

Some trends in modern mathematics resulting from the integration of science, engineering and interior design (Algorithm, Ornamatics)

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Abstract:

Since the early fourth and fifth centuries AD, geometry and mathematics have been used in Islamic architecture not only to overcome technical problems such as construction process or planning buildings with precise geometric shapes, but also to enhance the creativity of Muslim craftsmen, which is clearly visible in the highly complex geometric motifs. Perhaps the complex geometric motifs are a perfect example of the fact that geometry and mathematics are inseparable from Islamic architecture. Where it contradicts the traditional interpretations that claim to draw it through the ruler and the protractor, modern studies have proven its reliance on more advanced mathematical rules, and the Girih tiles method explained the use of a number of simplified polygons through specific algorithms in producing decorations impossible to draw precisely with traditional tools. The computational design opens up unlimited horizons in the field of Islamic heritage preservation. Applications such as (designer Girih) and (PATGEN) are one of the experiments that give a glimpse of the possibilities of converting Islamic motifs into mathematical variables to produce formations of infinitely complexity in a short time.

Digital design technology aided the process of representing engineering design and architectural drawing, so that most designers these days use software to develop ideas and not just draw or express them. These programs have achieved coordination between several data and different types of information that are provided to the program to be streamlined and coherent forms without specifying a specific function for them. This made it possible to create dynamic shapes in an organized and controlled way, which helped transfer these ideas from the designer's imagination to reality. These shapes are generated from information about the environment or other source of factors that may affect the design by converting them into equations or graphs and then applying them to the design to change its shape, which led to the creation of new styles of designs that did not exist before.

Just as computational design is based primarily on mathematics, it was necessary to explore the role of mathematics in Islamic architecture, and to search for Islamic architectural theory, in addition to fixed mathematical and engineering rules, so there are symbolic values and meanings that link the Islamic faith with architectural intellect, and it is considered as the theory that within it, the Islamic architectural design is realized, which was clearly evident in the study. The Islamic architectural art was based in its early years on the decorative architectural elements that are consistent with its spirituality, so it came out that are almost identical in most

Islamic countries with some slight variation imposed by each environment in terms of climate and skills and experiences of its inherited people in architecture and interior design.

The problem of this research: The interest of the West in Islamic architecture and the exploration behind it to devise the foundations on which these timeless works were based, whether in engineering or technology, with the Arab world lacking those theoretical and practical research, but on the contrary, the West is referred to know those foundations, and the lack of awareness of the importance of studying ancient Islamic research and manuscripts and making use of them in the subspecialty in a form that suits contemporary design.

The research aims: to review the role of Muslim mathematicians in the advancement of Islamic architecture, study the computational nature of Islamic geometric motifs, and arrive at a number of contemporary applications for the use of computational design in new engineering formations.

It is assumed that. acquaintance with ancient Islamic research helps to deepen awareness of the concept of Islamic interior design and thus work with well-established standards and foundations, and the use of mathematical theories in interior design leads to the integration of functional, technological and aesthetic thought.

The research followed: the descriptive and analytical method, the historical method for investigating studies dating back to the flourishing eras of Islamic civilization and analyzing most of what is related to the research topic.

The importance of the research: lies in highlighting the importance of mathematics and its relationship with Islamic architecture and interior design, shedding light on some Islamic research carried out by Muslim scholars and designers who have contributed to the development of Islamic architecture and interior design, and reviving some ancient Islamic theories in a way that is compatible with the spirit of the times in the field of Interior Design.

An introduction:-

Ibn Khaldun says that (Engineering enlightens thought and controls one's mind), and believes that the evidence in geometry is highly clear and organized, and that the mind that applies engineering logic is unlikely to fall into error, and this principle may have been derived from the aphorism inscribed on the facade of Plato's Academy. Only those who are accustomed to geometry are allowed to enter (it is rare for errors to enter into engineering logic, and the Muslim artist considered that geometry is the logic of God Almighty in creation and that geometric proportions are the source of harmony in the universe, so they used it in architecture and in calculating the proportions of spaces in buildings to bring continuity to the principle of sacred geometry, which Pythagoras asserted that they release music in a balanced form.

The word geometry is divided into two halves, each of which forms a Greek word, geo means earth, and metry means measurement, so it literally means measurable earth or earth measurements, and during the golden age of Islam, translations were active from Greek and Hellenistic mathematics, as well as Indian mathematics. The main aim of such studies is to benefit from them in solving the problems of facing the kiblah, times of prayer and fasting, which led to a special interest in engineering sciences and had the greatest impact on employing these sciences in the field of plastic art and decoration, as it is characterized by mathematical accuracy, aesthetic pleasure and symbolic meaning.

Keywords:

Geometry, Mathematics, and Computational design.

Geometry:

- Geometry is a logical system affiliated with mathematics, it is the first organized language in mathematics logic and this system is called Euclidean geometry or sometimes Parabolic Geometry, and geometry is concerned with things like points and lines and it is closely related to cosmic interpretations. Euclidean geometry is nothing but a translation of abstract points and lines into groups. A well-defined knowledge, as well as translating many relationships such as congruence, simulation and similarity into defined relationships on those groups.

Mathematics:

- It is the abstract science of number, quantum, and emptiness. Mathematics can be studied for its own sake (pure geometry) or applied to one of the disciplines such as physics and engineering (applied mathematics). Reflecting the architectural works Sinan is the mathematical background of a Muslim architect.

Computational design:

It is a term that differs from computer-assisted design (CAD) and despite that the two terms are often confused in general, the second term is more related to the use of the computer as a digital drawing tool, for completing some routine procedures in the design process, so the computer in this case does not interfere in the process. Thinking while designing, in contrast, computational design is about using the capabilities of algorithms - by programming and coding - to review endless alternatives from engineering configurations, solve highly complex engineering problems, and simplify them for the designer.

