

The fourth dimension as an influence in the design of lighting units

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Abstract:

The fourth dimension is related to the movement as a time dimension that rejects stasis and tends to accommodate the design in various ways. Therefore, the designer can control the design elements (lines, areas, colors, patterns, and materials) in the direction of motion in the design, whether on the two-dimensional or three-dimensional level as light and shadow enter as well in it as a basis for motion. Recent trends in the design of lighting units have called for new thinking that adopts the concepts of flexibility and interactivity in performance, which achieves the highest efficiency of the product in order to further meet the user's different and changing desires. We note that the motion, whether static or dynamic, has a very important impact in making a difference in the field of lighting unit design. The connection of the fourth dimension to the interaction, which has become one of the axes of the user's needs, has largely driven interactive products that provide them with multiple uses and different designs that mimic the nature of the age and satisfy their ambition.

The research aims to find solutions flexible in the design of lighting units, through the dynamic integration between the design elements, and the integration between its materials (mineral-glass), which allows the user to interact with it and with the product depending on the nature of its functional or aesthetic needs, or both. The research assumes that dealing with the fourth design dimension in terms of its temporal and spatial philosophy enriches the formative, aesthetic and functional values of lighting units, thus enriching the Egyptian market. As a result, the research concluded that there are some design ideas that achieve interactive and flexible lighting units.

Keywords:

Fourth dimension, visual deception, interactive design, flexible design, kinetic lamps.

الملخص

ارتبط البعد الرابع بالحركة باعتباره بعداً زمنياً يرفض الاستاتيكية ويتجه إلى استيعاب التصميم بطرق مختلفة، فيستطيع المصمم أن يتحكم بعناصر التصميم من (خطوط، ومساحات، وألوان، وملامس، وخامات) في توجيه الحركة في التصميم سواء على المستوى ثنائي الأبعاد أو ثلاثي الأبعاد كما يدخل الضوء والظل فيه كعنصر أساسي لبناء الحركة، فقد دعت الاتجاهات الحديثة في تصميم وحدات الإضاءة إلى فكر جديد يتبنى مفهومي المرونة والتفاعلية في الأداء مما يحقق أعلى كفاءة للمنتج وذلك ليزيد من تلبية رغبات المستخدم المختلفة والمتغيرة. نلاحظ ان للحركة سواء استاتيكية او ديناميكية لها تأثير بالغ الأهمية في إحداث نقلة في مجال تصميم وحدات الإضاءة. كما أن ارتباط البعد الرابع بالتفاعلية التي أصبحت

من محاور احتياجات المستخدم جعلته يتجه بشكل كبير إلى المنتجات التفاعلية التي توفر له استخدامات متعددة وتصميمات مختلفة تحاكي طبيعة العصر وترضى طموحه.

لذا رأى الباحث أن مشكلة البحث تكمن في ضرورة وجود وحدات إضاءة تفاعلية تحمل فلسفة البعد الرابع التصميمية وتساهم في تحقيق احتياجات المستخدم الوظيفية و إثراء حسه الجمالي, كما تكمن أيضاً في صعوبة التنافسية للمنتجات المصرية من خلال تصميمات تقليدية لا ترقى للمنافسة المحلية أو الدولية. ويهدف البحث إلى إيجاد حلول مرنة في تصميم وحدات الإضاءة وذلك من خلال التكامل الحركي بين عناصر التصميم, والتكامل بين خاماته (المعدنية- الزجاجية), مما يتيح تفاعل المستخدم معها ومع المنتج تبعاً لطبيعة احتياجاته الوظيفية أو الجمالية أو كلاهما معاً. ويفترض البحث أن تناول البعد الرابع التصميمية من حيث فلسفته الزمانية والمكانية يثرى من القيم التشكيلية والجمالية والوظيفية لوحدات الإضاءة مما يثرى بالتالي السوق المصري. ونتيجة لذلك فقد خلص البحث الى وضع بعض الأفكار التصميمية التي تحقق تفاعلية ومرونة لوحدات الإضاءة.

الكلمات المفتاحية:

البعد الرابع، الخداع البصري، التصميم التفاعلي، التصميم المرن، وحدات الإضاءة الحركية.

Research theme:

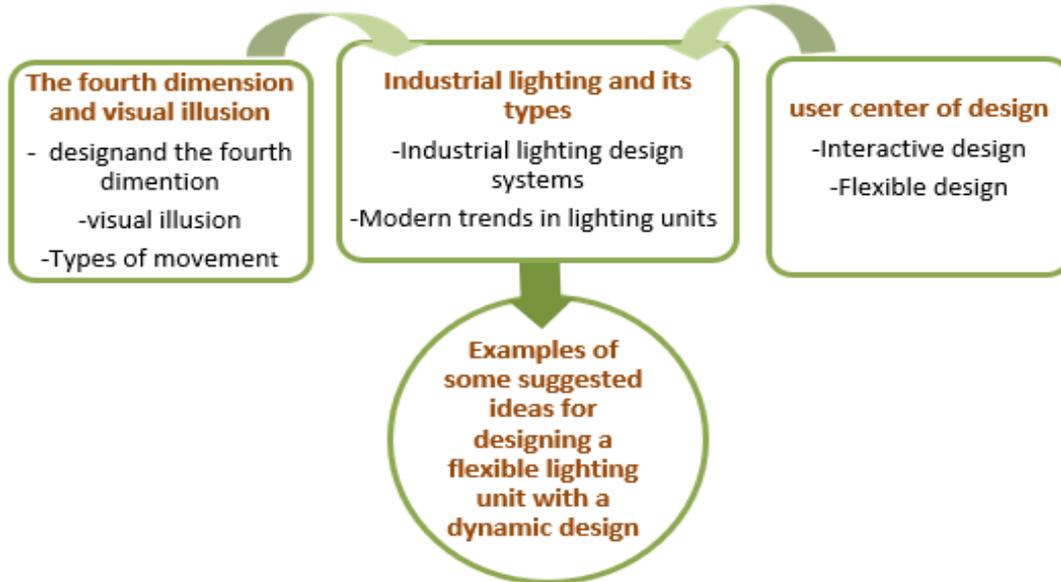


Fig (A): the research theme

Introduction:

A dimension is a physical property that is given to everything that exists, and the more numerous the dimensions, the greater the accuracy in determining the state. The fourth dimension is dynamic and is inherently a time dimension (Figure 1), adding to the design renewal and continuous movement, so the time dimension can be through the interaction of human beings with the design to add an interactive continuity of the design.

