Art and Architecture Journal
Volume 4, Issue 2, p 369 - 404
Print ISSN 2805-2838
Online ISSN 2805-2846

Parametric Applications of Acrylic Raw Material in Light of The Development of Digital Technology and its Role in Transforming The Concept of Contemporary Sculpture

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Abstract:

In light of the scientific and technological development and the strong dominance of the innovations of thought in the field of techniques and the manufacture and formation of raw materials, it was necessary for the plastic artist, especially the sculptor, to wonder and constantly search for new formulations and techniques through which he produces innovative formulations and bodies characterized by accuracy and high technology, in line with and keep pace with this technological knee, which has clearly affected the artistic and plastic methods of many artists who resorted to machine technology and its plastic capabilities in expressing their ideas and expressions in the field of sculpture There is no longer a need to waste time and effort in dealing with hard and heavy materials and very difficult to form as long as there are technological alternatives and media through which it can be used as a tool to express and implement ideas

This study focuses on the activities of the reciprocal interaction between stereoscopic design and application based on technology engineering to overcome many and complex problems that take place within the processes of stereoscopic design, despite the abundance of parametric design solutions, but there is a limited understanding of the generative and evolutionary aspects of parametric design and the role of creativity in these designs, whether as a process or product, depends on problem solving, imagination and renewal, as design activities require a solution to problems, which were characterized as a cognitive process, creativity must be a component Natural for the sculptural design process, process and knowledge are central ideas.

Therefore, the technology of machines and machines specialized in drilling on raw materials, including router machines, which are varied and multiple according to the specifications, nature and shape of the techniques to be achieved, as well as the required dimensions and many methods of formation and engraving, so the current research has taken a path towards how to use the technology of machines and drilling machines on raw materials as one of the methods of formation in the field of sculpture to develop new techniques and formulations And focus on the use of computer programs in the definition of the structural foundations of the shapes and then choose the most appropriate designs, then comes the stage of linking the design with the technique of parametric implementation to give the sculptural form its aesthetic character.

Acrylic is one of the plastic materials that can be reconstituted by thermoplastic , a material with characteristics that make it suitable for vacuum expression in different ways from other materials, it is highly transparent, but it is considered one of the most plastics to achieve the element of transparency and has high transmittance to light to the point that sometimes exceeds glass, and is characterized by its ability to attract light, and then the artist can use the light transmitted through this material as a plastic element that achieves new plastic capabilities that add other dimensions For spatial expression, colored light can thus enter as a moving element in the sculptural work by controlling its paths, degrees and rhythms.
Therefore, we look forward through the current research to try to employ acrylic material in the art of sculpture in the formulation of contemporary plastic using the appropriate new technology.

Keywords: Parametric Design, Parametric Transitions, Digital Technology

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Volume 4, Issue 2, p 369 - 404
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Search problem:

The research problem is determined in trying to use mathematical variables (parameters) of geometric shapes as main drivers in the design process so as to allow the student to reconsider the alternatives of contemporary digital design in improving the results of the sculptural form in terms of form and content according to future variables, which helps the student to come up with his ideas into practice.

The material has played an important role, both in the field of stereoscopic formation in general and in the field of sculpture in particular, and the material has become an important source for the sculptor to develop his innovative ideas to come out of the framework of the familiar to the framework of creativity to achieve a contemporary sculptural product that complies with the requirements of the times, and acrylic is one of the plastic materials that have multiple plastic capabilities.

The research problem lies in the following questions:

- How can parametric design technology be adapted in the service of linking sculptural design and form in the light of contemporary intellectual changes?
- To what extent does the application of the parametric model affect the design to affect the construction of the stereoscopic sculptural figure with acrylic ore in flexible and modern forms?

Research hypotheses:

The research assumes the following:

1- The researcher assumes that through the use of engraving and forming machines and machines in the field of sculpture as technological media, formulations and techniques can be developed that enrich the field of stereoscopic formation at the Faculty of Specific Education.
2- Parametric design technology can offer new approaches to enrich the design thought of sculpture students.
3- By applying the parametric system in the design and construction of the sculptural form and by advanced programs in design, the sculptural form can be analyzed into its constituent parts so that the shape departs from the traditional patterns of design.

Research Objectives:

The research aims to:

1- Demonstrate the role of parametric designs in updating the morphological variables of contemporary sculpture.
2- Shedding light on the technological techniques by which acrylic material can be treated to obtain plastic solutions in the field of sculpture.
3- Finding innovative techniques and methods of forming materials that enrich the field of contemporary sculpture.
4- Finding innovative methods and methods of formation that enrich the field of contemporary sculpture by taking advantage of the potential of plastic acrylic material.
5- Shedding light on the importance of using hardware technology in the field of stereoscopic sculptural formation.

Postulates of research:

1. The Industrial Revolution and technological progress helped the sculptor to produce creative production and break free from the traditional form.
2. Transparent sculptural forms have theories that determine their form and content.

The importance of research:

1. The application of the parametric system contributes to raising the rates of innovation and aesthetic values of the design of three-dimensional sculptural models.
2. Raising the efficiency of the sculptor artist using digital technology with the parametric system, which leads to the development of formulations to keep pace with contemporary intellectual development.

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3. Opening new horizons by studying the plastic potential of acrylic material in terms of transparency, opacity and polychrome to strengthen and enrich the field of sculpture.
4. Reaching new plastic, expressive and aesthetic formulations for teaching digital technology techniques and including sculpture curricula in technical colleges.
5. Linking the study programs for teaching the arts of design and its multiple entrances with its applications to sculpture as one of the fields of plastic arts.

Search terms:

1- Acrylic ore:

Acrylic material is one of the thermoplasticized plastic materials that have many glass properties, and most acrylic plastic is made of polymer (Poly Methyl Methacrylate) and acrylic can be formed directly using the number, tools and sculpting machines, or thermally formed or poured into sculptural molds and can be welded or glued using various adhesives and can be recycled and formed again without any change. (Reem Shawky Mokhtar, 2021, p. 70)

The nature of acrylic material: It is a plastic material that can be thermoreshaped, it acquires a rubber state when exposed to heat and heating, it can be formed for many shapes by pressing or making forms by connecting or welding. Left to harden again without cracking and can be heated many times without any change. (https://e3arabi.com).

2- Parametric Design:

It can be defined linguistically by the term parametric, an adjective that refers to parameter that originates from the Greek word para, and the word metron which means measure. Hence parameter is a measurable factor, i.e. a variable factor and parametric is the characteristic of relying on a variable number, so parametric design is the variable/standard design (Yasser Zarei, 2012, p. 17).

Mathematicians use the term parametric to denote what the Encyclopedia of Mathematics calls a set of equations expressing a set of quantities as clear functions of a number of independent variables known as parameters - variables - and this means that the parametric equation expresses a set of quantities with a number of variables, and that the results - the set of quantities - are related to variables through clear and explicit functions (Daniel Davis, 2013)

3-Technology

Technology can be defined as: the practical application of scientific knowledge (Ghaleb Abdel Muti Al-Freijat, 2010, p. 20) Technology - a word of Greek origin derived from two syllables, the first (Techno) and means a craft, skill or workmanship of Ofen and the second syllable (Logy) means study, science or field, and therefore literal translation means the craft of science or applied study, and in terms of the linguistic meaning of the word technology, it means technology or Applied science or employed science, so the technology is intended to apply and employ science.

4- Contemporary Sculpture:

Sculptural works with their various artistic styles spread in our contemporary world and whose creators are still active and working until recently (Abdel Wahed Attia Abdel WahD, 1998, p. 7)

Research Limitations:

- Human Limits: Conducting research applications on 12 fourth-level students.
- Spatial boundaries: Faculty of Specific Education - Department of Art Education - Matrouh University
- Time limits: Academic year 2023/2024

The study is limited to:

1. Experimentation in the field of study of mechanical techniques related to the sculptural formation of acrylic ore.

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2. Identify the philosophical, aesthetic and technical foundations of parametric sculpture.
3. Study the most important properties of acrylic commonly used in the field of sculpture and its link to design, plastic and technical goals.
4. The practical application depends on the use of techniques (thermal bending molding - drilling and removal - overlapping layers)
5. Study the performative and technical methods of sculpting technology.
6. Study the aesthetic and expressive dimension of the formulations and techniques of sculpture technology in the light of the concept of the parametric system.

Research Methodology:

In the theoretical framework, the researcher follows the descriptive analytical approach.
In the applied framework, the researcher follows the semi-experimental approach through a set of practical applications.

First: Theoretical Framework:

1. Clarify the characteristics and features of the parametric system.
2. The relationship of sculpture to technology
3. An analytical study of some performance and technical methods of sculpture technology
4. Study of types of digital control systems
5. Demonstration of a set of models executed using parametric sculpting technology
6. Applying some of the commands of the AutoCAD program to one of the technical elements to know the extent of their benefit in the field of digital sculpture
7. Formation by light through acrylic material.
8. Describe and analyze acrylic material and identify its characteristics, plastic capabilities and concepts developed with it using digital technology

The art of sculpture is one of the oldest arts in the history of human civilization and in succession of times the development of form and content and then the methods of performance as accompanied by keeping pace with the tools and equipment necessary for the art of sculpture the needs of each era separately where the tools moved from ancient times to the modern era from traditional primitive tools that depend on simplicity and what nature allows that until it reached the so-called digital sculpture depending on prior programs and machines dedicated to dealing with these programs so that it became an art Sculpture is a software and information language that is transferred to computers by a three-dimensional scanner, and this is what allowed visual manifestations and impressive treatments that were not in the past, although the Pharaonic civilization, for example, is still impressive that takes minds and sight even after a huge leap in scientific and technological development, but some digital sculpture works review the unprecedented potential of sculptural treatments that gave the material visual manifestations that integrate the development of science and performance methods and tools in sculpture.
The researcher believes that the art of sculpture is one of the most affected arts by the data of technology and scientific progress because of its association with many developments of raw materials, tools and machines and the direct relationship between raw materials and plastic formulations, which gave the sculptor the opportunity to experiment and develop the spirit of innovation and creativity through techniques and methods of performance of prominent sculpture technology.

