



The impact of dynamic movement on the development of Sustainable architectural formations

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ABSTRACT

The dynamic movement has emerged as a result of technological advancements, and it has an impact on all aspects of daily life. It affected buildings in general and architectural formations in particular. While architectural formations evolved from fixed determinants to new dynamic, and adjustable architectural formations resulting in numerous transformations via architectural formation concepts, Therefore, the research aims to review the impact of dynamic movement on architectural formation through a comparative analytical study between the means, patterns, and methods of general architectural formation and dynamic architectural formation, in order to formulate a framework for the impact of dynamic movement on the development of sustainable architectural formation and to understand its data and its positive and negative aspects. The study concludes with a set of conclusions and recommendations from the researcher on how to use dynamic movement in the development of sustainable architectural formations.

Keywords: Sustainable Architectural Formation, Dynamic Forming, and Dynamic Motion component, Adaptive Façade.

1. Introduction

An architectural formation is a process in which the designer proceeds using visual vocabulary as basic elements and design principles to transform them into blocks and spaces with a specific system. Changes in the means, methods, and patterns of architectural formation. Hence, it becomes clear to us the importance of research towards opening new horizons to study the extent of the impact of dynamic movement on architectural formation in order to achieve an environmentally sustainable architectural formation. as shown in **fig (1)**. Architectural work is made up of a material that forms its surface and defines its spaces; this material can be natural or artificial, with a soft or rough texture, that the architect employs as he sees fit, so that it has a color, whether in its mass or covering its surface, and light is required to demonstrate its vitality. [1]

These means have a great role in conveying the idea of the architect to the viewers of the building, and the means of dynamic formation include the following: material (natural, artificial)-texture-layout-color-light (natural, artificial). artificial)-texture-layout-color-light (natural, artificial) .

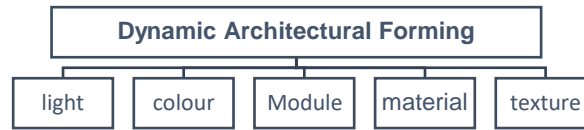


fig (1).Dynamic Architectural Forming

A-Research problem

The research problem is to explore the extent to which dynamic movement affects the development of architectural formations and how it affects the achievement of an environmentally sustainable architectural formation that combines the aesthetic aspect and the environmental functional aspect. Maintaining the Integrity of the Specifications.

B- The significance of studying

- By actually analyzing a number of crucial issues, it is possible to understand the significance of the study
 - How the dynamic movement contributed to the creation of sustainable architectural formations.
 - Research on dynamic mobility and how it affects the development of architecture
 - Dynamic Architectural Configuration: Dynamic Formation Patterns, Relationships, and Techniques
 - A comparison of the resources, patterns, and techniques used in the construction of static and dynamic architecture
 - creating a framework to analyse how dynamic mobility affects the growth of sustainable architectural formation.
- Dynamic movement and its impact on architectural formation The modern dynamic movement has provided an opportunity for renewal in architectural formation through the emergence of dynamic and adjustable architectural

Fig.2 the significant impact of dynamic movement on the development of architecture

formations, which have had a clear impact on the means and concepts of architectural formation. The following

