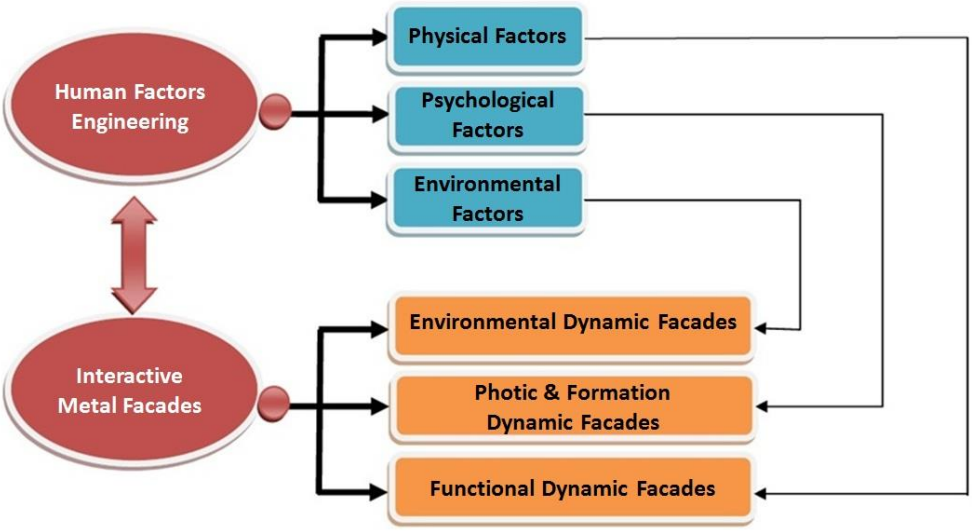
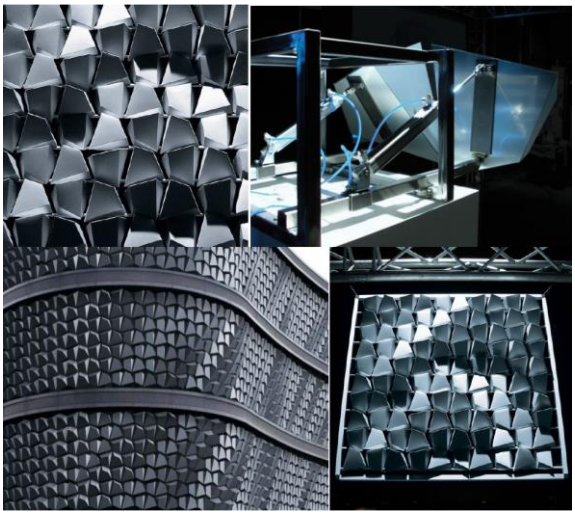


Fig. (1): The interrelationship between human factors engineering and interactive metal facades design

Third aspect: An analytical study for some examples of interactive metal facades

The analytical study in this aspect deals with the interrelationship between human factors engineering and interactive metal facades through three orientations; 1) the orientation of physical engineering factors, which represents the correlation with functional dynamic facades; 2) the orientation of psychological engineering factors, which represents the correlation with photic and formation interactive facades, and; 3) the orientation of environmental engineering factors, which represents the correlation with environmental dynamic facades, the following examples explain these three analytical orientations:
First orientation: Physical engineering factors / Functional dynamic facades

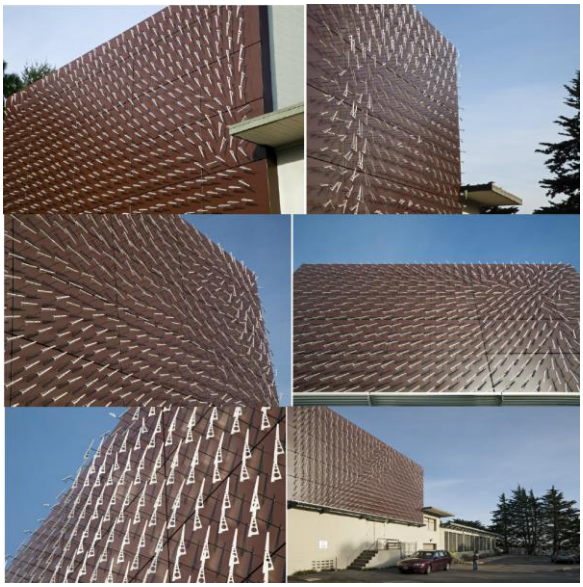


- The dynamic interactive façade using FLARE kinetic ambient reflection.

Second orientation: Psychological engineering factors / Photic and formation interactive facades

- The façade of hotel "WZ Gardens' Sao Paulo, Brazil

Third Orientation: Environmental engineering factors / environmental dynamic facades



a) Winds: The windswept façade, the outer surface of Randal museum, San Francesco

b) Shadowing: The dynamic façade of the Kiefer technical showroom

Fourth aspect: A proposed methodology to activate the utilization of human factor engineering in designing interactive metal facades

The integration and analysis of the information concluded from this aspect; in the form of a proposed methodology to activate the utilization of human factors engineering in interactive metal design; is a significant implication that confirms the importance of this research, as well as the information presented in it. The objective of the proposed methodology is to improve the methods of designing interactive metal facades, so that they conform to the considerations of human factors engineering from their very early stages.