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Thus, the sculptor can benefit from the data of modern technology and machine techniques in adapting technical media to expressive capabilities that are required by self-vision and unique imprint, and these means are to enrich his creativity and reformulate without prejudice to the content of what he creates, whether the artwork is based entirely or partially on the machine and its techniques.

Recently, several new terms appeared on the art of sculpture and soon began to spread, perhaps the most important of which is the digital mud and virtual sculpture, which is the latest technology in the world of digital sculpture, and perhaps one of the most important and latest is the formography, which is reproduction without templates, and these techniques have contributed a lot to crossing the psychological and practical barriers, which were spacing between the sculptor artist and those techniques so that they became given a boost to the artist for what he aspires to, through Exploiting all available possibilities, so that several perceptions of one form can be developed, and the sculptor can restore the plastic solutions he deems appropriate The research problem The use of technology of this era in bringing about radical changes in the concepts and methods of artistic expression of paramount importance to reach those technological innovations of machines and programs towards contemporary aesthetic and plastic concepts and values in the field of modern sculpture The problem is the extent of the impact of technological development on the techniques and tools of sculpture on the carved form to reveal concepts and treatments A new plastic and aesthetic and its compatibility with modern methods of sculpture.

In light of the scientific and technological development and the strong dominance of the innovations of thought in the field of techniques and the manufacture and formation of raw materials, it was necessary for the plastic artist, especially the sculptor, to wonder and constantly search for new formulations and techniques through which he produces innovative formulations and bodies in line with this technological knee, which clearly affected the artistic and plastic methods of many artists who resorted to the technique of the machine and its plastic capabilities in expressing their ideas and expressions in the field of sculpture is no longer the need to waste Time and effort in dealing with hard and heavy materials and very difficult to form as long as there are technological alternatives and media through which it can be as a tool to express ideas and implement them.

- **Parametric System:**

The use of the term parametric design originated with the beginning of the art of modernism by the architect Oigi Moretti, who specialized in defining the relationships between form and its dimensions with a set of parameters. They are not only numbers but can be shapes and curves to suit the content of the shape to be applied to. Where there was an effective role for computer software to facilitate the formation and composition of the designer to find aesthetic consistency between form and design.

While parametric design in general can be defined as an advanced way in the design process that differs from the well-known traditional methods, which allow the designer to interact with the idea, its materials or the resulting product starting from the first modeling stage «Prototyping», unlike the parametric design, which integrates most of the design requirements in the form of variable parameters with the stage of formulating the idea of the designer, which gives innovative, more creative and implementable design results and solutions for one design(Ahmad Yahya, fourteenth issue). Parametric design depends on computational and algorithmic systems, which in turn make it one of the most important generative and modular design systems because of the ability of these algorithms to solve a wide range of complex arithmetic problems, where algorithms are based on the use of parameters by changing their values, and thus we have a wide field of research to explore alternative design solutions and produce through these variables a series of dependency relationships resulting from each other and this is the basis of the generative system (Gürsel Dino, 2012 ،This parametric technology is used in the design process through digital applications such as Generative 'Components' Dynamo Catia Autodesk, ceros Grasshopper 3D

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Autodesk RevitRhinc and other programs that designers rely on to translate their ideas into 3D designs that accept realistic application.

- **Structural formulations of engineering units during parametric designs:**

Parametric techniques provide a process of geometric control of these irregular abstract forms, so that they contribute to finite actions that generate total characteristics of the shape and the stability of these forms in terms of the process of construction and symbolic prominence within a comprehensive design process based on software programs, successful computer programs in design (Xenakis, Gehrman, 2012, 108).

The researcher believes that parameters can be used to reach the concept of three-dimensional design to generate many variations of sculptural shapes in the light of intellectual dialogues arising from the change in the structural foundations of the shapes according to the variables of the axes and the extent of their interaction with the sculptural variables, which helps to document by determining different values for these parameters of elements that suggest movement and structural lines of design units with geometric visual variables, which enables the student to create different sculptural objects or formations, and enables him to use Equations to describe the relationships between objects and identify the associated geometries that are interchangeably related as formal transformations with geometric structural foundations.
Through the elements addressed, it is clear that the parametric system depends on two important axes in the field of design education in various fields of arts, such as ceramics, sculpture, architecture, artistic works and other fields of applied arts, and one of those fields that has been applied is the field of sculpture.
The first axis: The art student must be familiar with the structural foundations of the form, in terms of understanding the main axes from which the shape originates, and be flexible enough to find variable formal solutions, according to the criteria of good design derived from algorithmic parameters, as one of the fields of visual arts that allow the student to develop his design thought, as this comes through the multiple practices of art forms, and finding visual solutions that enrich the design and change its form according to the design data.
The second axis: aims to teach students on parametric programs as an entrance to the development of artistic designs on the surfaces of sculptural shapes; to create surface aesthetics of the artistic product with continuous training on computer programs as an entrance to the development of parametric designs through which the stereoscopic sculptural form can be enriched. This method requires training on the data of contemporary computer programs, while not neglecting the quality of the materials used to create aesthetics on the surface, and the most appropriate materials and techniques associated with them.

- **Parametric System Effect:**

With the beginning of the emergence of sculpture, the ancient Egyptian sculptors began to produce stereoscopic works of art with huge blocks, which required more effort and time to build the sculptural form, and with the development of new and new methods and applications of technological aids to form models by entering the computer and various programs that produced innovative design solutions, and the basis for the application of these programs was the use of mathematical logic, which is the basics and rules of mathematics with computer science theories in building the form, which allowed the construction of interconnected and complex designs based on each other. Some constructively

- **Parametric Design:**

The scientific development that has occurred in various fields of knowledge and after the development of old trends and principles after they were taken for granted and were later replaced, concepts that suit the requirements of the times with more objectivity and accuracy and the designer was dealing with nature with some simulation without full imitation of it where the designer was interested in rediscovering the

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vocabulary of nature so that it contains the bulk of the details This new trend that led to the arrival of many stereoscopic shapes that fall under the so-called parametric system.
and measured and re-enacted until the eighties of the twentieth century. But after the emergence of morphology, which was concerned with the study of forms and their functions in living organisms for plants and animals, non-living assets represented by the structure of mountains, rocks with irregular shapes, etc., morphology "morphogenics" the study of marine life, sponges, cell and its nuclei, fractional or hyperengineering "fractal" and technological development in computer science after 1990, there is an ability to complete what was impossible. Previously, parametric design became an independent theory based on several theories and the concept of parametric tendency applies to it, as it is too big to be a commonly used method to become a contemporary intellectual trend.
The term parametric design has many meanings, there are those who defined it as border design, or design modeling, or modular design, or standard, but the most correct meaning of parametric design is "variable design", and that parameters are software spaces that contain algorithms and mathematical operations one or more, and parametric design is based on engineering foundations and concepts with mathematical logic inspired by nature.

Foundations of parametric design:

The foundations of parametric design play a major role in the design process, as it leads to the development of the designer's mental and sensory abilities, seeking to achieve the aesthetic goal through it, to link between scientific and computational theories and sensory elements, and parametric design has three foundations, first engineering foundations, second mathematical foundations and third technical foundations. (Hessa bint Abdul Karim bin Saleh, 2022, p. 178.)

Parametric design elements Parametric design elements are visual messages that the designer uses to communicate the ideas required from the design, such as algorithms of various types and mathematical equations. (Hessa bint Abdul Karim bin Saleh, 2022, p. 179.)

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- **The importance of parametric design:**
  - Produce designs that are difficult to produce
  - The ability to modify design elements according to changes in the design
  - The ability to produce new structures and structures in their behavior, relationships and forms
  - Ability to produce complex shapes
  - Enhance my designer's creativity and save time.
  - Suitable medium for the conceptual stage of the design process
  - Explore a wide range of design options (Islam Magdy Taher, 2019, p. 7)
- **Features and characteristics of the parametric system :**

السمات البارامتريه هي السمات والخصائص التي يتم من خلالها عرض أهم المبادئ التي تحكمها ويتم عرضها كالأتي:

1- Morphological features of the parametric:

They are the features through which the rules and principles that enable the preparation and evaluation of the formal features of the parametric design can be determined, as they serve as the principles of achieving beauty and are represented in the following points:

- The shapes should be smooth bearing in mind that they are parametrically interconnected and therefore the influence on one of them affects the overall composition.
- Avoid grouping elements that have nothing to do with each other as this causes isolation within the composition.
- Avoid solid shapes (square, triangle, circle, cube, pyramid, sphere) This is due to the fact that these shapes are poor in adaptability and adaptability.