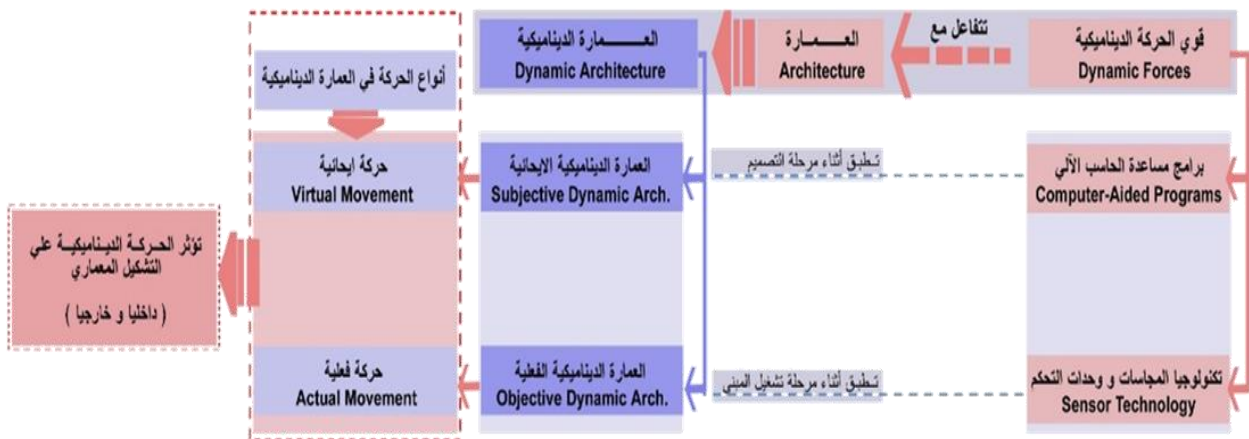


figure shows.the significant impact of dynamic movement on the development of architecture fig (2).

source : the researcher

2. Dynamic Architectural Forming

The study investigated various building types as instances of dynamic development and its impact on form. The goal of the research is to determine how much dynamic movement influences the growth of architectural formations and how it affects the creation of an architectural formation that combines the functional and aesthetic aspects of the environment.

2.1. The effect of materials on the architectural form

2.1.1. The material is in the general formation

- a. The figurative expression varies accordingly Due to the difference in the material used in architecture, either in its natural forms such as stone and wood, or it undergoes partial modifications in its appearance such as bricks, or becomes manufactured such as iron, glass, cement, ceramics, and others. [2]
- b. In order to obtain the best plastic results using the material, the architect must be familiar with the technology of his time in order to put it in a place that achieves its goals.

The article is divided into two parts:

- A natural material extracted from the earth, such as marble, or one derived from plants, such as wood.
 - A manufactured material with a more uniform texture and colors, such as iron or glass.
- C. The effect resulting from the use of the material varies according to the different treatments that were carried out on its surface.

2.1.2. The material is in the Dynamic formation

- a. Materials that are used in the formation of dynamic architecture must have certain properties:
 - Flexible and configurable
 - Simple to change and replace
 - Lightweight and long-lasting
 - The ability to adapt and transform in response to changing conditions.
 - Intelligent in the sense that it can be controlled remotely.

b. Types of smart materials used in dynamic architectural formations:

- Materials with the ability to move independently
- Materials that have been combined with motion control mechanisms such as (remote sensors and sensors; automatic actuators; microcontroller units).

2.1.3. EAP: Electro-active polymer

Among the smart materials used in dynamic architecture are: EAP, which stands for electro-active polymer. [3]An electrically active polymeric material, which is a flexible and lightweight material that can change its shape without the need for mechanical operating units, as it is able to convert electrical energy into mechanical force. **fig (3).**



fig.3 Electro-active polymer

• E.A.P material is of high quality in dynamic architectural applications due to its high density, lightness, the thinness of size, and easy operation method. E.A.P material consists of the following:

• A thin layer of highly flexible acrylic is placed between two electrodes, and when an electric current is connected. Between the electrodes, the polymer material changes its shape. **fig (4).**

A method of contemporary form expression for dynamic buildings is the use of materials with flexible qualities in movement and the most cutting-edge and intelligent ones. **fig (5).**

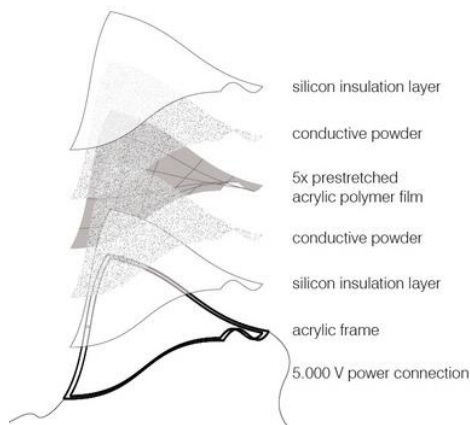


fig (4). The polymer material



fig (5). the Dynamic formation

<https://parametrichouse.com/information-materials/>

2.2. The effect of texture on the architectural form

2.2.1. The texture is in the general formation

a. The texture is defined as the set of properties that determine the surface feature, and a person recognises these properties at first sight by sight and then checks them by touch. [4]

b. The texture varies from one material to another, as well as according to the method of treating its surface, in order to serve plastic purposes.