The proposed methodology aims to reach multiple design solutions, by providing a scientific base and sequential methodological steps; which consists of four main phases, which are:

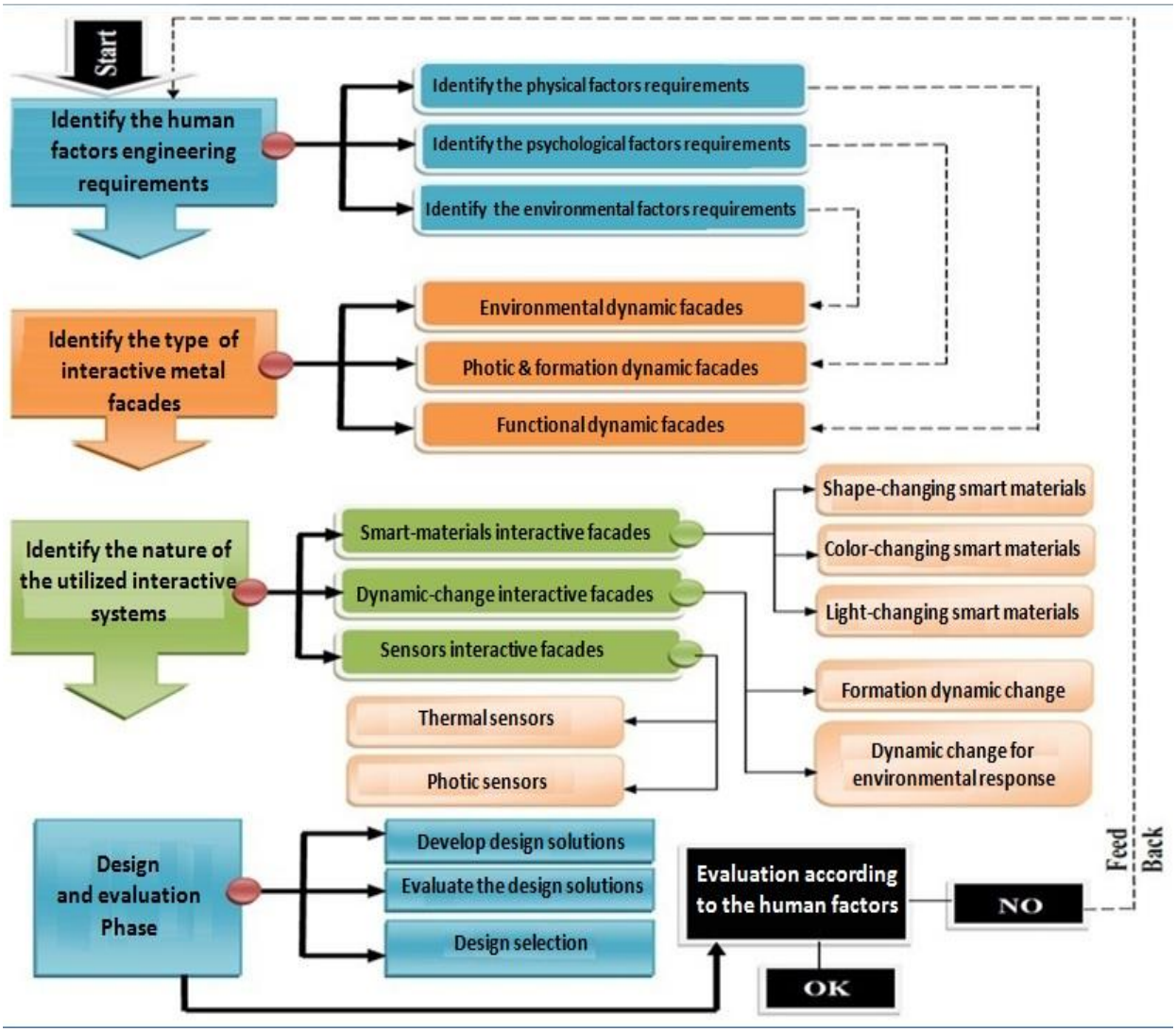


Fig. (2): The proposed design methodology

Conclusions

1- The research managed to provide a proposed design methodology to create interactive metal facades, that comply with the characteristics of the human factors engineering; and can develop a physical interaction between the interactive metal facades and the user, thus; create a three-dimensional change in all the units of the interactive metal facade, as a result of responding to the external environmental effects; such as sound, movement, light and temperature, so that active design formations are created due to the re-arrangement of its units.

2- The relation between human factors and interactive metal facades design is featured in the manner of the inter-relationship between them; as human factors is concerned with identifying the negative impact on humans and how to avoid it; while the process of designing interactive metal facades is concerned with achieving a changing reactions according to the type and size of the effect; thus the need to achieve responses that are consistent with the human beings and achieve their comfort inside the building; in which the façade is the first element and protective cover.

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