2- Functional features of the parametric:

They are the features through which the rules and principles that explain and evaluate briefly the functional performance of parametric design can be clarified, they are principles that activate performance and can be represented in all functions that take place within parametric scenarios and must be described within common terms for the possibility of assimilating them as well as achieving interdependence between them as one activity affects the rest of the activities. (Islam Magdy Taher, 2019, p. 4), and there are features of the parametric system that are determined in a set of rules and principles to reach parametric design through the realization of the principles of beauty.

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- **Parametric in nature:**

The construction of the parametric design depends at the beginning of its emergence on the science of morphology, which depends on the anatomy of the basic structure of living organisms in nature (plants - animals) and the reinforcement of these forms of complex structure that can be employed in many design ideas appropriate to the era, as in Figure (3) illustrates morphology (morphology) sponges.

Figure (3) Pictures showing the morphology of sponges
https://reefbuilders.com https://www. pinterest.com

The formal results of the parametric in its form are similar to the natural phenomena organic as in Figure No. (4-A) and inorganic as in Figure No. (4-B), which resulted from the processes of self-organization and evolution of the elements, unlike the formal results of previous design movements, where the parametric often gives formations similar in form to natural formations known as Biomorphism It is a term concerned with the formulation of design building elements according to patterns formed from nature or formations that express nature or living organisms, as a result of relying on one of the parametric design tools in building the shape, which is the formation algorithms known as Genetice algorithm, which simulates in its morphological behavior the behavior of nature in the production of shapes.

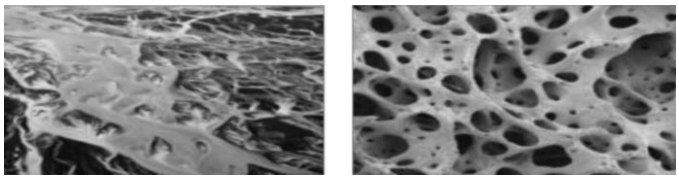

Figure (4-a) Internal formation of bones illustrating organic natural phenomena
Figure (4-b) Sea wave formations illustrating inorganic natural phenomena

It is also possible to attract the shape outside the natural range by using industrial forces simulating the forces of nature such as gravity, wind, sunlight, tensile forces and loads, which are limited by laws and affect in turn the shape, this type of artificial forces simulated by natural forces can be built through scripting in interactive environments of the computer similar in nature to the laws of nature affect the entire composition, creating a kind of intelligent differentiation in the external form and enrich the internal formation and achieve interdependence with the outside, Parametric images in nature are also manifested in formations of a repetitive nature or with a complex repeating pattern, which are known as molecular formations of a repetitive geometric nature, such as crystal, their irregular nature is difficult to describe with traditional geometric shapes, but they are easy to analyze into their initial formal elements that make up them and are known when simulating in the design process as inorganic or non-vital systems.

The most important patterns that exist in nature and are characterized by parametric composition are formations Fronoy, which is defined as a systematic phenomenon based on geometric foundations and concepts with mathematical logic and can be found in nature with different scales and materials as Figure (5) and perhaps the most important examples of this structural formation of bones. Spongy constructions. (Islam Magdy Taher, 2019, p. 9)

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Figure (5) Models of parametric parameters in nature

- **Inorganic repetitive patterns**

These patterns were called inorganic in reference to the formation of shapes in nature through the processes of self-formation has been used inorganic natural systems as inspirational models or sources of inspiration in the formulation of perceptions and building shapes where these systems were usually made of homogeneous natural materials such as sand dune formations or homogeneous dynamic masses such as fluids, the parametric design provides many templates that are used as computer simulations of formal patterns in nature, which enables the designer to give creative formal treatments to The product, also allows him the ability to simulate the self-organization and behavior of the formation of patterns in nature in order to build forms more integrated with their function as in nature natural constructions are integrated with their function surprisingly, in nature systems are self-formed in a one-way process where it leads to the emergence of complex and sophisticated construction and more differentiated and interconnected and the repeated pattern is known as a geometric composition resulting from a continuous process of repeating an element at different levels, sizes and scales and usually can be fragmented The result to several parts so that each part of them is symmetrical in construction, and embodied in nature different repetitive patterns and component of the shape repeated in different mathematical contexts where it includes several types, including symmetrical patterns wave and spiral and illustrates Figure No. (6) - (A - B) example of recursive patterns.

Figure (6-a) Visualization of parametric patterns in nature Waves and sand dunes
Figure (6-b) Inspiration in the design of the industrial product

- **Repetitive patterns in living organisms: Another**

image is formed for the parametric in nature, such as that observed in biological repetitive patterns, which means patterns that perform vital functions such as hives, such as shown in Figure (7), where such forms are produced through parametric design using one of the most important parametric design tools, which is genetic algorithms.

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Figure (7) illustrates a biotype in nature
Parametric design features in sculptural formation

- The shapes should be parametrically interconnected so that all their parts correspond in their overall composition as shown in Figure 8.

Figure (8) shows the interdependence between the elements in the composition
https://www.behance.net https://www.pinterest.com

- Parametric design using a set of programs, for example (Rhinoceros & - Autodesk Revit (Grasshopper), which allows modifications in any part of the design in order to shorten the time and effort required by the implementation of those modifications manually, and from here the designer can study the relationships between the basic aspects actually, including the intermediate material used in the implementation of the design as well as manufacturing techniques associated with implementation. As in Figure (9), which shows some designs using a program grasshopper.

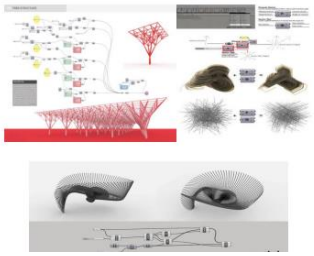

Figure (9) Some designs on Grasshopper

- The possibility of reaching a dynamic design characterized by fluidity through the parametric concept so that it is concerned with the philosophy of movement to design sculptural models, and the parametric design is a sustainable design because it achieves reuse, recycling and ease of replacement, replacement, dismantling and installation, as it is characterized by the strength of endurance due to the network engineering construction and the strength of its cohesion, as shown in Figure (10).

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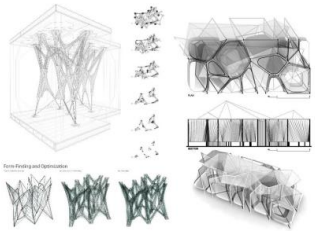
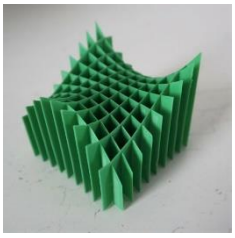


Figure (10) shows some designs that depend on the grid engineering structure and the strength of its cohesion

- One of the most important features of the parametric system is the diversity of materials in its designs, especially since these designs depend on the iterative unit, which can be achieved using laser cuts, for example, the use of wood to obtain a three-dimensional sculptural model with various textures, shapes, different areas and structural formations by simulating nature and understanding the structural systems by which the shapes are built, as Figure (11) shows.



https://www.iaacblog.com
https://www.bing.com https://theinspirationgrid.com
Figure (11) shows the diversity of materials in the designs

- One of the most important aesthetic features that distinguish the parametric design is the diversity of the contact, whether these touches are natural on the surface or after treating those surfaces in one way or another to occur a delusional texture that is aware of the sense of sight or a non-illusionary texture that is aware of the sense of touch as shown in Figure (12)

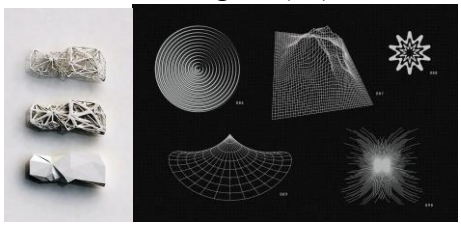


Figure (12) shows the diversity of illusionistic and non-illusionary contacts.
https://www.bing.com/images/search?view=detail

- The parametric design is characterized by a variety of colors and materials according to the nature of the sculptural structure that is implemented in this system, and therefore it is easy for the designer to distribute colors, textures and material suggestions according to the paths of the lines and the nature of the surfaces.

- **Digital technology and sculpture:**

The modern era is known as the information age or the computer age This innovation that changed the face of human life, the computer is one of the most important and latest modern technological means, a device capable of receiving, storing and retrieving data automatically and is used in various areas of life as the computer is used as a tool in the hands of the artist - expands the field of capabilities of the creator in the field of visual arts by thinking about new means and analyzing ideas so that they are entered into

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the computer, so he programs ideas and by order of the artist Executing the command saves effort, achieving a wider scope for operations simply because it works more certainly and quickly than the artist hopes to do " (Edward Lucy Smit, 1997, p. 130).

The challenge was for the sculptor to transform and translate his ideas and artistic vision of the topics he wants to express into a set of data, information and contents, for the sum of the elements and lines of his idea through a set of specialized electronic programs associated with those machines and machines, which technology can through these specialized programs turn them into practical applications, to create new ideas that enable the sculptor to express his ideas in the media and techniques of modern technology, through the above the researcher sees that it is necessary to take advantage of Innovations in the technology of drilling and cutting machines on ores and the new and advanced techniques they provide to express aesthetic and technical concepts and values in the field of sculpture.