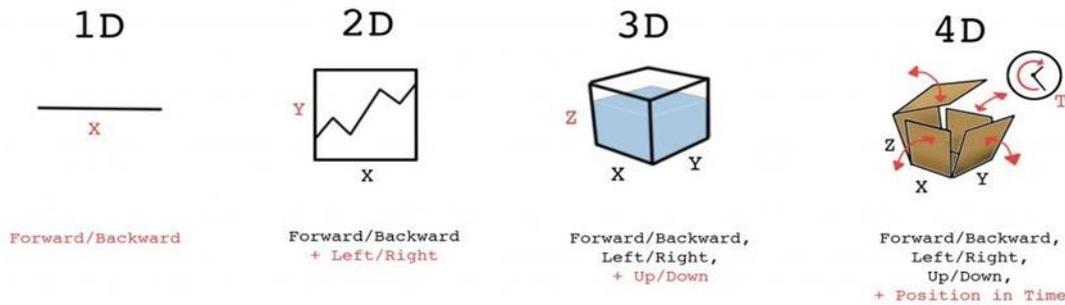


Fig (1): the fourth dimension

Dynamics is one of the crucial activities in nature, and it represents the liveliness Aspect of life, and the energy in the design means the direction that leads our eyes to perceive the design, through the formation of design and the relationship of its elements to each other; and movement is an essential part for all visual designs, and the designer can control the design elements from (lines, areas, colors, texture and materials) in directing movement in design, whether at the two-dimensional or three-dimensional level that introduces light and shadow in it as an essential element for establishing the dynamics. Interactive design is related to dynamic design through the concept of rejecting stasis and to accommodate different ways of the designation.

In light of this tremendous flow of the computer software and interaction systems, the designer has a major role in keeping pace with these variables, so the designer has to look at the needs and desires of the customer in a deeper manner. In view of these variables, it has become difficult to clearly define the needs and desires of the customer, as they constantly changes them according to the huge information flow, and this information flow has removed market boundaries, which has led to competitive challenges that are difficult to overcome

Dynamics and visual illusion:

1- Basics of design and movement

The design is based on a set of concepts and fundamentals that work together to build it. When we look at any of the designs, we need to understand the purpose of the movements or effects in the design that reflect a set of principles or foundations that may be apparent in the design in a direct or indirect way. The designers differed in determining those foundations, but they concurred on the extents of the effect added to the design.

These principles help us in obtaining an idea in which we achieve the goal of design, highlight its elements in the required form based on specific goals, such as showing the idea strongly, and always keeping it in the mind of the customer or offering an idea that shows multiple aspects presented to them, see Figure (2). When the designer perceives the basics of the design, it helps them in the planning process, design assessment and development; furthermore, it helps them in interacting with the customer and controlling the simplicity of the product.

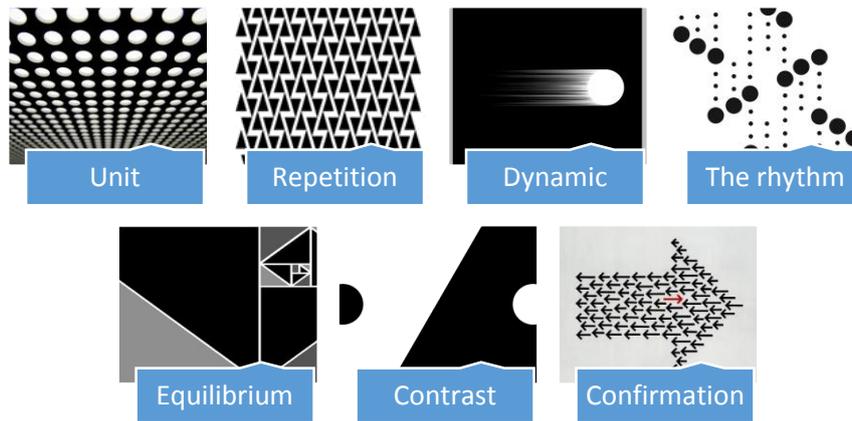


Fig (2) Examples of some basic design principles

The dynamic is one of the most important principles of the design, as it gives freedom to interact with the receiver/user to rely on change and time in the process of perception of the design and the diversity of its taste. The dynamic in the design had affected remarkably and directly with sciences and modern applications. It is worth to say that the integration of dynamics and visual illusion arts had great impact on the artistic works and recently, the contributions of the customer in tasting and evaluating the design.

2- The art of optical illusion:

Optical illusions are images and scenes made previously in a deliberate way to start first from the eye until you reach the mental perception so that the viewer imagines things that are different from what they are in reality, so the term visual illusion is defined as:

“It is the act that always depicts the visible image on the contrary of the reality and where the vision is deceptive or misleading”

This is based on the fact that the visual strength may see something contrary to what it is in reality for some occasional reasons and scientific explanation. Therefore, the information that the naked eye collects and after processing it with the brain gives a result that does not match the source or the visual element, and the art of visual deception and Optical art illusion are depending on the use of mathematical laws to create paintings that are inspiring the aesthetic values of movement, stillness, depth, and protrusion of the plate, even though they are on a flat surface. See Figure (3).

