

The Applications of Mathematics and Modular Art in the Education of Interior Design

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Abstract

The new learning processes should be piloted therefore; Interior design schools should be updated according to the results of progress in teaching methods.

For this reason, the objective of this study is to define the formulation of a mixed learning model for mathematics applications and technical models within the interior educational system.

This paper's main objective is to find explanations of incorporating the cotemporary interior design within the Mathematics & Modular art content, and to seek modern solutions featuring as new methods.

This paper was carried out by experimental procedure in University of Petra/Department of Interior Design based on basic design courses in the academic years 2011-2012 where the researcher took a sample of ten student forms based on the models which were chosen in this experiment combining both difficulty & ease. The students have completed these ten shapes by altering mathematical approach (Latin square) to create a new pattern design.

Art with Mathematical approaches have been applied in different practical applications as a basic design tool, and conclusions have been reached on the merits of the design. The advantages and disadvantages of teaching interior design have been introduced from Art & mathematical perspective as a method of design based on the results found during the practical applications of basic design projects and from information in publications on the subject. Relying on these proposed models, the proposals will constantly develop design tools.

In conclusion, educating future designers to digest the essence of these approaches will make it possible to train professionals who correctly use and understand the developed technologies that can create futuristic designs.

Keywords: Mathematics, Modular art, education, interior design

1. Introduction

Modular design generally known as the creation of a variety of diverse structures that is established using a small set of basic modules or elements.

The module usage and benefits, were historically presented by Vitruvius the Roman author and architect as a consistent unit of measurement for proportioning in classical architecture. (Pollio, 1940).

Therefore, they are mainly ingathered and accumulated to repeat periodic units, with a possibility of growing more organic free form arrangements. So as a result, the modular approach is highly beneficial when it comes to the ease of manufacture with the production of mass interchangeable parts.

It goes beyond that to benefit the geometric adornment composition where the non-experts can easily re-use the familiar forms of shapes appear in a variety of contexts, in other words, they can produce acceptable and satisfactory results distributing related elements just as modular design naturally creates. (Cromwell, 2012)

The outstanding developments in technology and construction techniques in the twentieth century, highly effected the use of modularity in arts to make it a measurement tool as well as consistent units that add up all together to create bigger structures, and the development did not stop here, but in the recent years was a growing interest in

modularity in the field of interior design defiantly because of its advantages such as simplicity of assembly/disassembly, customization, and cost efficiency, which results in pliability and a different contextual and adaptable design outcomes with the flexibility to be adjusted easily (Hur, E. S, 2011, p.217)

Since that, the Mathematics and Modular art has developed some characteristics for designing space and structures, making it a useful inspirational source in Interior design. Therefore, this study is an integration of Math and scale in art pattern in which we can find other types of applications of Mathematics and Modular art making it useable in a wider design context through knowing the shape and it's geometry, in this way we can say that Mathematics and Modular art is one of the most important features in the interior design field.

1. Propose the works by different artists and designers who have studied the forms of modular art & Mathematics
2. Provide different projects of Mathematics and Modular art implemented for the interior design elements.
3. Study & review many literatures in this field regarding to the Mathematics and Modular art in interior design

1.1 The Aim of the Research

To look for the interpretations of integrating the contemporary interior design within the Mathematics & Modular art context, and to find out new creative ideas as an innovative approach

1.2 The Objective of the Research

To present and redefine a new concept through combining the modern interior design with the Mathematics and Modular art context, and then to conclude the most creative ideas out of this innovative approach. Therefore, the objective of this study is to define the formula of mixing mathematics learning model with the interior educational system.

2. Definition

Modular systems includes the idea of “minimum inventory and maximum variety,” a model firmly related with architecture, engineering and the sciences. This system is made up of multiple standardized units (modules) that can be collected together to form different arrangements to configure multiple functions or create different structural forms (Pearce, Peter).

Modularity, in the design field, relates to the level to which a product's elements may be reshaped, removed and/or added and the laws that govern this (C.Y. Baldwin and K.B. Clark, 2000).