- Digital design thought and its impact on the sculptural form:

"During the last two decades, the world has witnessed tremendous technological changes, where progress in computer science and its applications, which led to the prevalence of (digital technologies), to witness the world what was termed the era of the digital revolution and sculpture is closely linked to the digital revolution, so sculpture artists seek to employ the latest technologies available to serve the sculptural product through the development of their designs and the adaptation of technology and its applications to serve the creative process, and the reflection of all this on sculptural thought, so sculptural production is distinguished with diversity and flexibility" (Nicole, Larson, 2015)

- **Types of digital control systems:**

1. **Digital Control: (NC)**

It is a form of programmable mechanism where the manufacturing equipment is controlled by a special program for the piece to be produced, and the program is in the form of numbers, letters and symbols, and is saved in the form of a perforated tape that is read by the machine control device, and when the work to be manufactured changes, the program also changes, and this ability to change the program is what makes digital control machines suitable for low and medium-sized production, The operating base of all these types of numerical control machines is based on the common principle of controlling the location of the cutting tool relative to the piece under operation or being carried out ." (http://www.anamuhands.net/2018/07/ne-cnc.html) Figure (13)

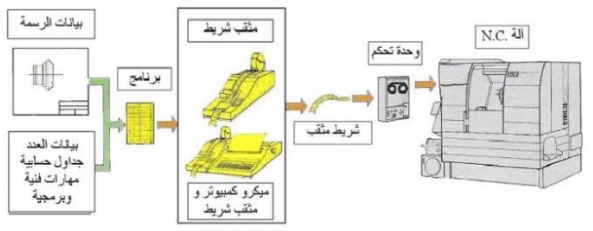

Figure (13) NC Digital Control Device
(http://www.flong.com/projects/aves)

1. **Direct Digital Control:**

It is a manufacturing system in which a single computer controls several digital control machines directly and live, where the program of the specific piece to be produced is transmitted from the computer's memory directly to the digital control machine. Figure (14)

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Online ISSN 2805-2846

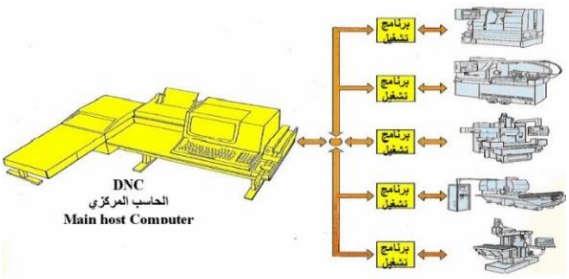

Figure (14) Direct Digital Control
http://ahmedbrhamy.blogspot.com/2010/10/cnc.html?m=1

1. Computer Digital Control (CNC):

(CNC) is an abbreviation for (Computer Numerically Controlled Machine) (a machine that is digitally controlled using the computer) - has a saving memory for programs that record it - to control the digital control machine, and the computer is an integral part of the machine, and the digital control machine can be programmed directly using the computer keyboard or by punched tape The computer reads it, and some CNC machinesIn addition to the above, the computer can read the recorded programs CDs and there are several reasons that led to the widespread use of computer control machines (CNC), such as: - Reduce time - Production schedules - Ease in accepting any changes in the design of the work to be carried out because this only needs to be changed in the previous program for cutting - Increase production accuracy and reduce errors, but despite these features, we must not forget if we enter the system (CNC) For production, it must face the following problems: - Increasing electrical maintenance and diversification. The high initial cost of CNC machines and the high cost of operating machines - Conducting new training for workers at all levels to understand the CNC system and its requirements of programming, operation and maintenance. Figure (15) (16) (17) (http://engsciences.blogspot.com/2014/07/blog-post_958.html 2)

Figure (15), (16), (17)
CNC Digital Controller

The CNC machine includes a system unit that includes a control unit, a monitoring unit and a unit to guide the operating mechanisms according to the design of the machine path provided by a specialized program, and the system usually includes a monitor screen used to display the driver for the purpose of reviewing, adjusting, following up work and receiving messages from malfunctions, in addition to indicators or indicators indicating the position of the tool at each stage of operation, as well as the machine table The console also includes memory for calling and storing the program, as well as a diagnostics device or program that analyzes faults and performs tests, as well as many different function keys" (Ahmed Wahid Mustafa, 2005, p. 91.)

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Printing Processes 3D: This method is one of the important methods in design offices, especially if it is available to the sculptor, where he can see the model he designed on the computer quickly in the form of a physical model, so he can feel the design stereoscopic and in this technique a layer of powder is spread on a basic base, and accurate points are printed through a continuous slot carried by a printer head, and this process is similar to an inkjet printer in well-known printers, and the materials commonly used in that technology are Ceramics, metal, plastic shape (18)

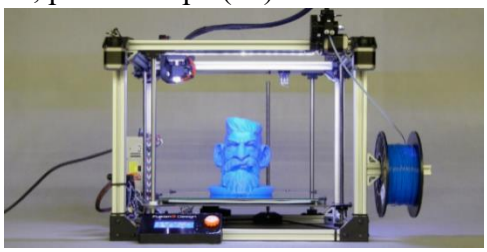

Figure (18) Three-dimensional printing sculpture

Among the techniques and performance methods of sculpture technology provided by these machines and equipment, we find the following:

1- The method of engraving using a V-shaped pin which is multi-diagonal and angular, giving different shapes in appearance and shape.
2- The method of engraving using U-shaped pants , known as Poul, shows shapes and elements as in bas-relief.
3- The method of drilling using straight lines and different diameters and lengths and this method combines the method of drilling sunken and prominent and in which the shapes appear on one level, whether prominent or sunken.
4- The method of unloading or cutting using straight section and different diameters and lengths and this method is used in the discharge of shapes and elements to be shown and these forms are considered the shape, but what is emptied and dispensed with is the vacuum resulting from the cutting and unloading process.
5- The method of drilling and unloading using more than one pent and in this method is combined two methods in the formation either prominent drilling with discharge or deep drilling with unloading.

- Industrial development in the development of raw materials and tools:

Acrylic materials as one of the developments of twentieth-century technology have caused a distinction in the methods of formation and a speed of spread that is a real difference from the previous materials that were used in stereoscopic formation, and this distinction is due to the material providing an integrated plastic unit of sensory, plastic and expressive properties that give benefit to the sculptor in providing what he desires from modern and contemporary ideas.

Acrylic ore:

Acrylic is one of the plastic materials that can be reconstituted by thermoplastic, a material resulting from polymerization, and it is the most prevalent in the many industry processes because it is characterized by cooling and thermoplasticization without change in its chemical composition, which makes it reconstituent many times by injection molding or extrusion, and this property is due to the weak formation of polymer molecules, which ignite when exposed to flame, but some of them do not ignite (Mohamed Ismail Omar, p. 370) It is known that the uses of this material sculpturally began in the late twentieth century, was the first to use the thermal formation of acrylic panels in the work of transparent models Naoum Gabo and Mahul Naji "Naoum Gabo Russian example began his experiments on synthetic materials, especially acrylic material, benefited from them after studying the nature of this material and the extent of its relationship to the void and relied in its formation on the creation of formations in space

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consisting of harmonious lines using nylon threads. (Rehab Essam Khalil, 2002, p. 2) Acrylic is one of the species of heat-laxed plastic that has many glass properties, and most acrylic plastic is made of polymethyl methacrylate.

The technology of forming acrylic material is divided into three main methods:

- Direct formation - thermoforming - molding by casting.

These methods can be implemented either using traditional manual methods or by means of new technology.

A- Direct formation of acrylic:

It depends on the formation of acrylic directly to be in the solid state using tools, tools and carving machines, whether in traditional ways or using the means of new technology and technology through digital control machines of various types CNC Machines.

b- Acrylic thermoforming:

It depends on heating acrylic panels or strips first, and then conducting various forming operations by traditional methods or using the means of new technology, taking into account that the thickness of the acrylic used is 3:1 ml to get the best results, and when cooling the material, it takes the form of the mold in all its details, and this method is summarized in the artist's selection of slices of acrylic material that can soften by exposure to heat and these slices are available in a variety of spaces and there are different types of transparency Or opacity according to the artist's desire to present his artwork.

C- **Acrylic molding:**

It depends on casting acrylic resin into traditional sculpture molds to obtain a copy of the sculptural work, or pouring it into industrial molds by innovative methods such as injection machines or extrusion machines, and either acrylic in liquid form or in the form of granules that are melted to obtain the resin necessary for forming processes. A mixture of monomer and thick liquid or powdered polymerized material (as acrylic polymers dissolve in the monomer) is prepared and the mixture is poured and the polymerization process is carried out in the molds after adding a catalyst Strong, the casting process has helped more than any other process to advance the formation and spread of plastics, and through it it was possible to obtain a large number of products. (Sherif El-Sayed Abdel-Meguid, 1999, p. 20)

- **Acrylic ore forming methods:**

a- Formation of transparent and opaque slides:

The contemporary sculptor was interested in benefiting from the plastic variations of acrylic panels, as they could be formed in several different artistic ways that provide various plastic possibilities for the sculptor in achieving stereoscopic bodies by overlapping acrylic surfaces, as in the works of the artist (Naum Gabo)

b- Forming slats by machining, bending and mounting:

This method is one of the advanced methods in the plastic formulations made by the sculptor through his knowledge of the plastic properties of plastic panels and their advantages and how to benefit from them in the formation and formulation of his sculptural works and these panels, which have been made in different sizes and the types manufactured from them can be dealt with by cutting, bending and installation, in addition to that they soften with the normal heat of flame.