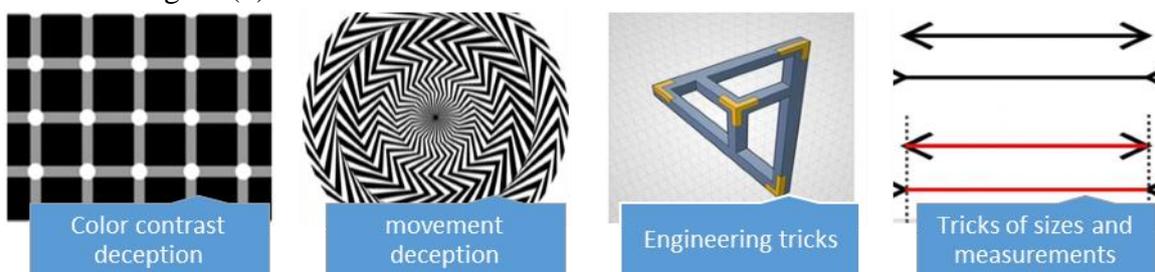


Fig (3): types of optical illusions and illustrative examples for each type.

Artist Victor Vasarely is the first founder of this school (school of optical illusion) optical art, as he was the first to present artworks that fall within the term optical art illusion or optical illusion. Victor Vasarely worked as a graphic artist in the thirties when he created what was considered the first work in optical illusion and he called it Zebra (Figure4).

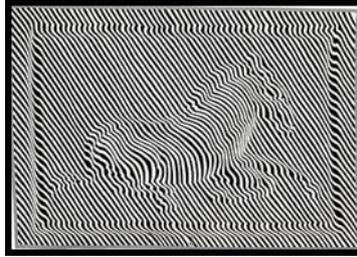


Fig 4: Optical illusion of the Zebra designed by Victor Vasarely

3- Active as an artistic direction

It is an artistic trend that emerged as a development of visual art (Op Art) within the framework of modern art, and then known as (L'art cinétique), which had been practiced partially or was paved by number of artists of OP Art. The action in the artwork is the method that achieves the success of the artistic work in a process that attracts the attention of the recipient. It raises their interest and lead them to examine the artistic work in series steps, so the artist's mission was to create a dynamic impression on the surface of the artwork by means of optical illusion; where they work on designing their paintings in a highly organized and sophisticated manner that causes deceptive illusions to the eye with movement. As the completion of the artwork depends on visual reception, so the search for dynamism is the goal of the visual artist.

- Types of dynamic art:

The path of kinetic art has taken several directions, one of which revolves around visual illusion and another that creates a movement in the vacuum with a three-dimensional and the researcher chose some of them: see the following figure (5).

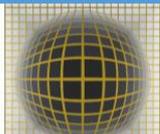
Dynamic sculptures	Acts of light and movement	Interactive Movements	Acts of visual interactions
 <p>• Nicolas Schöffer's CYSF-1 1956</p> <p>3D works moving in a pivot or vibrating way to change the position of the design, and that is through a driving force, such as wind or a motor.</p>	 <p>• Geany Colombo Flexible space 1967</p> <p>Actions in which light plays the primary factor as an influencer in shadow and light to form works in space that inspire effect of movement, either by reflections of light on different surfaces or by shadow formations.</p>	 <p>• Victor Vasarely Re.Na II A 1968</p> <p>Two-dimensional work that achieves the third dimension by overlapping the main axes or vertical and horizontal outer lines</p>	 <p>• Victor Vasarely Carwa A 1970</p> <p>2D or 3D works. The recipient participates in achieving movement through its interactions in various forms, such as moving, touching, or through artificial intelligence sensors...</p>

Fig (5): Types of dynamic art and examples for each one

We can say that the artistic visual illusion paintings opened the way to what is now called interactive design. So it is their paintings that made the spectator move in front of them, stare at and close the eyes, then open the eyes interactively, based on color contrast, with an indication of the presence of movement at times, and eye movement between mass and space at other times.

Modern design trends have emerged to help to interact with the user systematically as it considers the user is the main target in the design process in all its stages, and this direction

depends on the user's participation as an axis in the design process based on the goals and needs of all the steps of the process.

User design center

The term (User Center of Design) refers to a methodology for product innovation so that the end user is at the forefront of development in the design process, see Figure (6). This concept has gone beyond the study of human factors that study the limits, capabilities and used environment to include cognitive, emotional, aspects and physical and symbolic interaction with the product.



Fig (6): the concept of the user, the focus of the design process

“The user is the focus of the design” is a term and concept based on special forms of the user research methods that include cognitive processes, tests of use and the utility environment. The user research and its various procedures depend on a wide range of “experimental-cognitive” concepts that aim to explore the experiences resulting from the user’s interaction with products and inputs and outputs of responses through the means of motivation and reactions between the user and the product, and trying to understand these interactions and rendering this perception into a design and productive act.

It moves the user’s experience and different skills into participation in design from mere interviews and suggestions to participating in developing innovative additions and

modifications to the product with the aim of making the product more appropriate to their desires and needs, or as subjective solutions to unexpected problems - where Eric von Hippel of MIT discovered that most products and services are actually developed by users - which are a source and motivation for new ideas and product development.

Interactive design:

With the entry of the digital revolution, processing the design with the participation became in line with the concept of "User centered design" is not sufficient. Therefore, there was a need to find a new concept that engages the user in the design, but matched with the digital leap and the flawless development in the software world that extended its impact to the change in the nature of products. So the designer is attempting to change their style and methodology in design to keep pace with the continuous and successive change in the nature of the outputs of the digital revolution, the designer must put the user in an interactive state directly with the product to measure features and defects, test functions and identify needs in the environment of use. In this way, the concept of participatory design has evolved into interactive design, and the idea of interactive design depends on making use of computer technologies, software and their applications in the design process through assistive design techniques (CAD) and various communication software, where they can deal with a huge amount of data and information and provide a huge amount of design units and alternatives, making it easy to interact with the user. This means shifting from the personal case of the designer to a system of integrated experiences and better communication with the user, thus allowing the communication between the designer and the end user to provide an optimal system to take the decision.