3. Literature Review

3.1 (Mathematics and Arts: Connections between Theory and Practice in the Medieval Islamic World, 2000)

The Islamic Art was based on the use of mathematics in art & design in a geometrical context.

This study mentions the background of the hand-crafts artists involved in geometry, and how their experience in geometry connected history to the new studies that shows mathematicians educating practical geometry to hand-crafted artists influenced the beginning of these designs and maybe in designing the buildings themselves."

Therefore, the main goal of this paper is to highlight the experience of artisans as well as the mathematicians in the medieval times to drive the use of modularity in the use of some classes of designs. (Özdural, 2000).

3.2 [Modularity in Medieval Persian Mosaics: Textual, Empirical, Analytical, and Theoretical Considerations, 2005]

This study used the polygonal sub-grid system, which was employed in geometric constructions in the era of Persian medieval times especially in contrast of color which was used before in Maldives tiles.

The conclusion of this study showed that the work of Medieval Persian artists utilized the complex overlay of geometric patterns, calligraphy and floral designs. Their achievement & skills in design was inspired by working along with mathematics & art.

The most apparent method in creation of the ornamental patterns for the craft-man artists was by polygonal constructions & its meaning. A modular approach was suggested by cut-tile ornaments, based on repetition and color contrast using the trial and error method. (Sarhangi, Reza, 2005).

3.3 [Transformative Modular Textile Design, 2011]

We can state that the textile ornament in this research using the modular system is based on primitive objects. However, the use of these shapes can be translated into a new textile design which can be used in a new modern interior space to create a new interior design element.

This research combines the fields of textile design, mathematics, art and fashion to create a new element in interior

design. (Hur, E. S., 2011).

3.4 [A modular design system based on the Star and Cross pattern, 2012]

This article introduced a modular design system, which is called the Central Asian modular design system (CAMS). This study has introduced a modular system derived from the Star and Cross pattern. The family of patterns that can be produced by assembling the modules includes many traditional Islamic patterns from Central Asia and Iran. (Cromwell, 2012).

4. Methodology of Research (Experimental Work)

This research was based on the experimental method, following a qualitative approach, at Architecture and Design faculty, in 2011, and 2012, as part of basic design 1 (202101) course work in first semester for level one students at the department of interior design; this experiment focused on grid project as one of the most important order in principle of design to achieve innovative ideas with aesthetic values and a compatible benefit by using the simple and complex orders.

4.1 Describe the Experiments

The research divided the experiment into two years, First one was done in 2011 & the second was done in 2012, they used the same project of basic design 1(202101) course, the project took three weeks to finish the experiment, in two years which was 2011, 2012, but with a little development in the second experiment.

4.2 The participants

4.2.1 Human participants

There are two kind of participants in these two experiments 2011, 2012. The human participant; The project during the two years was lead by one instructor and one Teaching assistant and the jury members was divided into internal juries (faculty members) and two external juries (interior designers form the Labour market). 20 mix students male and female did the projects. The age of the students was between [18-19] years in one class room for each of the two experiments.

4.2.2 Instrument participants:

- In the first & second experiment 2011, 2012 the students used:
- Two class room for practical courses with all good conditions for working.
- White thick paper colour and black rota ring pen, and Katter with cutting pad were used also in these two experiments.
- 40 white drawing board with 40 stool movable chair were used.
- Withe board for writing & one desk office with two chairs for instructors
- Withe foam and UHU glued were used in the 2012 experiment only.
- Data show with it's screen was used in the two experiments.

4.3 Data Collections

Data was collected from books, articles, scientific journal web sites and the final result of the evaluations from internal and external jury members from the second projects of basic design 1 in the two years 2011, 2012. The target population in this research was interior design students, academicians and interior designers from the labour market. The selection of research samples was based on the top tenth projects with highly evaluations from all years, five form every years.