- Chemical properties of acrylic:

- Polymerization: Polymers are formed by a chemical reaction known as polymerization, a reaction in which the longitudinal chain is built by adding monomers to each other. (Sherif El-Sayed Abdel Meguid, 1999, p. 66)

- Structural properties of acrylic:

- Crystal body: It is one of the important structural properties that affect the behavior of thermoplastic, and it is impossible for the plasticizer to crystallize completely such as metals and this is due to the difficulty of regularity of placing each part of the chains in a regular position and on this the property of crystallization in plastics is limited to clusters of crystallized molecules surrounded by other groups of matter in its

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amorphous form, and crystallization depends on the arrangement of molecules in a repeated form and the forces of attraction between molecules. (Rehab Essam Khalil, 2002, p. 15)

- Thermal properties of acrylic:

The property of thermally formable acrylic (thermoplastic) due to its possibility of heat annealing is due to the reality of the bonding force between molecules where it is strong between the parts of the chemical chain and composed of chemical units (monomers) while the bonding force between the chains known as Van der Waal forces is weak (about a hundred times less), which facilitates the chains to slide on top of each other when heating (E. Driver, Walter,1967,p 20-22.)

Thermal properties can be summarized in the following points:

1. Heat resistance
2. Thermal conductivity
3. Specific heat
4. Coefficient of thermal expansion
5. Flammability
6. Melting Index

The Glass Turning Point (Rehab Essam Khalil, 2002, p. 25)

-Optical properties of acrylic ore :

These properties with regard to light can be divided as follows:

1. Transparent: where light runs out and can be seen through.
2. Semi transparent: light runs through them and cannot be seen through.
3. :opaqu where light is not penetrated through the material, and therefore objects cannot be seen from behind them. (L Richardson, Terry,p 7,13)

Optical properties relate to the molecular structure of a material such as chemical and crystal bonds, so the electrical, thermal and optical properties of acrylic are related to each other, the properties of luster, luster, transparency, color, purity, and refraction are some of the many important optical properties of acrylic.

The optical properties of acrylic can be summarized into:

- 1transparency :

It is a criterion for the degree of crystallization, as amorphous polymers such as styrene and polymethyl acrylate are characterized by very high transparency and the transparency of polymethyl methacrylate is relatively high compared to many other plastics, while the transparency of many plastics ranges between semi-transparent and opaque, as this is due to the crystallization rate. E. Driver, Walter, 1967, pp. 20-30.

-٢Index of Refraction :

When a light beam penetrates into a transparent material, part of the light is reflected and the other part is refracted (when it penetrates from the material) and the refractive index (n) depends on both the angle of incidence (a) and the refraction when the light penetrates in the material (r).

Light forming through acrylic material:

Light formation aims to produce sculpture that attracts light and radiates it, whether its source is natural or industrial, and the technology accompanying light has helped to emerge what Majouri called 'stand-alone light art, a sophisticated art in the forties and fifties, where the light sculptural forms that illuminate and enter into our world made a sense of movement, color and design This art is based and the acrylic polymer material is the most material that shows the effect of shaping with light directly, as it is a resinous material (plastic) that has the property of transparency that It allows the transmission of light, which adds an unusual character to the sculptural work. (A.M. Hammncher, 1999, p 37.374), and unlike glass, acrylic is one of the few

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materials that allows light to pass through the shape, as acrylic can be polished to a degree that enables it to reflect light.(Mohamed Zeinhom, 1995, p. 42)

Lighting during acrylic material can be divided into two types:

1- Bare lighting: What is meant is the light of the edge in shapes made of acrylic material, and in fact, this phenomenon is unique to transparent acrylic material, especially transparent panels, where it can be transmitted through internal reflections about 92% of the light entering a polished sheet of acrylic material to the other edge of that panel. (Ress, David, p 31)

2- Lighting the recessed inscriptions: If we make engravings or engravings on the surface of the acrylic sheet in one way or another, some of the light will penetrate into the air, causing a kind of light glow, and we can obstruct reflective surfaces in a deliberate way in any of the designs made of acrylic, which is intended to leak light to the outside, so that the light leaks out through any cut or drill made by the artist on the outside of that design, and by determining the property of the light that will We achieve it depending on the angle of the scratched surface with the glossy surface, how deep the cut or slitting is and the distance it distances it from the light source.

Mechanical properties of acrylic material:

The mechanical properties of thermoplastic can be summarized in the following points:

1. Shock effect.
2. Response - submission.
3. Cracks caused by stresses.
4. Tensile strength.
5. Rigidity.
6. Durability.
7. Rigidity.
8. Modulus of Elasticity" (Rehab Essam Khalil, 2002, p. 35)

- **Organoleptic and structural properties of acrylic material:**

The sensory properties and composition of the acrylic material constitute aesthetics on which the sculptor relies as an experience when starting to form his work, and contributes to the clarity of his aesthetic idea.

A- Sensory properties of acrylic material: "Sensory properties are the properties that are realized by the five senses of man for acrylic material, where the potential in the artistic formation in the field of sculpture is an attraction factor when realizing the artistic forms and sensory properties of the acrylic material and with special aesthetic qualities that distinguish it from the rest of the other body materials of texture, color and smell, in addition to the possibility of acrylic material in providing a sense of the value of space as a plastic element in stereoscopic shapes through the sculptor's formulation of the material represented in the transparency that appears The inner depth of the visual perspective, especially when the sculptor shapes it to give gradations of transparency in the sculptural formation of the material. Huda Anwar Awad, 2002, p. 29).

B. Structural properties of acrylic material: The structural properties of acrylic material are inseparable from its sensory properties, such as structural properties, the plastic and structural capacity of the material, specific gravity, density and mechanical forces, which are the properties that the sculptor must realize when starting to build and implement his artwork by dealing with the material, and acrylic material has hardness where it is possible to implement and build sculptural works of magnitude in terms of size with high durability with a high possibility of stability of stereoscopic structural shapes in space. (Huda Anwar Awad, op. cit., p. 41)

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Second: Applied Framework :

The practical application aspect includes a sample of fourth-level students of the Faculty of Specific Education, Department of Art Education, Matrouh University, in the light of the results reached by the researcher during the theoretical framework of the research study, which aims to adapt parametric design technology in the service of linking design and form in the light of contemporary intellectual variables with acrylic ore, and the practical application depends on the use of machines that depend on electrical energy (CNC machines - Golden Laser - Vacuum machine for thermoforming XSHYD)

The researcher found in the technological development of the devices used in the formation of sculptural acrylic ore multiple plastic possibilities compatible with the artistic ideas that he is heading to, the raw material has achieved in the light of the concept of the parametric system stereoscopic artistic formations that included several properties combined contributed to the expression of aesthetic dimensions, which prompted the researcher to experiment and discover the possibility and properties of the material in various plastic and expressive ways to stand to the distinctive properties of it Perhaps those artworks of the experiment add a cognitive aspect about The nature of the formation of the material and the nature of dealing with it technologically to be a field of knowledge that students can view to benefit from it because of the diversity and multiplicity of sources of stereoscopic formation using technological techniques and digital design programs.

Objectives of the experiment:

The applied aspect of the research aims to achieve the following:

1. Finding multiple entrances in the formulation of sculptural works to achieve modernization and modernity in the work of students of the Faculty of Specific Education, Department of Art Education.
2. Benefiting from the parametric system as an aesthetic value in sculptural works executed in acrylic material.
3. Taking advantage of the plastic techniques of acrylic material in achieving different and varied forms using CNC devices.

The importance of the experience:

1. Identify the characteristics of contemporary sculptural formation with acrylic material.
2. Finding multiple entrances in dealing with digital technological techniques and including sculpture education curricula in technical colleges.
3. Clarifying the dimensions of the use of transparent materials in light of the use of structural formulations for contemporary sculptural formation.

Limitations of the experiment:

The researcher applies a practical experience to the students, in which he deals with the results of the analytical study of the models of sculptural plastic works implemented with acrylic ore and the consequences of the theoretical framework for research in the design and implementation of a sculptural work inside the classroom implemented by the fourth level students at the Faculty of Specific Education, Department of Art Education, Matrouh University, and their number is 12 students to produce a transparent, semi-transparent and opaque sculptural work with acrylic material by a work for each student The work is a stereoscopic formation of transparent and colored acrylic material implemented with devices cnc.

Time limitation of the experiment:

- The researcher designed his experiment to be applied over a month and a half in the form of a study unit consisting of six lessons, ie by six interviews by one interview per week and duration of four hours.
- The experiment in the application of the work takes four interviews, during which a sculptural work is produced with acrylic material implemented using the CNC device for cutting and shaping by a work for each student in an area of 40 cm ×40 cm.

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- The experiment takes place in the first and second half months of the first semester of the academic year 2023-2024 to benefit from the accumulation of cognitive and skill experiences in achieving the results of the experiment.

Plastic limits of experience:

- The experiment is carried out in the application of parametric systems data and their role in changing the concept of contemporary sculpture.
- The experiment is carried out using transparent and translucent acrylic material and dealing with them using the methods of cutting, engraving and direct engineering sculpture as a methodological basis in the study of the fourth level.
- The experiment is carried out using various thicknesses for the thickness of the available materials, which suit the student's idea of work and dealing with them using sculptural formulations according to what is required to implement the idea of creative work using the CNC device.

Place preparation:

- The researcher conducted his experiment in a laboratory equipped with the necessary capabilities to form acrylic material and it is possible to be available in the halls and laboratories of stereoscopic expression at the Faculty of Specific Education.