Flexible design:

Flexible design is a type of interaction in design in which the designer is able to give a variety of responses that do not belong to a single appearance in which the user is free to move between the variables without the designer intervention. Flexibility in the language is "the ease of changing something to suit new circumstances" and Friedman defined it as "allowing the user to participate in the design decision-making process, and providing them with design and management tools to be able to reconcile their changing needs and requirements" among them, the flexible product is the one that can accommodate the changing needs of users and provides the ability to provide each user with the appropriate and effective limit of the basic efficiency, on the formal and functional level of the product and the ability to respond to the new needs and functional requirements of the user across the lifecycle of the product.

The flexibility of the industrial product is divided to several forms, the product may contain one or more of these forms to belong to the family of flexible products, see figure (7).

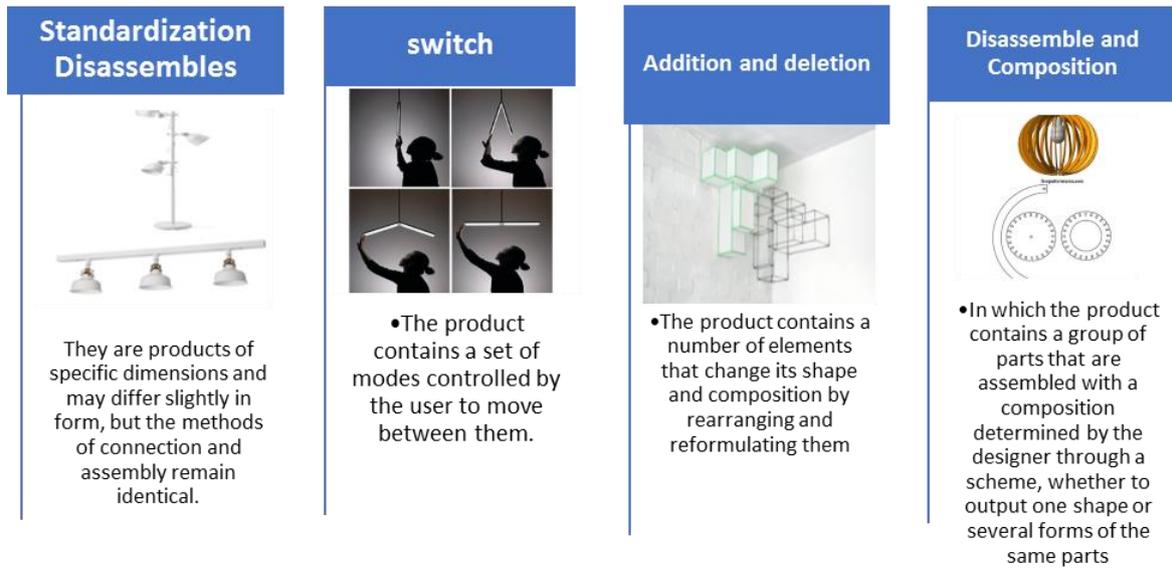


Fig (7): flexibility forms and examples of each lighting units

Lighting and its types:

Lighting is one of the most important elements that affect the visual perception of the vacuum, as it defines the vacuum shape and changes which it is using different levels of it, also it is possible to focus on the important parts of it and show its elements by concentrated lighting. There are different types of lights like natural and artificial lights or external and internal lights. The internal light is the subject of this research and it divides to wide-ranging light (surrounding) and focused light (directed) lighting. Surrounding lightening is pervading the vacuum and the space in workplaces, classrooms and public buildings. The directed or focused lighting is the spotlight, which shines on a specific zone or thing in the internal space to perform a specific activity, such as reading and studying. Finally, decorative lighting, which is aesthetic lighting that aims to create a beauty effect of the environment through the shadows on the walls and creating a special atmosphere for spaces.

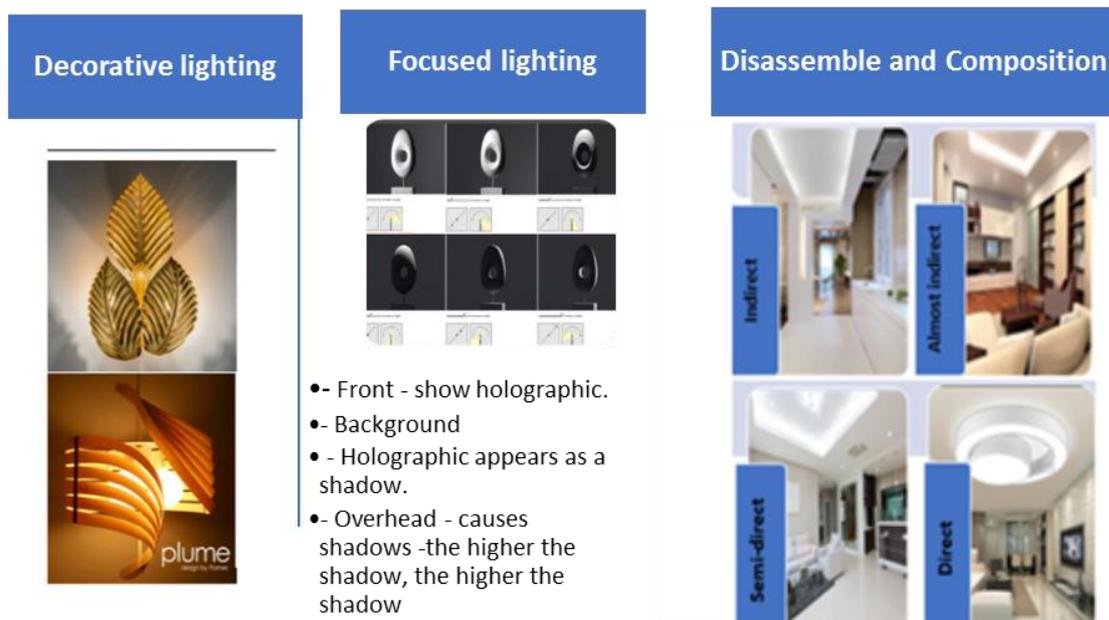


Fig (8): Industrial lighting design systems and its types

Light plays an important role; it shows the texture and confirms or conceals it. Many lighting units depended on the formative values reflected by the light due to the surface appearance, which affects the shape of the elements and organizing the form of components in the space. Figure (9) illustrates the effect of the light reflections on the walls and the surface appearance contributed to the lighting unit.