The data were gathered and analysed to test what kind of relationship is between Math and Art in interior design. The researcher is really aware that the data gathered from jury members, is not hundred percent accurate but the researcher assumes that the result will be near to the indeed.

4.4 Research Design

In these two experiments (2011& 2012). The students have implemented these tenth following points in their tenth samples:

- ❖ The simple basic design pattern was created from modular arithmetic operation tables measuring 10 x 10 cm. with Angle 90° & 45°.
- ❖ Each patterned square was allocated to a numbered cell (Latin square) in the table, then each square was filled in it with the pattern according to the number marked in it.

- ❖ The basic design pattern was copied in one of the four corners of a 2 x 2 grid, then these merging of 25 squares were used as a pattern in this project, also the (slide), reflect (flip), or rotate (turn) could be translated in to form larger, more artistic designs.
- ❖ After that this pattern had been copied in the upper left quadrant, it was reflected from the upper left quadrant onto the other three quadrants of the grid - in a vertical line of reflection for the upper right quadrant, and each of these in a horizontal line of reflection for the lower two quadrants. For example see Fig. 1 show the application of Mathematic and art by using simplicity method to create basic pattern.
- ❖ The design pattern was created according to the basic fundamentals (Scale/proportion, Size, Divisions, Dominance, Emphasis, Similarity, Contrast, Movement, Variety, Repetition, Rhythm and Harmony then applied the main concept to the form.
- ❖ The next step of the project students designed a complex and distorted pattern, in the rate of (70%) where the width and height were directly fixed above. the new complex pattern had been zoomed in to the same size as the original project pattern.
- ❖ By using two proposals in every pattern from the four, all four patterns used in first and fourth proposal of it, flip and rotate inside and outside, but in the second proposal of it the student used flip and repetition show fig. 2
- ❖ Finally students should change the 2d figure into 3d figure using Addition and Subtraction form and connection methods between these unites like: edge to edge contact and face to face, overlapping, interlocking, interlacing volumes.
- ❖ white and black colour were used in the final result of the projects in year 2011, then paper and foam were used in the final experiment of year 2012, with different sizes and thicknesses.

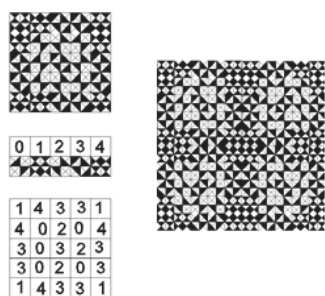


Figure 1. Show the application of Mathematic and art by using simplicity method to create basic pattern

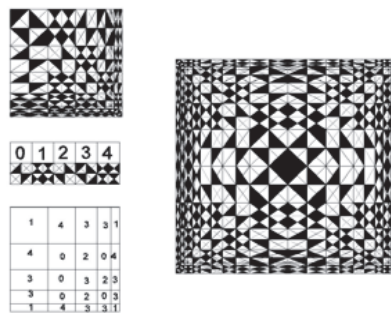


Figure 2. Show the application of Mathematic and art by using complexity method to create a destroyed pattern

5.1 First Experiment in 2011

5.1.1 In proposal 1

Four simple patterns measuring 10 * 10 cm were created. The first one was the grid with 90 angle, the second grid with 45 angle, the third grid was with a combination of 90 and 45 angle and the fourth grid created by free curved lines.

These four patterns were made by black and other colours according to the basic fundamentals (Similarity, Contrast, Movement, Variety, Repetition, and Rhythm).

The next step of the project students designed a complex and distorted pattern, in the rate of (70%) where the width and height were directly fixed above. The new complex pattern had been enlarged to the same size as the original basic design pattern.

By using two proposals in every pattern from the four, all four patterns used in first proposal of it, flip and rotate inside and outside, but in the second proposal of it the student used flip and repetition.

See Fig 3 show (proposal 1) the application of Mathematic and art by using complexity method to create basic pattern. The Final size was (A2)(42.0 x 59.4cm) blue & white CANSON paper.