Tools used in forming:

The researcher used technological tools represented in the laser cutting device (Golden Laser) and that cutting in an accurate way to implement the required design and thermoforming device (Vacuum XSHYD)

- Haddadi files of different sizes to level the dents from the cutting effect.
- Sandpaper to polish the countertops and then use the fixing material chloroform.
-

- Tools and tools used in the direct acrylic forming process:

A- Drill 2- Saws 3- Files 4- Lathes, clickers and milling machines 5- Cutting tools

For good results when using acrylic machines, some minor modifications are made to the tools, the presence of a series of thermal expansion of the material, increased friction, increasing heat arising and increased consumption of machines, all lead to damage to the material. The most important thing to note when operating in acrylic is to keep the number always sharp from the strawberry knife to the small hand drill (RJ Craw, 1981, p164).

- Forming methods in acrylic material:

There are multiple methods of forming acrylic material that are used to obtain the desired effect and formation, including:

1- Drilling 2- Sawing 3- Lapping 4- Clicking and Milling 5- Cutting 6- Cold 7- Sand Blight

There are many methods that can be used to complete the assembly process, but the most common ones can be summarized into:

- Splicing by gluing - welding

The use of adhesives provides the possibility of obtaining very strong bonds, although they are not a suitable medium for all plastic materials. Welding also produces strong bonds, but this can cause pressure or voltage condensation in the welded yard, both of which result in permanent bonds and welds.

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Experience:

Subject: Contemporary sculptural formation based on the concept of the parametric system with acrylic material and the integration of forming techniques through the use of semi-transparent acrylic sheets and strips of (different) thickness in order to achieve a simplified form of geometric overlap of a flat surface and different sectors.

View the subject of the experiment:

In the beginning, the researcher is fully aware that what he wants to measure and reach is the extent of benefit from the philosophical and creative dimensions of the concept of parameter resulting from contemporary methods of formation and the use of technological media and the adoption of contemporary thought in the production of contemporary sculptural formations, and from here the researcher began to present and present to the sample of the experiment that the initial abstract forms, which the fourth-level approach is based on studying, analyzing and using them in the work of stereoscopic configurations, can be used in the same ways as plastic treatments in the work of existing sculptural formations On the parametric system, the researcher intended to choose the linear geometric shape as one of the elements of installation to create a kind of determinants, which calls for thinking to find multiple plastic solutions, and in order for the student to focus the idea of switching from three-dimensional shapes to a transparent form body vacuum contemporary, then the researcher asked the experiment sample to do the work of a number of sculptural machines and linear formations with specific parametric geometric bodies for the subject of the experiment with a focus on the conversion between stereoscopic works and transparent works, and the researcher was based on To their experiences in the study of sculpture in the fourth year in the sculpture curriculum of the Faculty of Specific Education. After the students finished the work of the maquette, the researcher explained the distinctive properties of acrylic material, and the students began the practical procedure of the experiment with acrylic material, parametric design methods and the technological capabilities of the advanced CNC devices, and the researcher explained the methods of implementing the design on some Graphic programs (Corl Draw- AutoCad) in preparation for implementation with technological devices. Obstacles such as problems encountered in the processes of practical and executive procedure of sculptural spatial formations.

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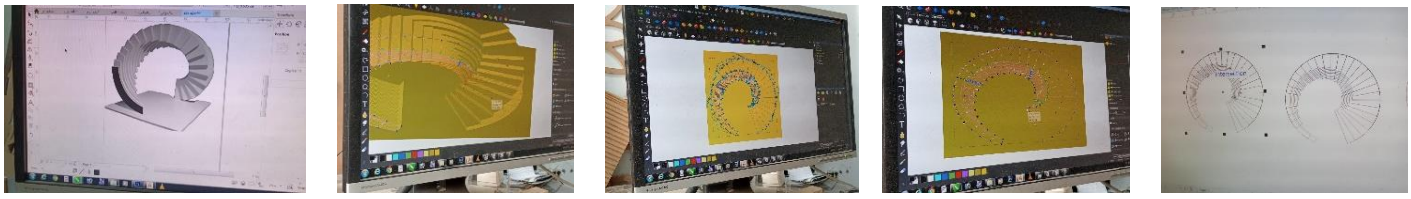
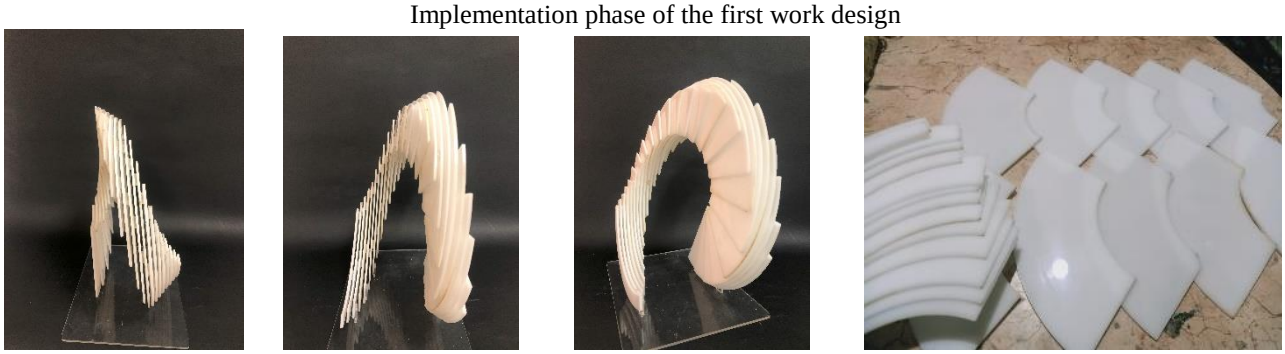
Research Experience
For students of the fourth year - Department of Art Education, Faculty of Specific Education - Matrouh University
Models of some sculptural models executed in acrylic material (Figures 19-30)
The designs were implemented using some digital programs (Curl Draw, AutoCAD, Illustrator)

First action:

Figure (19) The final form of the first work



Implementation phase of the first work design



The stage of cutting the work parts before assembly using the Golden Laser machine and different viewing angles for the final shape of the first work

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Second work:

Figure (20) The final form of the second work

The stage of implementation of the design of the second work and the stage of cutting the work parts using the Golden Laser machine and thermoforming with the vacuum machine, which is an oven system and acrylic is flexible at 250/280 degrees

Different viewing angles for the final shape of the second work

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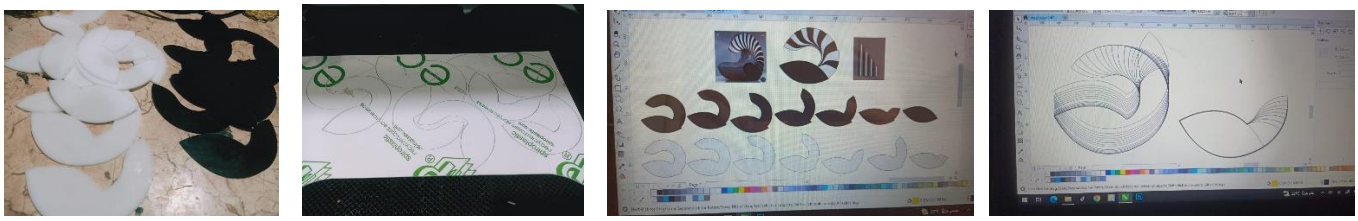
Third work:

Figure (21) The final form of the third work



The stage of implementation of the third work design and the stage of cutting the work parts before assembly using the Golden Laser machine

Different viewing angles for the final form of the third work

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Fourth work:

Figure (22) The final form of the fourth work




The stage of implementation of the fourth work design and the stage of cutting work parts before assembly using the Golden Laser machine




Different viewing angles for the final form of the fourth work

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Fifth work:

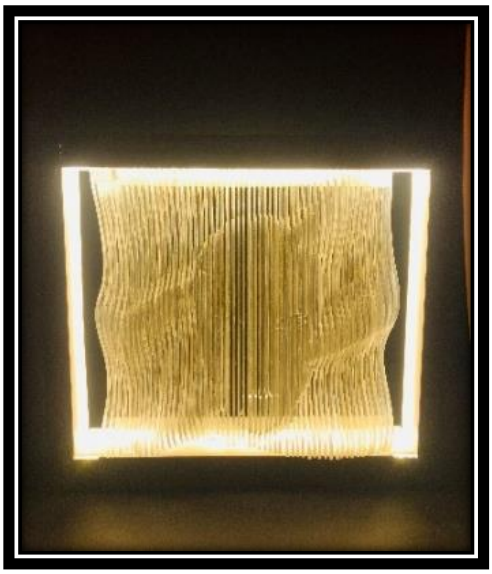
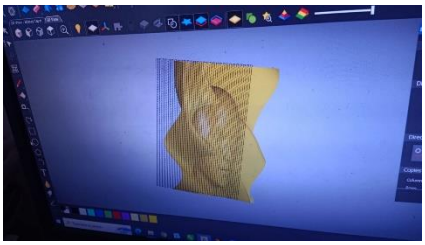
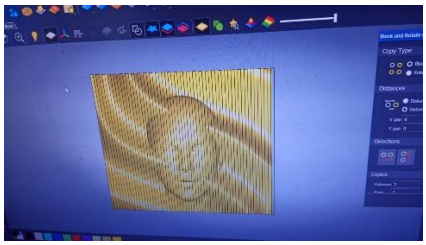
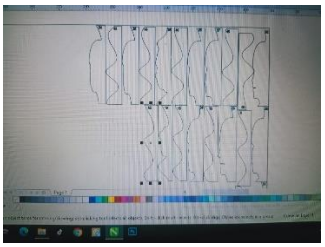
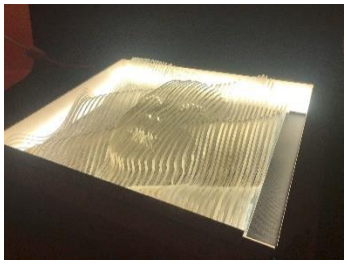
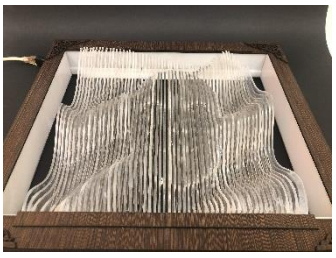
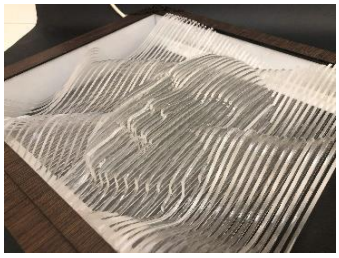
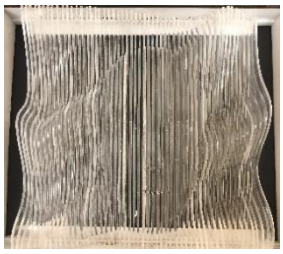