Fig (9): the effect of light on the brightness and the reflected shadows

Modern trends in lighting units:

Modern trends in the design of lighting units called for new ideas that adopt the concepts of flexibility and interactivity in performance, which achieves the highest efficiency of the product, in order to further meet the user's different and changing desires. We note that the movement, whether static or dynamic, has a very important impact in the events of a shift in the field of designing lighting units. Figure (10) illustrates the dynamic movement and static movement in suspended lighting units so the movement appears in the crystal units despite the stability of their units while in the metal unit we find a real movement achieved from opening and closing metal slats.



Fig (10): Demonstrates dynamic and static movement

Thus, it is one of the patterns circulating in the direction of lighting units' designs and what the research was based on previously (decommissioning / erection / deletion and addition / switching / standardization) operations and the aforementioned about movement and its impact on art and visual deception so we note the role and effect of movement as a concept that achieves interactive values in lighting units' designs.

The fourth dimension and its impact on the design process in lighting units

The temporal dimension is the dimension by which the interaction time between the user and the design is determined, and thus the effect of time may be determined by determining the type of activity that the user performs, the time is the ruling between the human interaction with the design and the technology used. In addition, the human interaction with the design is affected by the variables that design can cause and how much it interacts.

In figure (11), the different interactions that the lighting unit can have with the user, whether by the angle of illumination, the difference in the area of the directed lighting, or the different shape of the lighting unit.

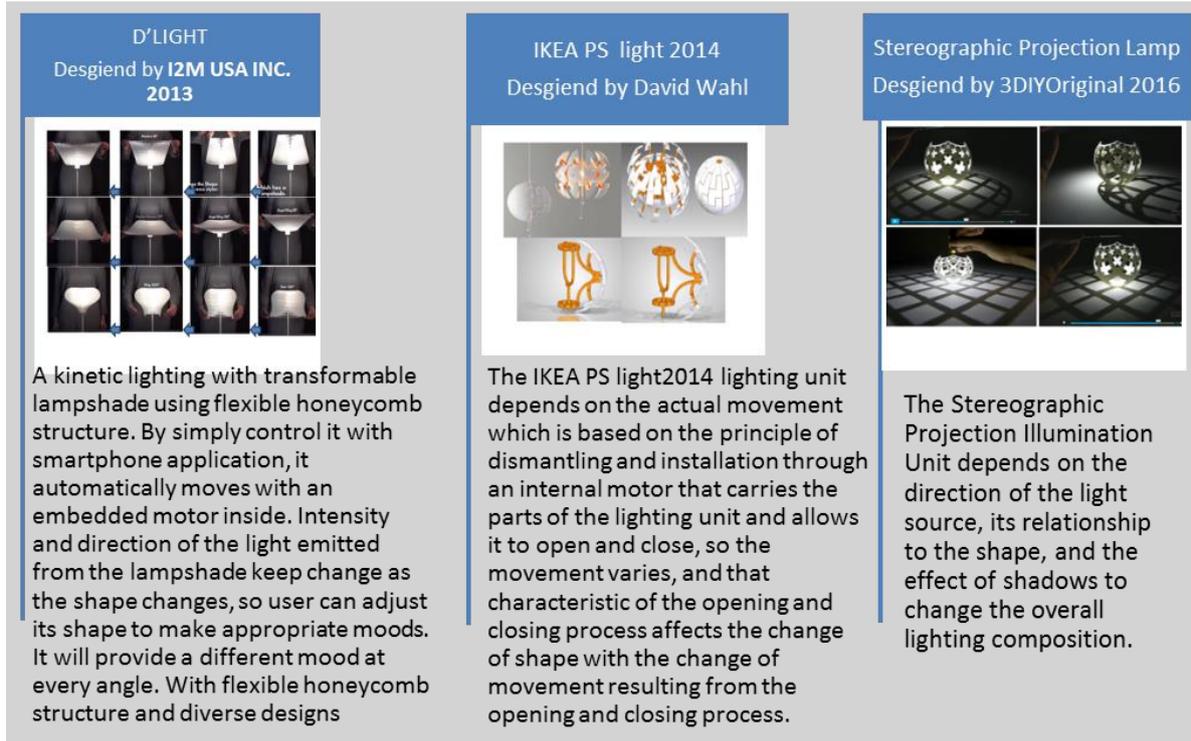


Fig (11): the different interactions that the lighting unit can have with the user

Lighting units' analysis :

Table (1) analysis of a Ceiling unit

Type of unit	Ceiling unit	Working image 1
Artist's name	Studio ART Subscribe Selux to design factory.	
Date of work	1.2 x 2.4 M	
Type of artwork	Metal plates - metal wire - OLED lamps	
Materials	Interactive actions according to the desire of the user depends on switching in lengths to achieve movement despite the stability of the (unit standardization)	
The type of movement and how to achieve it	Actual movement is achieved through the movement of the wires attached to it.	
Lighting type	General direct lighting	
Installation method	<p>The design consists of 140 units of OLED lamp and 14 metal plates are moving in series from the top to suggest the movement of the wave or floating in a vacuum, when turned off, the metal panels look like small mirror</p> <p>The metal structure extends 1.2x2.4m, while each optical –lighting unit is installed separately. The movement of optical units with metal panels is controlled through a program that includes light guidance and movement. This smart program allows the user to change the optical dancing movement according to the place and desire. This intelligent control also allows light intensity and intensity, regardless of optical movement, to be stable.</p>	