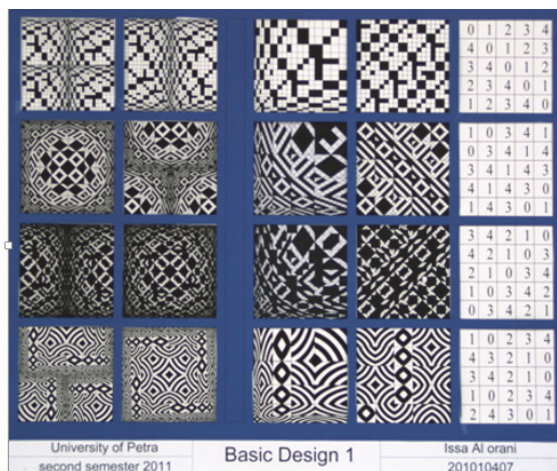


Figure 3. show the First experiment in 2011/ proposal 1

5.1.2 In proposal 2

Four simple patterns measuring 10 * 10 cm were created. The first one was the grid with 90 angle, the second grid with 45 angle, the third grid was with a combination of 90 and 45 angle and the fourth grid created by free curved lines.

These four patterns were made by black and other colours according to the basic fundamentals (Similarity, Contrast, & Repetition are in all four new patterns but specially in the second and fourth patterns the Dominance, Emphasis, Repetition, and Rhythm were used in it).

The next step of the project students designed a complex and distorted pattern, in the rate of (70%) where the width and height were directly fixed above. the new complex pattern had been enlarged to the same size as the original basic design pattern.

By using two proposals in every pattern from the four, all four patterns used in first and fourth proposal of it, flip and rotate inside and outside, but in the second proposal of it the student used flip and repetition.

See Fig 4 show (proposal 2). The Final size was (A2) (42.0 x 59.4cm) blue & white CANSON paper.

5.1.3 In proposal 3

This proposal follows the same process in the last proposal yet, the differences came by using a new four patterns, These patterns were made by black and white colour according to the basic fundamentals (Similarity, Contrast, Repetition and Rhythm are in all four new patterns but specially in the second pattern the Dominance, Emphasis and Repetition, were used in it).

The next step of the project, complex and distorted pattern were designed in the rate of (70%), and the width and height were directly fixed above. the new complex pattern had been enlarged to the same size as the original basic design pattern.

By using two proposals in every pattern from the four, all four patterns used in first and fourth proposal of it, flip and rotate inside and outside, but in the second proposal of it the student are used flip and repetition, See Fig 5 show (proposal 3). The Final size was (A2)(42.0 x 59.4cm) Gray & white CANSON paper.

5.1.4 In proposal 4

Four simple patterns measuring 10 * 10 cm. were created. The first one was the grid with 90 angle, the second grid with 45 angle, the third grid was with a combination of 90 and 45 angle and the fourth grid created by free curved lines. These four patterns were made by black and white colour according to the basic fundamentals (Similarity, Contrast, Repetition and Rhythm are in all four new patterns but especially in the second pattern the Dominance, Emphasis and Repetition, were used in it).

The next step of the project, complex and distorted pattern, were designed in the rate of (70%) where the width and height were directly fixed above. the new complex pattern had been enlarged to the same size as the original basic design pattern.

By using two proposals in every pattern from the four, all four patterns used in first and fourth proposal of it, flip

and rotate inside and outside, but in the second proposal of it the student are used flip and repetition. See Fig 6 show (proposal 4). The Final size was (A2)(42.0 x 59.4cm) Blue & white CANSON paper.

5.1.5 In proposal 5

This proposal follows the same process in the last proposal yet, the differences came by using a new four patterns, These patterns were made by black and white colour according to the basic fundamentals (Similarity, Contrast, Repetition and Rhythm are in all four new patterns but specially in the First and fourth pattern the Dominance, Emphasis and Repetition, were used in it).