Figure (23) The final form of the fifth work

Implementation phase of the design of the fifth work

Different viewing angles for the final shape of the fifth work

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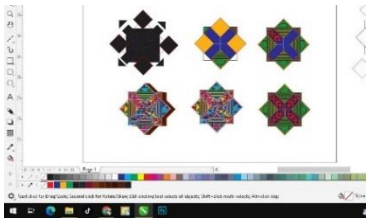
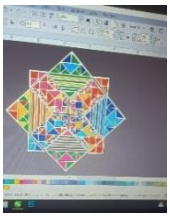
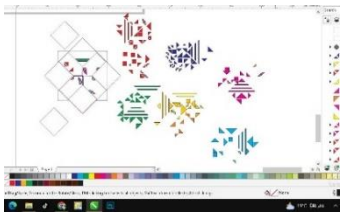
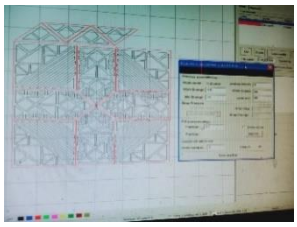
Sixth action:

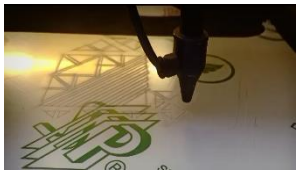
Figure (24) The final form of the sixth work

Implementation phase of the design of the sixth work







Stage of cutting and assembling work parts using chloroform welding

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Different viewing angles for the final shape of the sixth work

Seventh action:

Figure (25) The final form of the seventh work

The journey of implementation of design, cutting and installation of the seventh work

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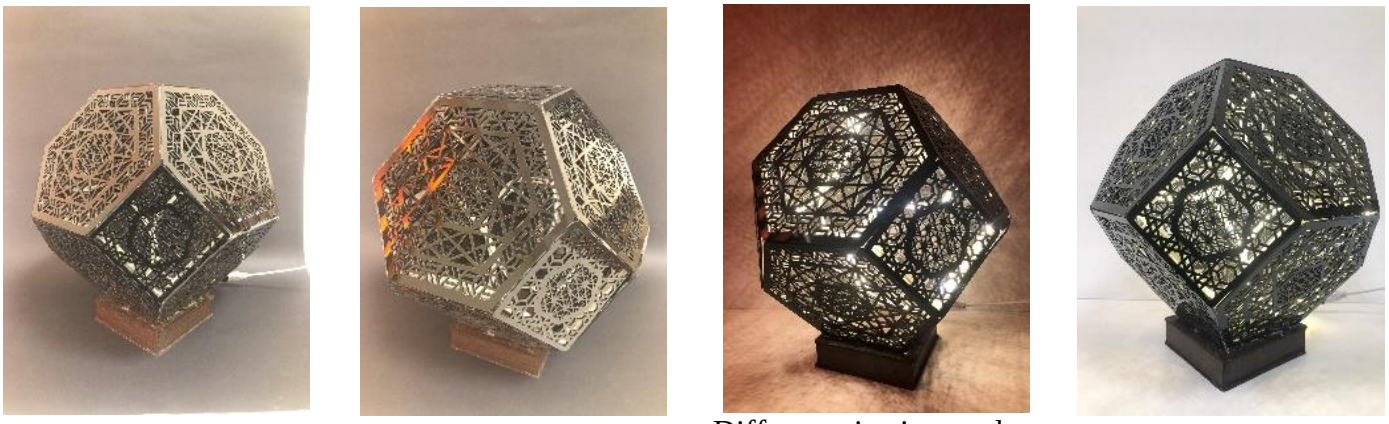

Different viewing angles for the final shape of the seventh work

Eighth action:

Figure (26) The final form of the eighth work

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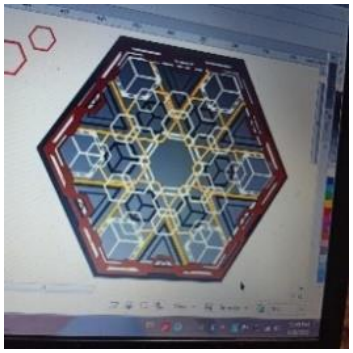
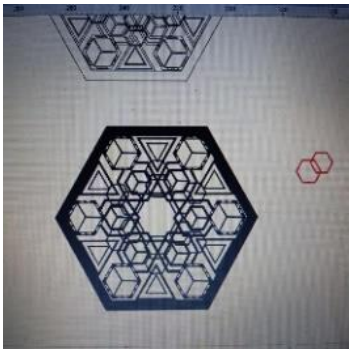

Design Implementation Phase



The stage of assembling the working parts using chloroform welding the eighth work

Ninth action:

Figure (27) The final form of the ninth work

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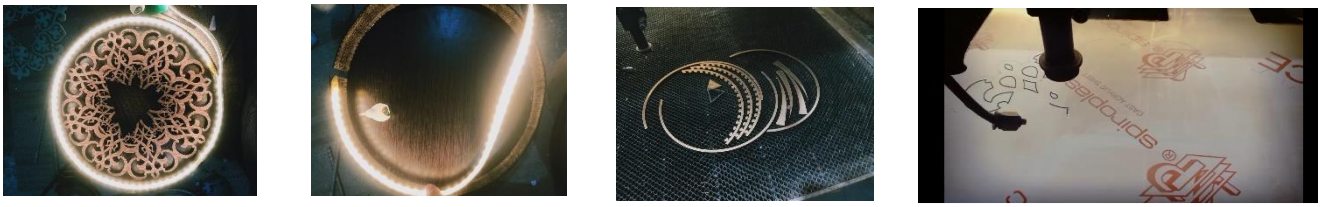
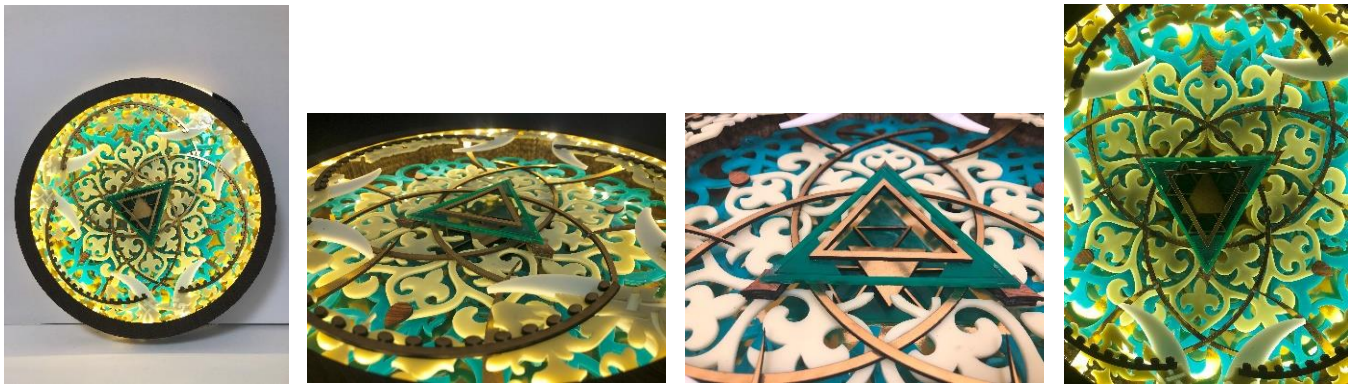


The stage of cutting and assembling work parts and installing lighting



Different viewing angles for the final shape of the ninth work

Tenth Action:

