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A Study on the Interaction Envelop Design through Ned Khan's Works

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Abstract

Since the problem of global warming has occurred in modern times, various countries in the world have implemented various policies for energy saving in buildings, and the building envelope in the aspect of eco-friendly subject called energy consumption and preservation in consideration of natural environment is being revitalized.

Therefore, the purpose of this study is to analyze the concept and form of interaction envelope design applied with natural elements, which could change according to energy saving and surrounding environments, which have become issues currently. This study also aims to examine the envelope technical elements where interaction design is applied through the analysis of Ned Khan's interaction envelope cases using natural elements in this study. In the building envelope, aesthetic elements are no longer emphasized in the interaction aspect and the function to satisfy both the demands of people and energy saving at the same time is carried out in energy saving aspects. The type of building envelope applied with interaction is classified into 3 elements, including graphic element, media façade, and phenomenon element, and either artificial or natural elements of the phenomenon element. Natural elements were appropriate when the aspect of energy saving was emphasized in the modern times. The purpose of this study is to draw technology elements of applicable interaction design when carrying out the interaction design through such analysis.

Keywords: *Interface Design, Interaction, Building Façade (Skin), Sustainable, Ned Khan*

1. Introduction

1.1. Background and Purpose of Study

It was difficult to classify the boundary between the structure and envelope precisely in pre-modern buildings so that the structure and envelope were comprehensively defined and the concept of building envelope was not separately defined in architecture. After the Industrial Revolution, the aesthetic quality of building envelopes was emphasized by users according to the appearance of various building materials and the development of construction methods. As a result, the boundary between the structure and building envelope became so vague that building envelops started to be made with elements, which can change according to the surrounding environments, not the fixed elements in the past.

Also, since the problem of global warming has occurred in modern times, various countries in the world have implemented various policies for energy saving in buildings,

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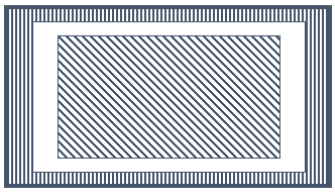
and the building envelope in the aspect of eco-friendly subject called energy consumption and preservation in consideration of natural environment has begun to be revitalized.

Therefore, the purpose of this study is to analyze the concept and form of interaction envelope design applied with natural elements, which could change according to energy saving and surrounding environments that have become issues currently, and examine the envelope technical elements in the envelope where interaction design is applied the analysis of Ned Khan's interaction envelope cases using natural elements in order to applicable technical elements when carrying out interaction designing process.

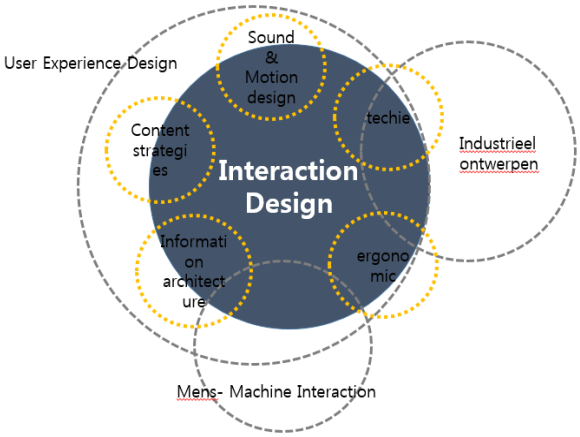
2. Relationship between Interaction Design and Building Envelop

2.1. Concepts of Envelopes and Interaction Design

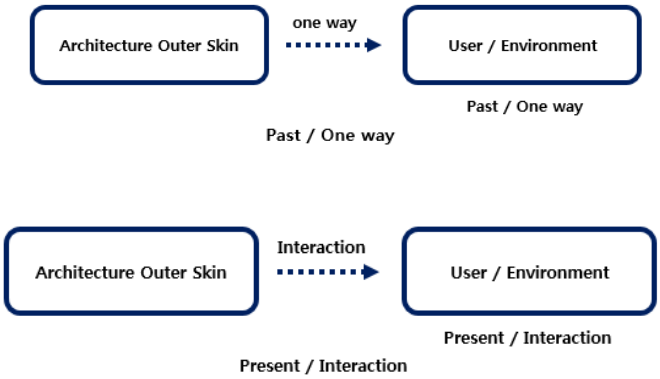
The dictionary definition of a building envelope is the ‘outer shell of a building that covers the inner volume’, indicating the façade of a building in today’s architecture with the main entrance for the building [5].