Complex and distorted pattern were designed in the next step by using the rate of (70%), the width and height were directly fixed above. The new complex pattern had been enlarged to the same size as the original basic design pattern.

By using two proposals in every pattern from the four, all four patterns used in first and fourth proposal of it, flip and rotate inside and outside, but in the second proposal of it the student are used flip and repetition, See Fig 7 show (proposal 5). The Final size was (A2)(42.0 x 59.4cm) Gray & white CANSON paper.

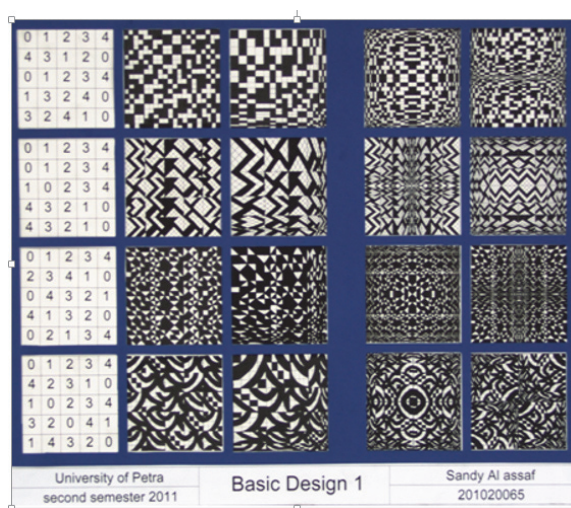


Figure 4. Show the First experiment in 2011/ proposal 2

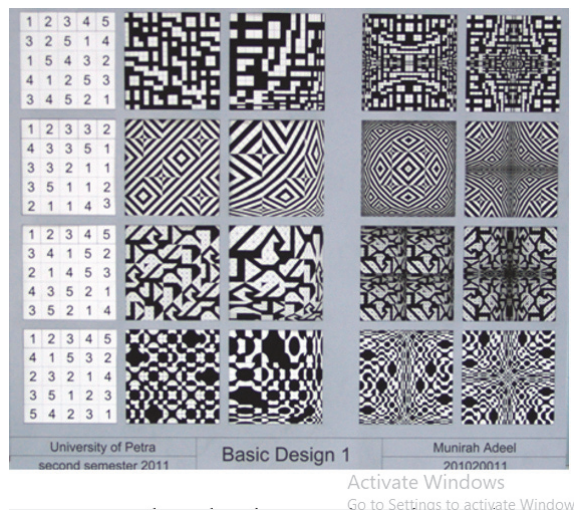


Figure 5. Show the First experiment in 2011/ proposal 3

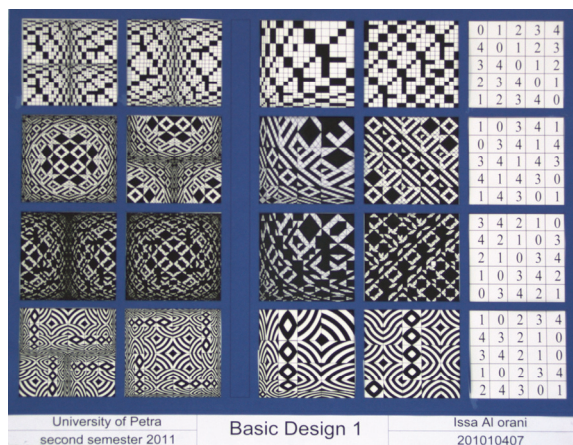


Figure 6. Show the First experiment in 2011/ proposal 4

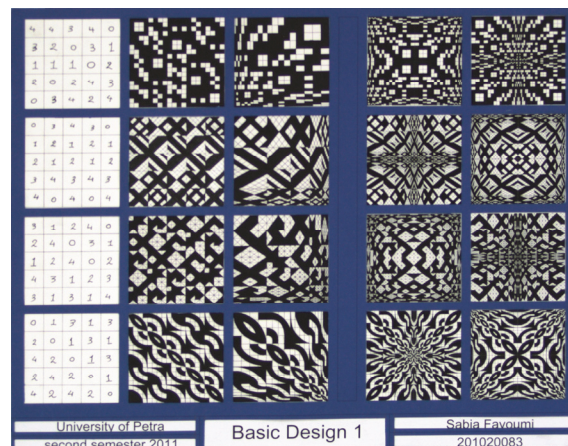


Figure 7. Show the First experiment in 2011/ proposal 5

5.2 Second Experiment in 2012

This Experiment follows the same process in the last Experiment yet, the differences came by using a new material and handmade cutting paper, with different heights, the overlapping connected methods were used in these units. Also, white and black papers, foam, were used with a different thicknesses of layers in the next five proposals:

5.2.1 In proposal 6

This proposal follows the same process in the last proposals yet, the differences came by translating the 2d patterns into the 3D figure by adjusting the new forms and applied all the basic elements (Dominance, emphasis, rhythm, repetition, flip and rotate) and also using the rate of (70%), the width and height were directly fixed above. The final size was 50*50 cm. Gray & white CANSON paper were used in it. See Fig 8 show (proposal 6).