c. The textures are divided into three types:

- A smooth texture, similar to polished marble and glass
- Textures with a medium texture, such as manufactured stone and wood.
- A rough texture, such as cloudy stone, and materials that have been treated to show roughness and heterogeneity on their surfaces.

2.2.2. The texture in the Dynamic formation

- a. In the process of forming dynamic architecture, the texture is one of the tools the architect can use to convey to the observer a certain sensation or set of emotions he wishes to elicit in the building. [5]
- b. Since the building's surface might alter multiple times due to the shifting movement of its outside surface, the dynamic direction aided to contrast the texture of the building.

2.2.3. Flare Façade

The roof of the building consists of regular units that move mechanically in more than one direction and in a way that gives more than one appearance to the building envelope, which helps to control the external texture of the building.

fig (6).

The roof of the building consists of regular units that move mechanically in more than one direction and in a way that gives more than one appearance to the building envelope, which helps to control the external texture of the building.

The dynamic development of the building envelope: [6] when a person touches the structure, he feels another different feeling, and this is what the architect intended from the dynamic formation of the building envelope. fig (7).

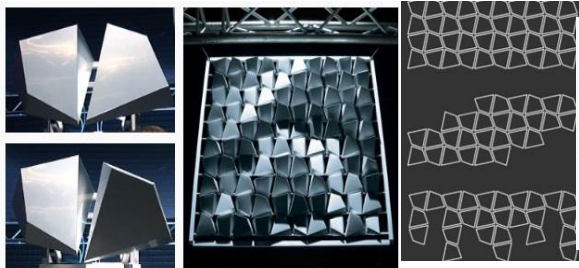


fig (6). Flare Façade
www.flare-facade.com



fig (7). Kinetic Building Envelopes
www.flare-facade.com

The dynamic building envelope's changing movement contributes to the surface's ability to change textures. [7]

2.3 The effect of the planning on the architectural form

2.3.1. The planning in the general formation

- a. Layouts or divisions on the surface of the building are intended for a specific visual phenomenon, such as making the building appear smaller, larger, longer, or wider than its normal size, to increase the sense of scale or deception, or to emphasize a certain element in the building. [8]

2.3.2. The planning in the Dynamic formation

- a. Dynamic architectural works depend on modifying the dimensions of buildings to display dynamic layouts on their façade.
- b. The dynamic architecture uses the shifting movement of the layouts on the moving building surfaces to express form.

2.3.3. THEMATIC PAVILION EXPO

- Using flexible materials for exterior cladding allows for dynamic facade planning, which is a division of dynamic architecture (with non-fixed dimensions).

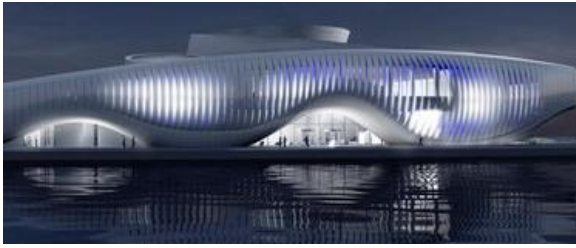
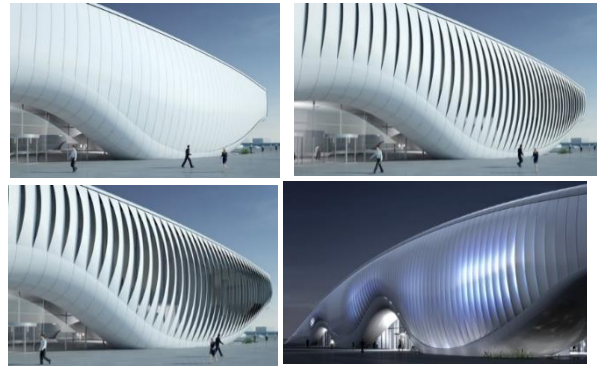


fig (8). THEMATIC PAVILION EXPO

<https://www.iaacblog.com/programs/parametric-skin/>



Using flexible materials for exterior cladding allows for dynamic facade planning, which is a division of dynamic architecture (with non-fixed dimensions). **fig (8).**