	Skin	Surface
Similarity	The concept of both elements is same in their meaning and usage	
Concepts of Image		
Concepts	Physical entity which has width	Concept of side
Meaning	Covering which covers the inside. Used to emphasize the characteristics of a certain layer as a physical entity	Method to specify the boundary of an abstract object or express according to effect of side due to the form and texture of surface

Interaction design refers to a mutual interaction between humans and products or services, mostly designing the interaction between humans and computers. Human-centered design as well as usability and accessibility are the main goals of interaction design.



With the application of interaction design in the field of building envelopes, the building envelope has become an active agent, in contrast with its previous role as a passive separator. In other words, the envelope is developing from one-way and fixed expressions toward two-way communication that perceives and responds to the surrounding environment.



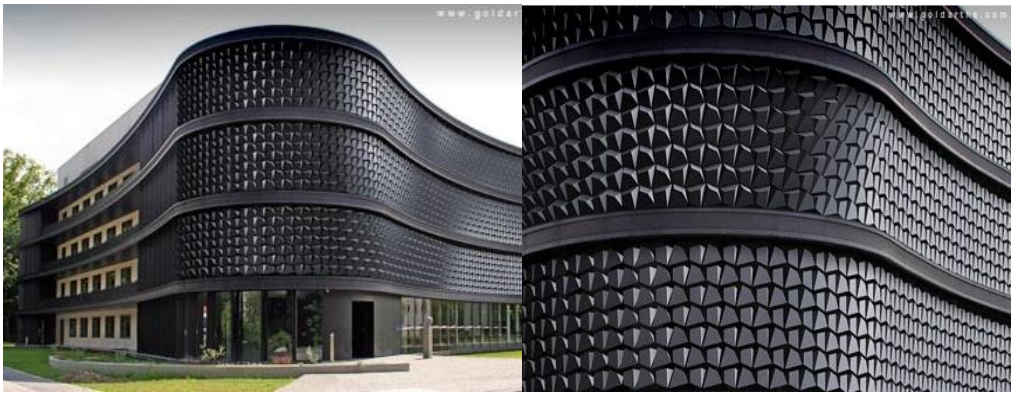
2.2. Type of Interaction Design Applied To Building Envelope

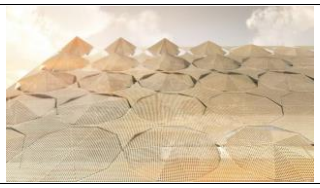
Building envelopes applying interaction can be categorized into three types: graphic element, media façade, and phenomenological element [2].

2.2.1. Building Envelope as A Graphic Element: Method that enables users to experience various façades of the building by adding graphic elements to the formerly fixed building envelope, creating a visual façade without physically changing the exterior

2.2.2. Building Envelope As A Media Façade: Method that enables mutual communication among human desires, buildings and the surrounding environment by breaking away from the fixed architecture of the past, using new media to program electronic, acoustic, and visual events into aesthetic concretization, with the electronic device acting as the main lexicon of architecture

2.2.3. Building Envelope As A Phenomenological Element: Method of building envelope that changes while enabling practical expressions by surrounding environment or context, classified into artificial and natural elements



Type	Case	Feature
Artificial elements	 Umbrella facade designed for Shanghai complex	Method in which the envelope responds to the external environment by programming the inner sensor according to the changing weather of the outdoor environment and the indoor environment of the building
Natural elements	 Blur Building, Swiss, 2002	Method in which it is possible to elicit infinite responses of the envelope toward the external environment, with the envelope infinitely responding to the external environment immediately

2.3. Summary

An envelope in architecture is a term indicating the "skin part of building which covers the inside volume", which represents the type and form of building, and the interaction acts as design that refers to the interaction with surrounding environments through use of person, product or service. While an envelope in the past was a measure by

a simple segment, a building envelope in the present times is mainly a link mode according to the interaction with surrounding environments.