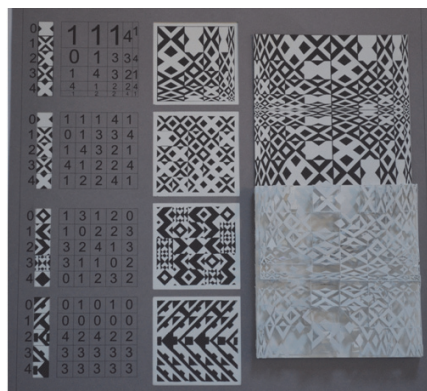


Figure 8. Show the Second experiment in 2012/ proposal 6

5.2.2 In proposal 7

This proposal follows the same process in the last proposals were as, the differences came by translating the 2d patterns into the 3D figure by raising first and applied all the basic elements (Dominance, emphasis, rhythm, repetition, flip and rotate) and also using the rate of (70%), the width and height were directly fixed above the final size was 50*50 cm. Gray & white CANSON paper were used in it. See Fig 9 show (proposal 7).

5.2.3 In proposal 8

This proposal follows the same process in the last proposals yet, the differences came by Translating the 2d patterns into the 3D figure, this first grids were tilted up and down by cutting and raising the new shapes and applied all the basic elements (rhythm, repetition, flip and rotate) and also using the rate of (70%), the width and height were directly fixed above the final size was 50*50 cm. Red & white CANSON paper were used in it. See Fig 10 show (proposal 8).

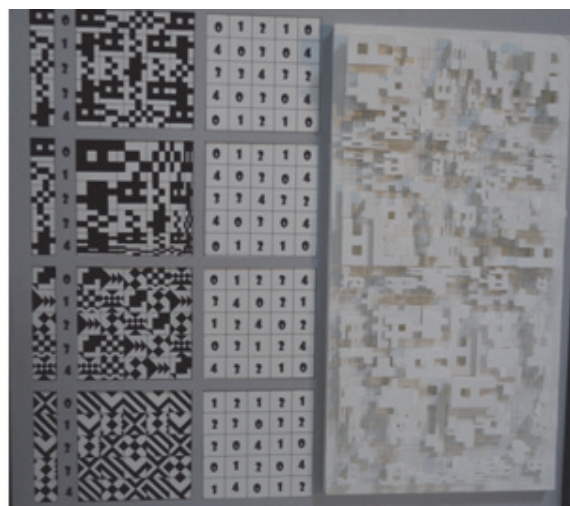


Figure 9. Show the Second experiment in 2012/ proposal 7



Figure 10. The Second experiment in 2012/ proposal 8

5.2.4 In proposal 9

This proposal follows the same process in the last proposals were as, the differences came by Translating the 2d patterns into the 3D figure by raising the third grid and applied all the basic elements (Dominance, emphasis, rhythm, repetition, flip and rotate) and also using the rate of (70%), the width and height were directly fixed above the final size was 50*50 cm. Red & white CANSON paper were used in it See Fig 11 show (proposal 9).