2.3. The effect of colors on the architectural form

2.3.1. The colors in the general formation

a. Since matter and light have an impact on the type and intensity of the colors employed, color is not a separate element from the other tools used to create architecture. [9]

b. Depending on the color utilized, the building's hues have a different impact on the spectator.

2.3.2. The colors in the Dynamic formation

a. The use of varying colors on the facades of dynamic buildings plays a significant role in the architectural formation, has a beautiful visual effect, and helps to clarify the concept of movement in the dynamic architectural formation.

b. The use of color aided in the immediate perception of architectural structures.

c. The alteration of colors on the AI-exterior surfaces has a favorite impact on the viewer's emotions and psychology, giving him a sense of a different ambiance in the same location and increasing his desire to connect with the building closely.

2.3.3. Media Façade of Lanchid 19 Design In Budapest

The hotel's facade's shifting colors serve as a means for both aesthetic quality and material expression, as well as a stylistic feature.

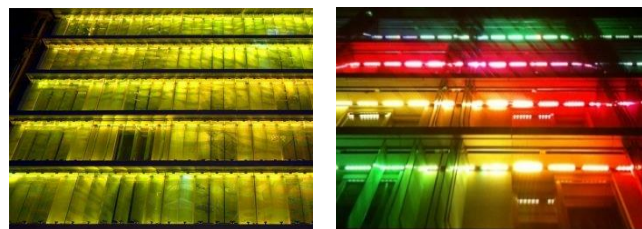


fig (9). Media Façade of Lanchid

<https://facadelight.com/lighting-a-building-exterior-secure-efficient-well-designed/>

The changing colors on the interfaces Buildings act as an effect to accentuate movement in a dynamic architectural building. **fig (9)**.

2.4. The effect of light on the architectural form

There are two categories of lighting in buildings:

both natural and artificial lighting[10]

2.4.1. The light in the general formation

a. Natural light

Its source is the sun, and the atmosphere's condition affects how it functions.

The movement of the sun on the facades of buildings and different blocks affects the process of architectural creation, necessitating research of the sun's movement and the selection of appropriate materials and forms by the architect. [11]

The impact of natural light is reflected in the interior design as well, and the architect can use the quality of light and the transparency of white or colored glass to breathe some life into the various spaces' interior designs.

b. Industrial lighting

It is either external lighting for roads, building sites, or building facades to obtain special architectural formations and expressions during the night or internal lighting for different spaces.

In general, industrial lighting is divided into:

direct lighting: using visible lighting units

- Indirect lighting is achieved by concealing the light source.

This method forms a homogeneity of light that results in the appearance of shapes, where the shadows almost fade.

- Combining the two cases: providing indirect general lighting while focusing direct lighting on specific elements.

Here we find a source of enrichment for toning and a springboard for the architect's imagination.

2.4.2. The light in the Dynamic formation

a. Natural light

- **Outside the building:**

- Lighting plays an important role in the architectural formation of dynamic buildings, where natural lighting highlights the movement of the architectural form through the changing contrast between shadow and light.

-The movement of the sun helps the dynamic facades in their permanent expression of movement and vitality.

• **Inside the building:**

-The effect of natural light on the interior design enables the architect to take advantage of the building's dynamic movement to obtain the desired effects within the space.

-The changing distribution of natural light in the interior spaces creates a dynamic interior space.

b. **Industrial lighting**

-The use of variable artificial light on the dynamic rooftops of buildings, intended for a formative effect, speed in people's perception of the building and helps the architect to clarify his dynamic plastic style. It also achieves sometimes enables people to interact with the building through those light expressions.

