

## The impact of using Voronoi diagrams on the contemporary interior design.

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### Summary

Design is a process that requires an advanced stage of thinking in order to find suitable problems solutions. Consequently, Designers are no longer relying their creations on ordinary resources, but are always looking for unconventional ideas. The interior design depends on the previous designer experience through which he generates new ideas and inventions. Contemporaneity is a term that reflects the rapid changes that the design world faces each day. Accordingly, the designer must cross the barrier of everything traditional in his designs, using all the disciplines that directly or indirectly serve his field. Moreover, computer applications, which are developing rapidly, have a pivotal role in stepping up vision and design horizons. Many applications allow 2D and 3D modulation, which positively affects both the output and the design process. This paper investigates the impact of using Voronoi Diagram -as one of the mathematics methods in space and surface dividing- on the interior and furniture design. Voronoi Diagram used to divide two-dimensional surfaces through specified points. This application result is used recently in interior and architecture drawings without relying these forms to the mathematical rules and fundamentals. The lack of the foundations and principles of the Voronoi diagram for many designers, consequent, contemporary design insufficiency. Interior designer's perception of the foundations and the basic rules of that counterpart will positively reflect on the design outputs in that it can develop in the governing ratios of the building and not only the formal benefit. The computer also has applications associated with the Voronoi scheme that helps the designer to form surfaces effectively.

### Keywords:

Interior Space, Futuristic Design, Voronoi Diagram, Biotical engineering ,Computational Geometry.

### Introduction:

Interior design is one of the Applied Sciences that is influenced by other disciplines. Every invention has its design impact in away, making it difficult to identify contemporaneity. It also makes the designer always in a state of anticipation for every new that may open his intellectual and cognitive horizons and affect the design process .For example, Biotical Engineering Which is defined as a science that relies on the use of nature elements functional mechanism and their impact in other fields. Based on its principle's designers can innovate new design solutions that reflects Organisms mechanism of adaptation with nature. Designers did not relay their knowledge about the appearance of biological structure of organisms but dived further in order to explore the mathematical theories behind these forms. With the help of computer applications, the mathematical relations in which the organic organisms were structured was analyses. This new analyses forms shapes new source of inspiration for the designers, in which designers search for new creations. Voronoi Diagram is a model for the

biological coordination of forms in nature and how to visualize them to give a mathematical base through which internal and external spaces can be treated. The Voronoi Tessellation defines a process of biological structure self-organization evident on a dragonfly's wing, turtle shell, honeycomb, or sea urchin shell. (Fig.1)



**Fig.1 the Voronoi division in the structure of dragonfly wings and honeycomb.**

Many designers using the Voronoi decigram application as from without understanding the principles of the application. This research helps in understanding and clarifying the basics of the Voronoi diagram structure and how it could benefit design. The research assumption that the designer's understanding of the Voronoi diagram basic rules will effectively affect the design output to be contemporary.

### **Research questions:**

**The research will try to answer the following questions:**

What's Voronoi diagram and how deep it could affect interior and furniture design?

Does the impact of Voronoi diagram on design outputs only or also on the designing process?

Can we describe the design outputs as a contemporary futuristic design?

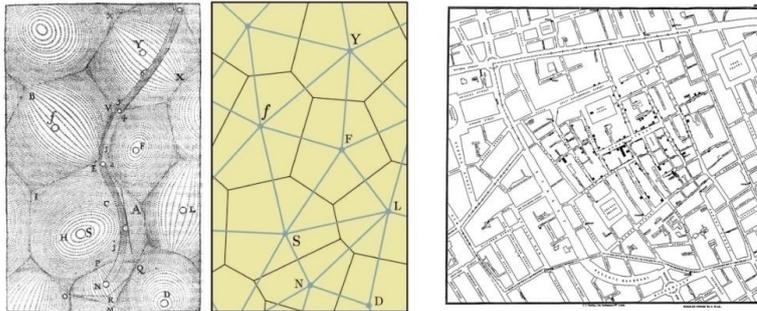
### **Research methodology:**

The research will use the descriptive and analytical approach to present the Voronoi diagram basic rules, moreover, display, and analysis some existing projects that are influenced by this application.

## **1. Voronoi Diagram**

### **1.1 History of Voronoi Diagram**

in the nineteenth century R. Descartes presented a Solar system diagram that shows the distribution of matter in the cosmic vacuum forms swirls around the centers of stars. Illustrations of space analysis showed convex areas surrounding stars formed in swirls to explain the solar system and its relationship to the surrounding space. More than two decades later, the British physicist John Snow presented the Voronoi scheme in a different context during the cholera outbreak in London in 1854, linking the epicenter of the epidemic and the water centers of the map. Fig.2.