Since building envelopes in the present times have advanced into envelopes which could reduce energy consumption in building and interact with surrounding environments, envelope technologies applied with interaction design are being developed, and aesthetic elements are no longer emphasized for building envelopes in the interaction aspect. The function to satisfy both the demands of people and energy saving at the same time is also being applied to the building envelopes in energy saving aspects. This is a visual design composition measure.

3. Case Analysis of Interaction Envelope Design Applied With Natural Elements through Ned Khan's Works

3.1. Analysis of Technical Elements in Interaction Envelope Design

Detailed technical elements in envelope design that apply to the interaction design are divided into management, operation, energy, communication, and external natural aspect.

First, the Building Management System decides the proper response types and extent, based on the information recognized by various sensors installed to each architectural factor by forming a system in which the building's central management office controls the buildings

3.1.1. Learning Ability: Operate in response to climate by storing data related to current climate and foreseeable climate

3.1.2. Response Type Artificial Lighting: Depending on brightness of indoor space, lighting responds to the existence of an occupant. Thus, lighting energy is automatically reduced due to automatic control of entire lighting

3.1.3. Solar Radiation Control: Data related to latitude and longitude depending on regional location is entered through computer algorithm. Through it, the sun's altitude is calculated in real-time, transmitted to the building's shading device and is operated automatically

3.1.3. Ventilation Control: Automatic control is possible through open mode devices like motored roof, windows and doors and dampers of the building envelope, which can easily be opened and closed, as a motor is used for ventilation.

3.1.4. Double Skin Façade System: Device to maximize sunshine effect and enhance energy efficiency according to adding another envelope to the building envelope.

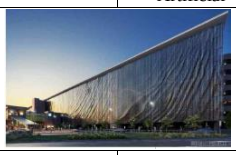
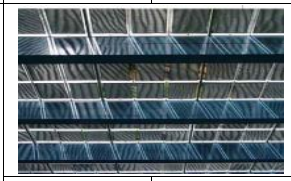
3.1.5. Interaction Façade: Use visual images as a means for communication by emphasizing mutual sympathy in relations with human, nature, and architecture and by regarding interaction as an important factor.

For detailed technical elements of the envelope design applied to the interaction design as above, a method to attach a sensor to control the inside and outside of the building is being applied mainly just as a measure of the system applied to intelligent envelopes. However, since energy consumption also occurs, it is intended to analyze only cases applied as the structure of double envelopes without additional energy consumption by applying external natural environmental elements based on Ned Khan's works, as consideration on eco-friendly envelope technology.

3.2. Case Analysis of Interaction Envelope Design Applied With Natural Elements through Ned Khan's Works

In terms of interaction, building envelopes no longer just emphasize aesthetic elements, but fundamentally approach the aspect of saving energy and thus satisfy both human

desires and energy saving at the same time. This study will analyze the interaction design of environmentally friendly building envelopes through a case analysis of building envelopes applying natural elements by focusing on the works of Ned Kahn, an environmentally friendly architect and writer.

Ned Khan's works	Important factor technology		Feature
Mare Indurum			This is a double-skin structure that forms the building envelope using the natural environment, and reflective shapes of each module appear due to the influence of the reflection of light and wind on thousands of mirrors arranged between glass layers on the envelope.
	Application factor	Natural	Wind, Water, Light
		Artificial	-
Kinect artwork for Brisbane airport			It is a façade of the short-stay car parking lot that shows different forms of envelope depending on the reflection of sunlight, as the aluminum panels sway in the natural element of wind.
	Application factor	Natural	Wind, Light
		Artificial	Mechanism: hinge, Aluminum panel
Vertical canal			Thousands of small and clear plastic panels are hanging on minimized thin stainless steel cables to endure the wind in order to express a transparent, horizontal, and flat water-shaped plate. In this way, light is reflected depending on the movements caused by the wind, diversifying the expression of colors on the façade.
	Application factor	Natural	Wind, Light
		Artificial	Mechanism: Transparent Plastic
Wind silos			Steel disks that respond to the wind are hanging and moving up and down by inserting a metal screen on the exterior wall of the parking lot, inducing external reactions through the changes of the façade.
	Application factor	Natural	Wind, Light
		Artificial	Mechanism: Steel disk
Fragmented dunes			Panels moved individually by the wind are perceived differently according to the direction of the wind and the visible distance, and the shadows created by the sun as it passes through the screen are projected on the floor and bottle, enabling the interior and exterior to interact with each other.
	Application factor	Natural	Wind, Light
		Artificial	Mechanism: Steel disk
Technorama Facade			The front façade, consisting of thousands of aluminum panels, moves by the wind, changing the surface of envelope, so that the user can experience various facade features of the building.
	Application factor	Natural	Wind, Light
		Artificial	Mechanism: Plastic