-The method of directing artificial light in a dynamic way on the roofs of buildings gives different effects that have a good effect on the viewer, which makes him feel the thrill and attraction to explore the building and interact with it.

2.5.3. Lighting façade building examples

1. Adaptive Façade

-The interactive movement of the building envelope with the direction of the sun shows the change in the position of the shadows in each changing movement, which shows the importance of natural lighting in showing the dynamic architectural formation.

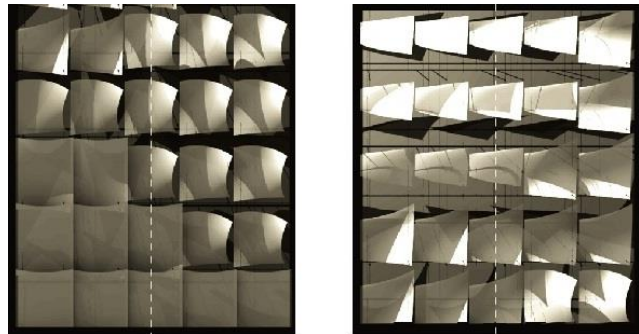
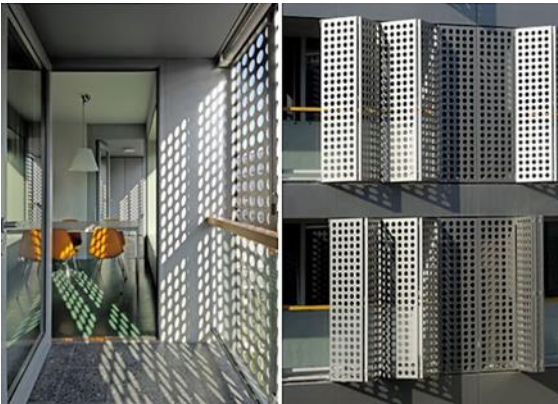


fig (9). Adaptive Façade

<https://www.malnguyen.com/intar1.html>

fig (10). Ljubljana University designed

<https://www.alamy.com/stock-photo/mediacom.html>

A. Ljubljana University designed by Bevk Perovic Arhitekti

-The movement of the dynamic envelope makes the interior space capable of changing to suit all user needs for ventilation and lighting .fig (10).

-Natural light illuminates the movement of the blocks outside and adds life to the space inside.

B. Kunsthaus Building by Peter Cook & Colin Fourinier

-The use of artificial lighting in this building has a clear effect in showing the architect's idea of achieving movement in the dynamic architectural formation.

-The distribution of lighting sources on the facade in a dynamic manner by making the outer shell of the building interactive so that it can be used as a formative method that displays information or displays the reality of the space inside. **fig (11).**

- Artificial lighting acts as a motion effect in a dynamic architectural building.

3. Dynamic formations patterns, linkages, and techniques

Composition is the creation of an integrated form by assembling architectural elements according to functional requirements, in a compatible proportion according to relationships and methods based on the use of logic, good behavior, and conscious flexibility. [12]

3.1. Principles of Configuration

3.1.1. The Principles of Configuration in the general formation

The configuration patterns in architecture differ according to the different points of view.

The composition is either facet or spatial.

The facial composition has two states: a two- or three-dimensional composition.

- The two-dimensional facial composition: in this composition, all form means related to the vitality of the surfaces are used, and the vision points are successive in one direction directed to one of the building's sides.
- The three-dimensional facial composition: a third dimension is introduced, as well as a sense of space, even though the composition is still facial.
- Spatial configuration: -in which the vision points are crossed at different angles around the building.

In this configuration, the organization of shapes and spaces does not appear on one level or levels of successive confrontation, but rather on several levels of different situations.

3.1.2. Composition in a dynamic architectural formation

Whether the movement is actual or suggestive, the principles of creation in dynamic architecture differ.

The spatial configuration pattern, where no organization exists between the shapes and spaces on a single directed level or facing levels, is what determines the suggestive dynamic buildings.