Table (2) analysis Ceiling unit

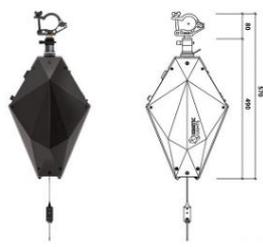
Type of unit	Ceiling lighting unit named (Living Sculpture)	Working image 2
Artist's name	Lunar Hare Agency in Moscow to Celebrate the Anniversary of Tiffany's Devotion	
Date of work	2017	
Type of artwork	Kinetic art depends on the influence of light and movement with the stability of the unit	
Materials	Glass mirrors - metal wire - winches - metal joints	
The type of movement and how to achieve it	Actual movement is carried out through 72 LED hoists and 24 OLED triangles carrying 864 ultra-thin glass mirrors. The computer does the movement and light sequences.	
Lighting type	Decorative illumination	
Installation method	<p>WINCH LED hoist</p> <p>Suitable for permanent and temporary installations.</p> <ul style="list-style-type: none"> -With a cable specially designed to be combined with power cords and hanging wires. -At the end of a steel cable end with a quick power shutter. <p>The possibility of rotating 360 degrees.</p>	

Table (3) analysis of a table unit

The name of the artwork	5+5	Working image 3
Type of artwork	The work is one of the interactive actions in which the user plays a fundamental role of formation and change, and the change in formation is direct according to the user's desire and needs.	
The type of movement and how	The work here is characterized by a great diversity of movement and design, as it has simplicity and flexibility, the work consists of 7 parts that can rotate 360 degrees, may be	

to achieve it	fixed or mobile, which allows flexibility and diversity in formation and design, it is based on the idea of jaw and installation (puzzle)	
Lighting type	Concentrated decoration	
Material	Wood and Plexi Glass	

Table (4) analysis of a Ceiling unit

The name of the artwork	Cinnamon's jewelry	Working image 4
Artist's name	Design artist, Cinnamon Lee	
Lighting type	Concentrated decoration	
The type of movement and how to achieve it	<p>The movement is actually done through The main axes of work with suspension from both ends through which the work moves</p> <ul style="list-style-type: none"> • The use of proximity sensors to switch and partial control increases interactivity and achieves user responsiveness in more complex images. 	

<p>Material</p>	<p>Aluminum sticks, LED cloves</p>	
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Examples of some suggested ideas for designing a lighting unit with a kinetic sense:

Design ideas depended on how to achieve the kinetic dimension (direct or indirect) in the relationship of the glass and metal materials in lighting units through what the research dealt with in terms of investigating the user’s interaction - by overlapping flexibility in design and kinetic dimension, whether through vertical and horizontal lines or axial lines.

The first design idea :

To achieve the flexibility targeted by the research, ideas were launched to how to use an effect in which the idea depended on the effect of shadows on the walls, which enriches the internal environment with formative values with a dynamic dimension, through the assumption of paperwork represented by the metal structure and the effect of light falling on the background and to confirm the movement and the integrity of the glass and metal materials between the overcast and the transparent color, which gives variable silhouette and color values. The researcher assumed several ideas for overlapping with each other to achieve different formation values when applying the dynamic movement of the unit through which the processes of deletion, addition, switching, disassembling and installation can be performed to achieve the highest amount of flexibility desired in use.

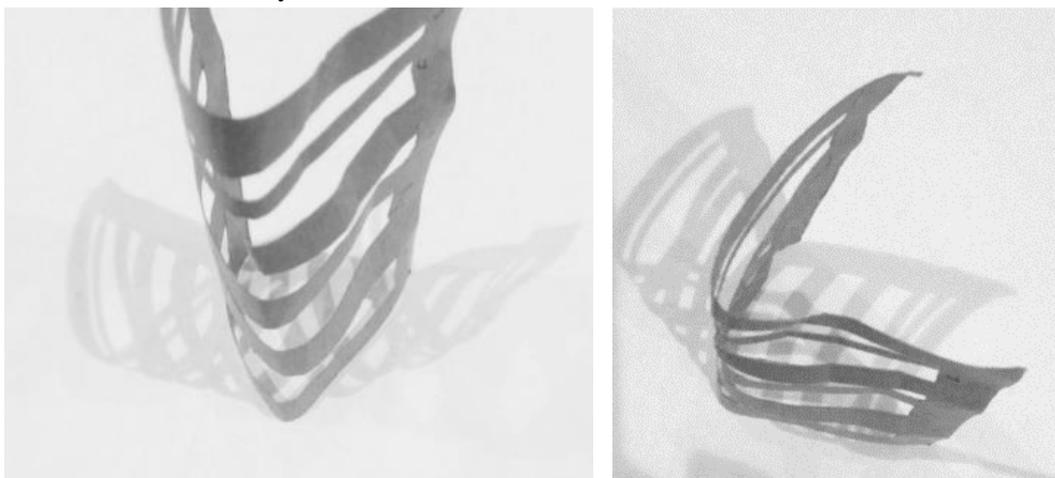


Fig (12): Paper model for forming as metal sheet that is used as surface treatment for a lighting unit

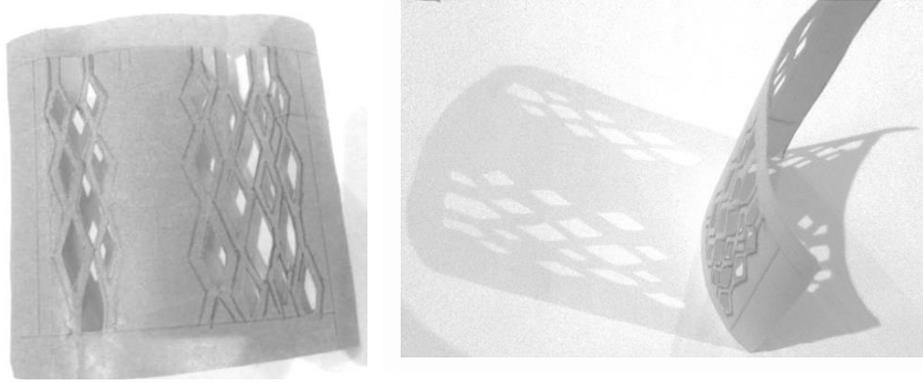


Fig (13): Paper model for forming a finely detailed sheet of metal that is used as surface treatment for a lighting unit

1- Wall lighting unit :

The design idea aims to change the plastic and color values and light values controlled by the user according to their aesthetic or functional desire by opening and closing metal slices and also controlling the intensity of illumination through the movement of the metal slices.