Building	Component							
	Natural elements				Artificial elements			Structure
	wind	Water	Light	Fog	Program	User	Mechanism	Double Skin
Mare Indurum	O	O	O	-	-	-	-	O

Kinetc artwork for Brisbane airport	O	-	O	-	-	-	hinge, Aluminum panel	O
Vertical canal	O	-	O	-	-	-	Transparent Plastic	O
Wind silos	O	-	O	-	-	-	Steel disk	O
Fragmented dunes	O	-	O	-	-	-	Steel disk	O
Technorama Facade	O	-	O	-	-	O	Plastic	O

Ned Khan's interaction envelope designs were mainly combined with artificial and natural elements as building envelopes. Since the aesthetic elements are no longer emphasized for building envelopes in interaction aspect and the function to satisfy both the demands of people and energy saving at the same time is applied to the building envelopes in energy saving aspects, building envelopes could bring unlimited and immediate responses to outside environments, enabling occupants and outside users to experience various facade features of the building. Also, natural elements were mainly used and the envelope had the structure of double envelope, using two layers to block energy loss and incoming heat from the outside, enabling indoor energy saving in the building.

The result of the case analysis showed that wind and light were mainly applied as natural elements, and various facade features of envelope were expressed only through light and wind that changed according regional conditions and characteristics, and not variable elements such as water and fog, while the stability from outside impacts was secured by using materials with small load for the material of envelope

3.3. Summary

As a result of considering technical elements in interaction envelope design, a method to attach a sensor to control the inside and outside of the building is being applied mainly just as a measure of system applied to intelligent envelopes. However, since energy consumption also occurs, two layers as the structure of double envelope were applied with only outside natural elements based on Ned Khan's works to block energy loss from the envelope and incoming heat from the outside, enabling indoor energy saving in the building without additional power consumption. Wind and light were applied as natural elements from the outside to show various facade features of the envelope, and material with small load was used for the material of the envelope to secure the stability from the outside effects

4. Conclusion

The purpose of this study is to analyze the concept and form of interaction envelope design applied with natural elements, which could change according to recent issues of energy saving and surrounding environments, and examine the technical elements in envelope where interaction design is applied through the analysis of Ned Khan's interaction envelope cases using natural elements in order to applicable technical elements when carrying out interaction designing process, and the following conclusion was drawn from the result of the case analysis.

First, since building envelopes in the present times have advanced into envelopes which could reduce energy consumption in building and interact with surrounding environments, envelope technologies applied with interaction design are being developed,

and aesthetic elements are no longer emphasized for building envelopes in interaction aspect. The function to satisfy both the demands of people and energy saving at the same time is applied to the building envelopes in energy saving aspects.

Second, two layers of the structure of double envelope were applied with only outside natural elements based on Ned Khan's works to block energy loss from the envelope and incoming heat from the outside, enabling indoor energy saving in the building without additional power consumption.

Third, the structure of double envelope was used but the weight of envelope was reduced structurally to secure the stability of building from the outside, and various facade features of the building were reflected through the interaction with natural elements due to lightweight materials.

The modern interaction envelope design has been developed into an envelope design where the interaction between the inside and outside of the envelope is possible. However, in Ned Khan's case the interaction envelope design was applied with natural elements, and only the facade property of envelope as reaction to the external environments was emphasized. In order to enable interaction between the inside and the outside of the envelope based on the pure concept of interaction design, technical elements of intelligent envelope for the condition of occupants and outside conditions should be introduced partially, while internal and external controlling of building by some sensors for energy saving are necessary.

A study focusing on the interaction envelope design to carry out interaction through internal and external controlling, not the design to display external reactions, should be carried out in future since natural elements as well as intelligent element technologies will be introduced to the interaction envelope design based on the previous studies.

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