5.2.5 In proposal 10

This proposal follows the same process in the last proposals were as, the differences came by translating the 2d into the 3D patterns by raising the free curvilinear grid with a different heights, quilling white paper were used with a difference size and axis. all basic elements (Dominance, emphasis, rhythm, repetition, flip and rotate) using with the rate of (70%), the width and height were directly fixed above the final size was 50*50 cm. Red & white CANSON paper were used in it See Fig 12 show (proposal 10).

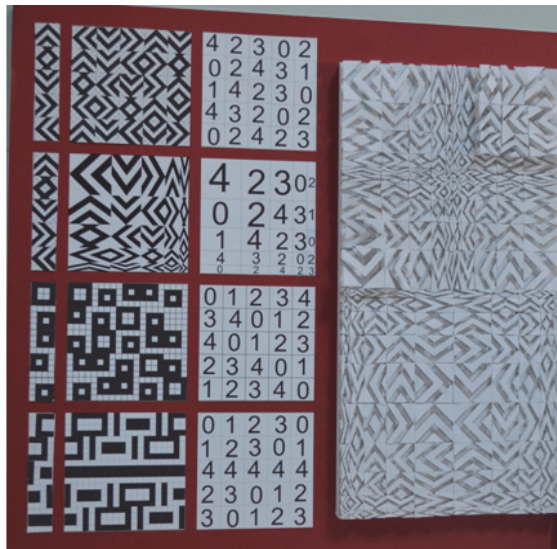


Figure 11. Show the Second experiment in 2012/ proposal

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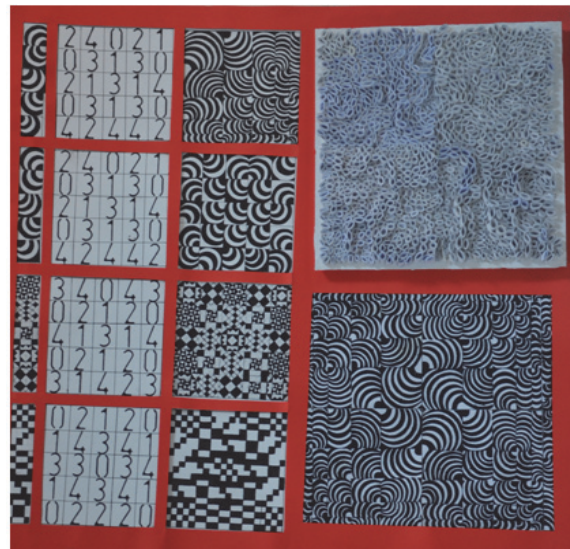


Figure 12. Show the Second experiment in 2012/ proposal

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6. Conclusion

- This article has introduced a modular system derived from the vertical and diagonal pattern, as technical innovations provided new media, the new proposed patterns were adapted and developed
- The grouping modules together were used also to form larger ones either as a hidden organizing principle or to generate a complementary pattern on a different scale.
- Educating future designers to digest the essence of these approaches will make it possible to train professionals who correctly use and understand the developed technologies that can create futuristic designs.
- The worthiness of mathematics and art was much more strongly connected to the attitudes of create a new form from the past to the future.
- The math and art experience have led to a reconceptualization of math being a useful subject for learning principles of interior design spatially to create a new grid of forming the floor, wall, furniture, ceiling ... ect.

7. Recommendations

- This research demands for modern and complete visions of the scientific and technological foundations of a society for the future by using Math and art to create a new order of interior spaces

- The application of math and art in Interior design can have a reasonable message through its design elements showing connected science which can be emphasized through the creation of movement forms.
- These logarithm projects can transfer Math and art from fine grid drawn on paper to computer through the usage of these designs in order to form 3d spaces.

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