Fig (14): shows the process of opening and closing the two metal plates on the glass disk

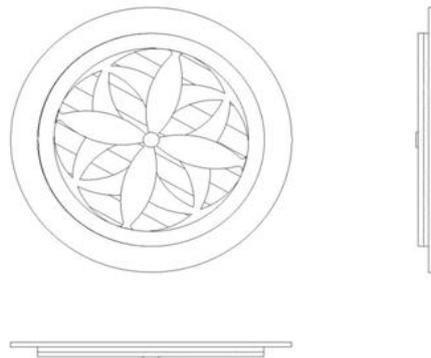


Fig (15): The executive drawing of applic

2- Suspended ceiling unit :

It also followed the same previous approach in goal and thinking. A glass ball with a visual illusion design was supposed to suggest movement through pivotal main lines and emphasize it through its shadows on the walls. The formation of glass by torches and the unit here represents a diffused decorative lighting.

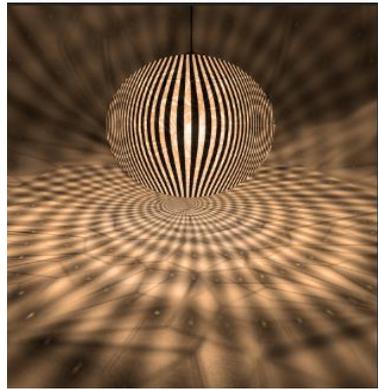


Fig (16): ceiling lighting units affected by the art of optical illusion while achieving silhouette values.

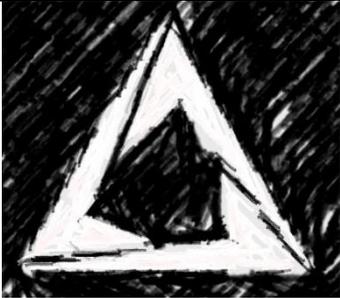
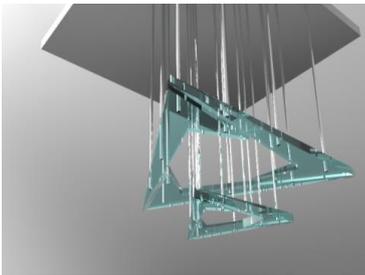
The second design idea :

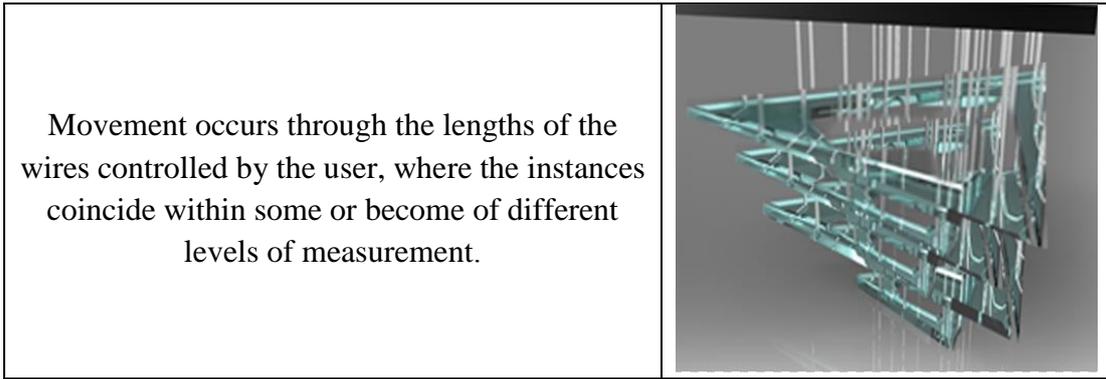
1.Suspended ceiling unit :



Figure (17) design ideas for a ceiling lighting unit

Table (5) Suspended ceiling unit

Characterization	Working image
<p>The first design idea is a roof unit of glass and stainless steel. It depends on the separation of the triangular ribs, with the possibility of rotating the ribs separately, but with time sheets proportional to its context.</p>	
<p>The material used is transparent glass with a thickness of 1 cm, with metal wire with a thickness of 1 mm, where the suspension is attached to a metal plate through which strips of LED connect to the lighting to fall from the top on the glass surfaces, which shows the light scattering and visual enjoyment of the reflections and color.</p>	



2. Wall lighting unit

Through the same design idea applied to a wall lighting unit, the movement depends on slipping through a stream that moves onto the glossy metal layer that carries the glass slides.