Through the addition of the fourth dimension, time, where the placements of shapes and spaces can be changed at any time, the actual dynamic buildings are not connected to any pattern in the composition.

3.1.3. façade building examples

a. The Seattle public library by Rem Koolhaas

-In the suggestive dynamic building, the spatial configuration pattern appears due to the lack of a clear organization between the forms and spaces. **fig (12).**



fig (11). THE ARTS MUSEUM KUNSTHAUS GRAZ, AUSTRIA
https://www.researchgate.net/figure/The-Facade-of-the-Arts-museum-Kunsthhaus-Graz-Austria-Architects-Peter-Cook-and-Colin_fig3_255704138

fig (12). SEATTLE PUBLIC LIBRARY
<http://bit.ly/1196gED>

b. Wind-Shaped Kinetic Pavilion

-It appears in this dynamic building that it is not defined by any style in the composition due to its changing movement.

-Suggestions for dynamic architecture are related to the spatial composition pattern, while the actual dynamic architecture is not defined by any type of composition.

3.2. relations in architecture in the general formation

Composition is the creation of an integrated shape by assembling architectural elements according to functional requirements and in a compatible proportion according to relationships and methods based on the use of logic, good behavior, and conscious flexibility. **fig (13)**. [13]

a. The axes determine the direction of movement inside the building, and as a result of their good distribution, a sense of order arises.

The dynamic axes system dominated the dynamic architectural works through the free movement of the spaces within the building.

-Variable movement of the dynamic spreads results in changing the positions of the axes.



fig (13). SEATTLE PUBLIC LIBRARY
<https://inhabitat.com/wind-shaped-pavilion/wind-shaped-pavillion-8/>

- OFT Transformable House by Samanta Sindaro

The dynamic spaces in this building are a system of units (spaces) that can be freely assembled or removed from them. **fig (14).**

Increasing or replacing spaces inside the building works to change the paths of movement inside the building and thus the axes of movement.

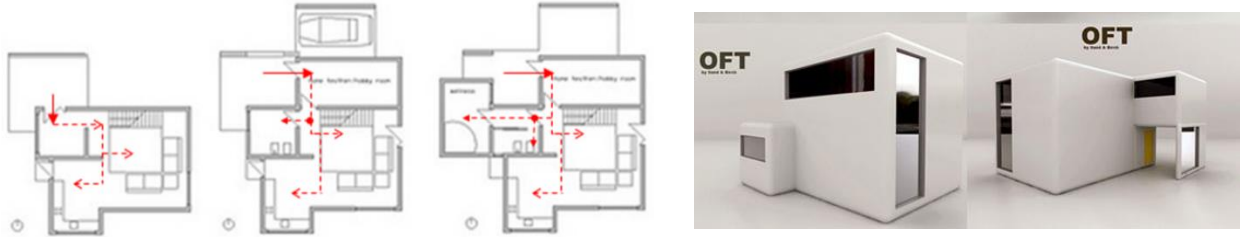


fig (14). OFT TRANSFORMABLE HOUSE
<http://www.architetturaedesign.it/index>

b. Repetition is the continuous sequence or sequence of an element, and this sequence takes several different manifestations that affect the repeated elements and the dimensions of the single element. [14]

Repetition can appear regular in most dynamic buildings and then turn into irregular repetition through the changing movement of the building and thus achieving a kind of diversity and rhythm.

- **Adaptive shading for the Ciudad de Justicia, Madrid, by Hobermann Associates**

Most dynamic architectural works exhibit repetition, which can be seen in the repetition of shading units on the facades of those buildings. But it is not possible to determine the type of repetition, whether regular or irregular because the dynamic movement of each unit is separately in a direction that affects the continuous succession of those units, hence the rhythm of the sequence of these units. **fig (15).**

- **Perimeter wall to Nordic Embassies, Berlin, designed by Berger and Parkkinen**

Rhythm appeared in the dynamic interfaces, but we find it a rhythm of a new type where it is a regular rhythm and then turns through the dynamic movement into a complex rhythm. **fig (16).**

The composition relations in the dynamic architecture achieve a new kind of repetition and rhythm.