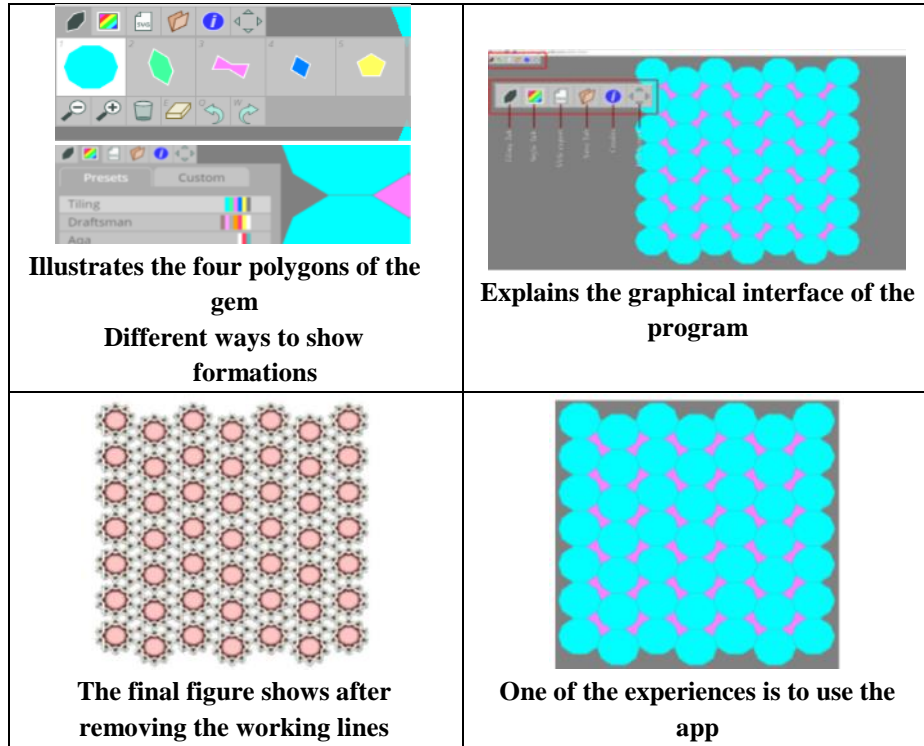
The benefits of using this technology do not only save construction time, but also provide the designer with final design choices and remove all technical restrictions that hinder his creativity through traditional techniques. Also, it helps to integrate all design phases into a smart unified model, whose parts are easy to analyze and manufacture with extreme accuracy with minimal human intervention possible.

(Girih Designer) application:

(Girih Designer) application, which is a web program, that allows showing two-dimensional and three-dimensional graphics, as the application uses the five basic shapes previously mentioned (decimal, rhombus, elongated hexagon, pentagon, and equal arc)

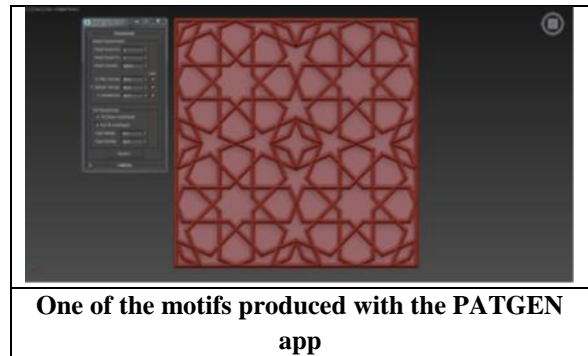
It relies on three simple variables on those shapes to link them together (move, position, and rotate at an angle of 36 degrees). Engineering.

In the example, the researcher used the application to design a set of geometric motifs using only two elements, the decimal and the equal arc, and after arranging the elements, the building lines were removed and the inner lines of the units were added through the clearing style command, then exported the design to SVG format for use in engineering drawing programs.



Application Study (PATGEN): -

This example is based on the work of researchers (2008, Uysal, & Yazar, Çolakoğlu.) It is a code attached to the MAX 3Ds program for three-dimensional design, dedicated to designing Islamic geometric motifs in a flexible parametric way through the use of the problems of the grammar algorithm shape algorithm, the computational design was used in reaching the required algorithm. First, the mathematical rules and variables for those configurations were defined in all their cases. Then (maxscript) codes were used to produce a small application that allows drawing motifs by changing the values of different mathematical variables. Digital fabrication from the experience of the researcher of the application, it becomes clear that it depends on a different algorithm, where it takes the eight Islamic star as a building unit for the variables and not the five basic polygons.



During the research, these results were achieved:

- Complex geometric motifs are the best example of the fact that geometry and mathematics are inseparable from Islamic architecture, as they are the fruit of mathematical thinking based on careful calculation that may turn into a kind of diagrams of philosophical ideas and spiritual meanings.
- Algorithm is a mathematical way of thinking, giving geometric relationships and presenting new ways of thinking to solve problems of multi-dimensional designs, by developing coding for decorative units to make equations within a computer program.

- Computational design is related to the use of algorithms' capabilities (through programming and coding) in reviewing infinite alternatives from engineering formations, creating new styles of designs, and opening unlimited horizons for preserving the Islamic heritage.
- The existence of integrative study relationships between engineering sciences, mathematics and design, which keeps pace with modern trends, and one of the most important of these trends is (the orientation of dynamics), and it is one of the modern trends that rely on the use of geometric Islamic motifs in designing in a contemporary manner through computational design programs.

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