Figure (18) employin a wall lighting unit in a living room

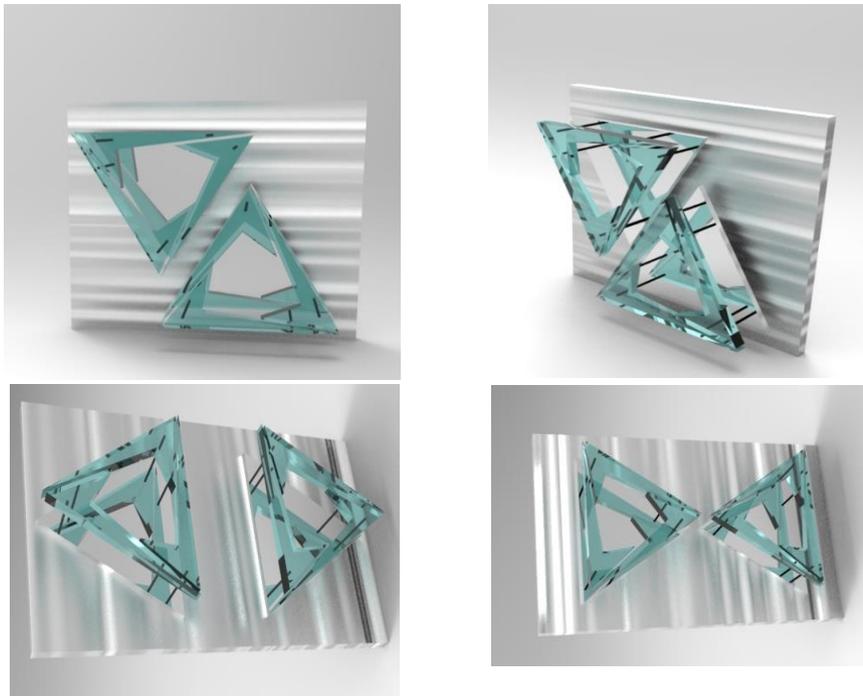


Fig (19): the wall lighting in a vertical and horizontal position

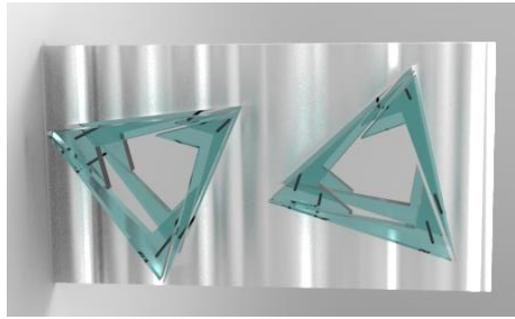


Fig (20): changing the position of the wall lighting according to the user's desire

The third design idea:

It depends on the difference of the kinetic outer line of the design between the glass body and the metal casing, which creates a kinematic complementarity of the shape and an optical diversity of the light values emitted by the illumination unit between opaque and luminous. The work can be employed as a single or multiple ceiling unit or office unit, most of which are in the area of decorative oriented lighting.



Fig (21) employing a ceiling lighting unit in a reception room

Here are some illustrations of the lighting unit with its executive drawing.

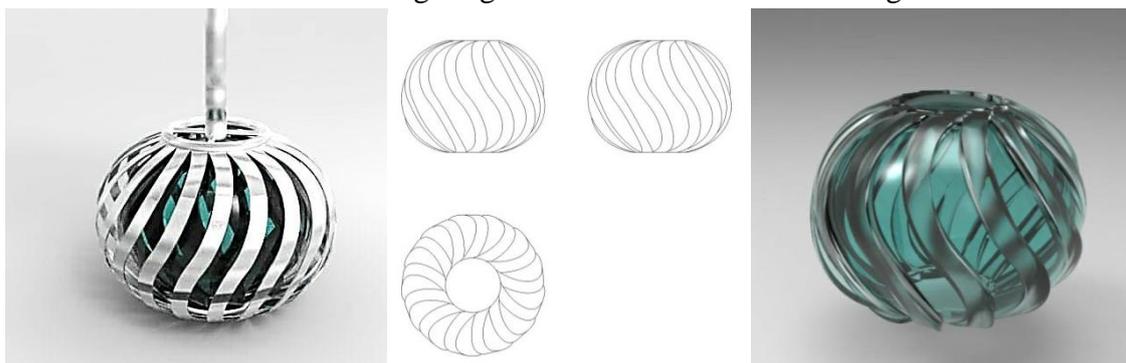


Fig (22): illustrations of the lighting unit with its executive drawing

Applied Results

Table(6) applied results

	Design Idea	Lighting systems	Flexibility	Types of movement	Result
1		Decorative lighting	Flexibility of the switch	Interactive movement	<ul style="list-style-type: none"> - Various formative values. - Different color and light values. - Dynamic integration between design elements. - User interaction according to their needs.
2		Decorative lighting	Flexibility of the switch	Light and movement	<ul style="list-style-type: none"> - Indirect silhouette and lighting effects. - Formative and Aesthetic Values. - Interactive kinetic effects.
3		Decorative lighting	Reassemble and Assemble	Interactive movement	<ul style="list-style-type: none"> - Varied artistic collections. - Flexible jaw and mounting. - Integration of two materials (glass-metal). - User interaction according to their needs.
4		Decorative lighting	Flexibility of the switch Add And Deletion	Interactive movement	<ul style="list-style-type: none"> - Formative and aesthetic values. - Interactive kinetic effects. - User interaction to develop Al Jamali's urging. - Dynamic integration between design elements.

Results

1. By adding the kinematic dimension - as one of the basic design principles in the design of lighting units, it has given the lighting unit another dimension that helps the user to interact with the design and gives more excitement to change between different design positions.
2. Highlight the importance of the complementarity of raw materials in lighting units and show the aesthetic value of the union of glossy opaque (metal) with colored transparent (glass) as the idea of the first design and the interaction of lighting with each of them, within the framework of interactive design with a dynamic dimension.
3. The artistic formations and the relationship of space, the space to the lighting unit give aesthetic effects to the silhouette, light and reflectivity by lighting the interior space, especially if the kinetic dimension is added to it.
4. The intensity of the lighting, its direction and its colors can be controlled according to the user's desire, depending on the flexibility of the lighting unit and the design in motion and those targeted by the first design idea.
5. Achieving flexibility through disassembly and installation, as with the second design idea, with switching and changing positions of lighting unit parts, which enriches the design, reduces monotony, and increases the constant updating of the product's shape.

Recommendations

Research is recommended:

1. Adopting the concept of interactive design as a new intellectual trend for designing mineral glass products, which increases the competitive value of Egyptian products in the local and international market.
2. It is recommended to add interactive design as one of the directions for designing industrial products in the curricula of the glass and furniture design and metal construction departments because of its design integration between the materials of a single product strengthen and enhance the value of the product as in the materials of glass and metal.
3. The necessity of studying digital software applications used in interactive products, in order to be able to identify the positive aspects of them to benefit from them in developing product design.
4. Encouraging researchers to establish joint research between different disciplines to achieve complementarity and exchange experiences.

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