Figure (28) The final form of the tenth work

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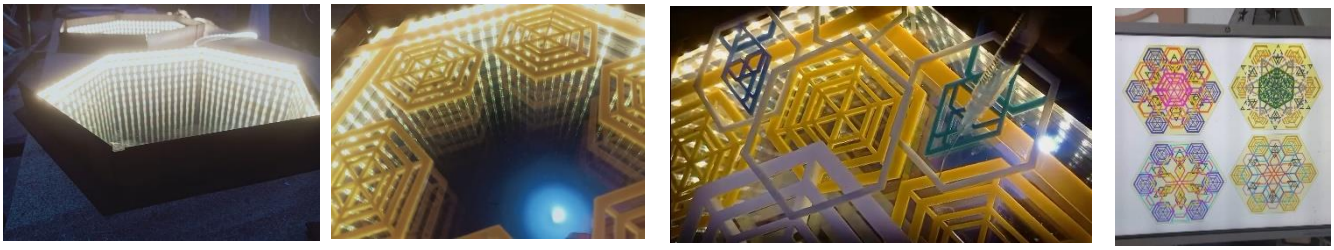
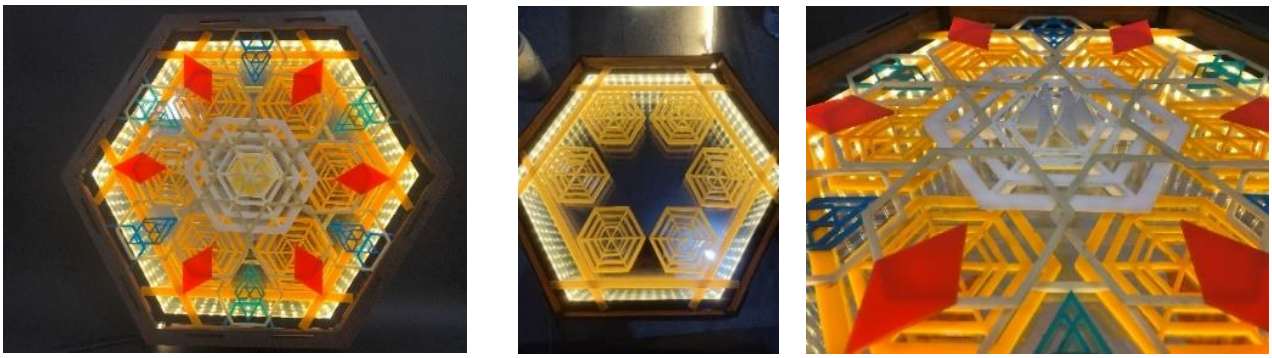


Implementation stage of design, installation and assembly of work parts using chloroform welding and lighting stabilization



Different viewing angles for the final shape of the tenth work

Eleventh Action:

Figure (29) The final form of the eleventh work

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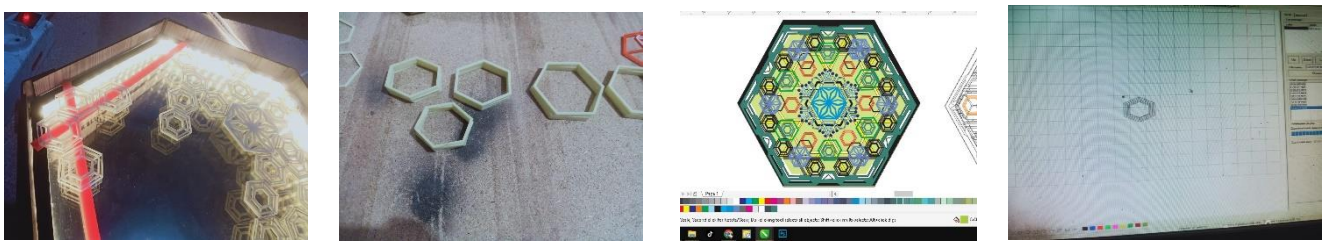
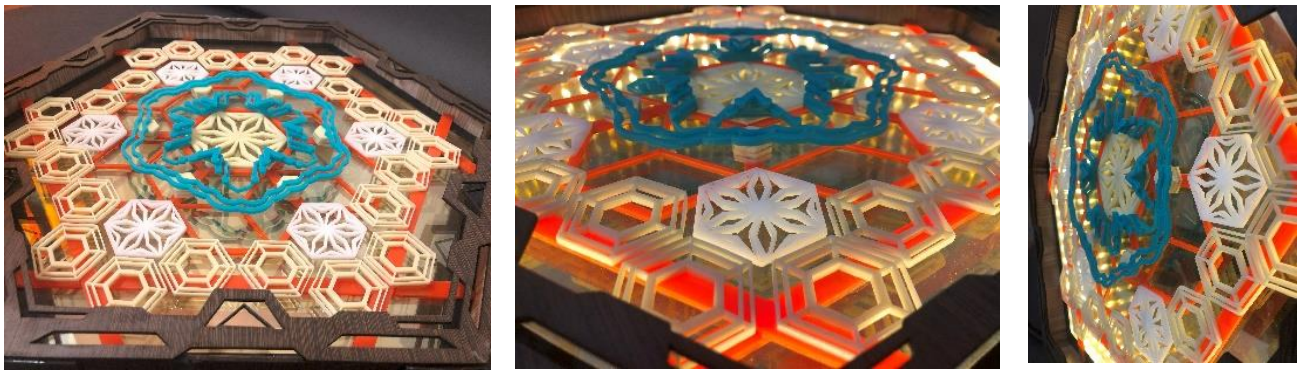


Implementation stage of design, installation and assembly of work parts using chloroform welding and lighting stabilization



Different viewing angles for the final form of the eleventh work

Twelfth Action:

Figure (30) The final form of the eleventh work

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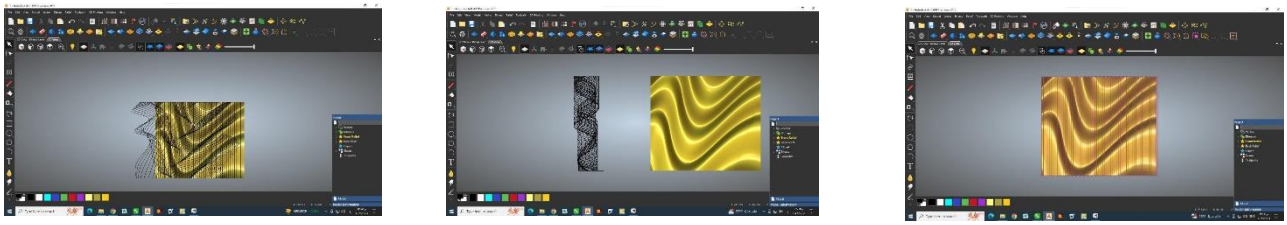
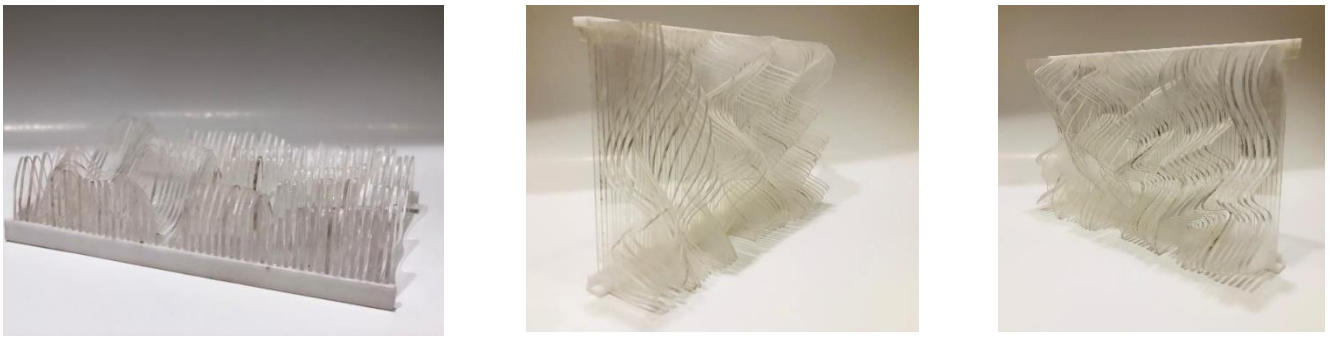


Implementation phase of the design of the twelfth work

Stage of installation and assembly of work parts



Different viewing angles for the final form of the twelfth work

Results:

Search results:

1. Through descriptive and analytical studies, it was possible to prove that the parametric design is characterized by flexibility, fluency and fluidity, in addition to aesthetic and functional values uniquely.
2. Parametric design technology provided students with multiple creative solutions based on the foundations of structural constructivist thought of form.
3. Linking the design with parametric execution technology gives the shape its aesthetically distinctive character using computer programs (Curl Drew and Alastair Tourautocad)

Results related to the natural properties of acrylic material:

1. Acrylic material is lightweight, hard, resistant and moisture resistant in sculptural formations by measuring it with traditional sculpture materials such as bronze, stones and wood.
2. Some of the plastic media used when carving acrylic can be used such as light, color, texture, and transparency.

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3. Acrylic material can be used to carry out some functional and aesthetic applications using the appropriate technology.

Results related to modulation methods:

Some types of plastic take the appearance of other materials such as (transparency of glass - the feeling of bronze and granite through coloring - the durability and hardness of stones - light weight - ease of formation).

Recommendations:

1. The need to introduce parametric design programs in sculpture courses in the Department of Art Education as one of the most important trends affecting the development and innovation of designs and the field of three-dimensional stereoscopic sculpture.
2. Emphasizing the need to link the contemporary sculptor with everything that is modern, whether in the field of raw materials technology or machinery technology.
3. The need to train sculptors in universities, whether students or faculty members, on the new technology, which has an impact on the development of the field of sculpture.
4. Attention to preparing a place equipped with all the necessary tools for forming with acrylic material in technical colleges.
5. A sculptor can transform the digital model into any possible material for sculpture.

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