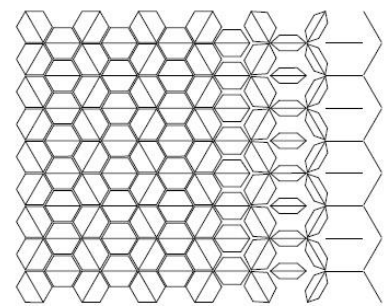
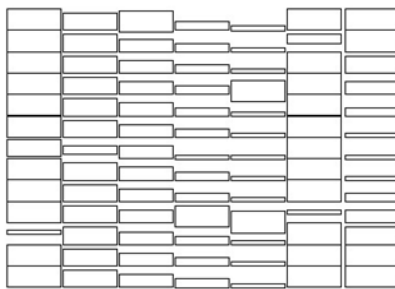
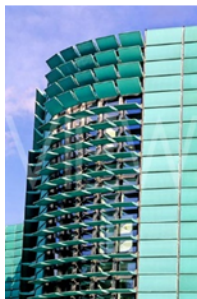


fig (15). Adaptive shading for the Ciudad de Justicia
www.nordicembassies.org

fig (16). Perimeter wall to Nordic Embassies, Berlin
<https://www.architecturalrecord.com/>

4. Results

The dynamic movement had an impact on

- 1) The methods of architectural formation
- 2) The patterns of architectural composition.
- 3) Compositional relationships and techniques

As a result of the architectural formation's influence on the dynamic movement, many positive and negative elements have emerged.

The dynamic movement can be used to create architectural formations that are sustainable and achieve a building's adaptation to the climate and the standard of its internal environment.

The creation of dynamic architectural forms necessitates the integration of construction techniques, new building materials with properties (lightweight, adaptable, etc.), and sophisticated control systems.

5. Discussion

We should consider a few of both positive and negative features that have emerged as a result of the influence of dynamic movement on the means of designs and methods of architectural formation as:

Positive features

1) The architectural formation has reached a high degree of flexibility in light of the dynamic movement due to the ability to change (shape, proportions, colours, etc.) in the construction of the external building.

2) By adding the fourth dimension (time) to the architectural formation, it is possible to create new plastic formations that are not related to any particular pattern in the composition. Additionally, the relationships between the dynamic formation relationships can be changed from regular repetition to irregular repetition and change Rhythm to a more dynamic rhythm in buildings.

3) Developing dynamic, sustainable architectural formations that can adapt to their surroundings and change as necessary to meet environmental, technological, plastic, and climatic objectives.

A) Managing (light, natural ventilation, heat, etc.) that are set in accordance with the desires of the building users, achieving the quality of the building environment and the comfort and satisfaction of those users.

B) Achieving environmental sustainability in the buildings.

Negative features

1) The high cost of dynamic architectural forms in motion is due to the employment of contemporary building materials, systems, and smart systems to manage the movement condition.

2) The necessity of routine maintenance to prevent plastic building components from moving

6. Conclusion

- Dynamic architecture has a clear impact on the means of architectural formation, as well as the renewal in the internal formation extended to the different determinants of space and the shape relations between the different spaces, and also in the shape relations between the internal space and the external space surrounding the building.
- The use of materials with flexible properties in movement and the most advanced and intelligent is a means of modern shape expression for dynamic buildings.
- The changing movement of the dynamic building envelope helps in changing the texture of its surface to more than one texture.
- The suggestive dynamic architecture is linked to the spatial configuration pattern, while the actual dynamic architecture is not defined by any configuration pattern.
- Most dynamic architectural works result in a shifting relationship between building dimensions or internal spaces and human dimensions.
- Dynamic architecture is not of specific dimensions but is variable in dimensions, as it can be increased or decreased according to its purpose.
- The dynamic interior spaces can be easily integrated into the exterior spaces through the movement of the space determinants outwards.
- There are no clear rules in the SHAPE relations between the dynamic spaces because they move freely and can also be freely assembled.

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