**Fig.2.**  
Descartes solar system and to the left. And the epicenter of the epidemic and the

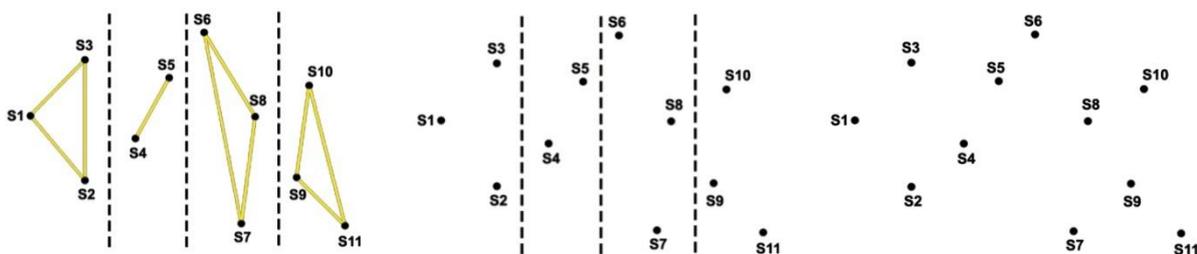
### 1.2 Voronoi Diagram definition

The Voronoi Diagram is a tool used in the fields of science and engineering to explain processes that depend on growth and spatial division. It can be defined as a special method of dividing two- or three-dimensional areas into small zones by reference a specified number of elements or points depending on the area to which the scheme is applied. Voronoi diagram is named as the Georgy Voronoi (1868) a Ukrainian mathematician. He is the first to consider the double vision of any two points connected in the plane and resulting in special areas for each adjacent point. The Voronoi diagram of a set of sites in the plane partitions the plane into regions, called Voronoi regions, one to a site. The Voronoi diagram is a set of points (S) called generators that are randomly distributed in the plane is contains (S1,S2,S3..), this points forms the center of the plane division (V), which will be divided into Voronoi zones (V1.V2,V3..) The set of points that are far from more than one generator at the same distance represents the points that pass the axes separating between the areas of Voronoi by creating axes that pass by and perpendicular to the half distance between the generators. The final form of the Voronoi scheme consists of:

1. **Voronoi generators:** central points in the level distributed randomly or by mathematical equations to control their position in the level.
2. **Voronoi shape:** convex polygons formed around each point.
3. **Voronoi region:** represents the inner void of convex polygons.
4. **Voronoi axes:** lines that mediate the distance between adjacent generators and are perpendicular to the lines connecting them and form the edges of polygons.
5. **Voronoi Point:** It intersects all two axes together and forms the angles of polygons.

### 1.3 Drawing Voronoi Diagram

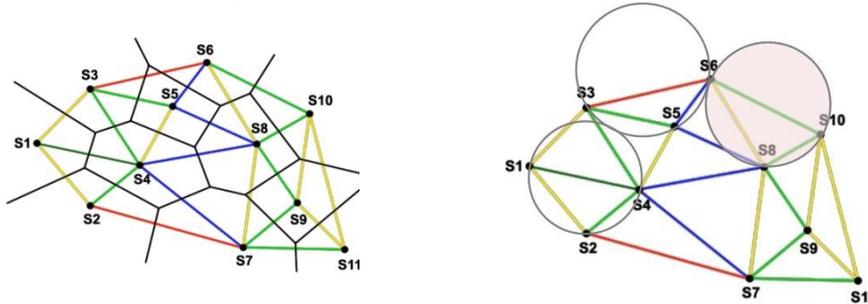
As mentioned previously the diagram will start from a sit of points in the two-dimensional plane, Fig.3. will describe and simulate the drawing steps.



Determining the number of points in the two-dimensional flat (S1 .... S11) and this may be random or by the use of computers, this process may require the interior designer experience

to see the future of the formal product when the distribution of points in a certain way in the plane differs from the distribution This may have a greater impact on the design of furniture and small surfaces, so regular arrangement results in more stable forms that can be used more widely.

The connection is made so that the Delawn triangulation of the set of points in the plane is connected so that the connection lines do not intersect each other. The rules of Delawn triangulation shall be applied in the formation as shown in the Fig. To create a Voronoi Diagram, the vertical is drawn on the middle of the lines connecting the dots. The intersection of the previous vertical lines (created for each connecting line between two points) represents the shape of the Voronoi Diagram.

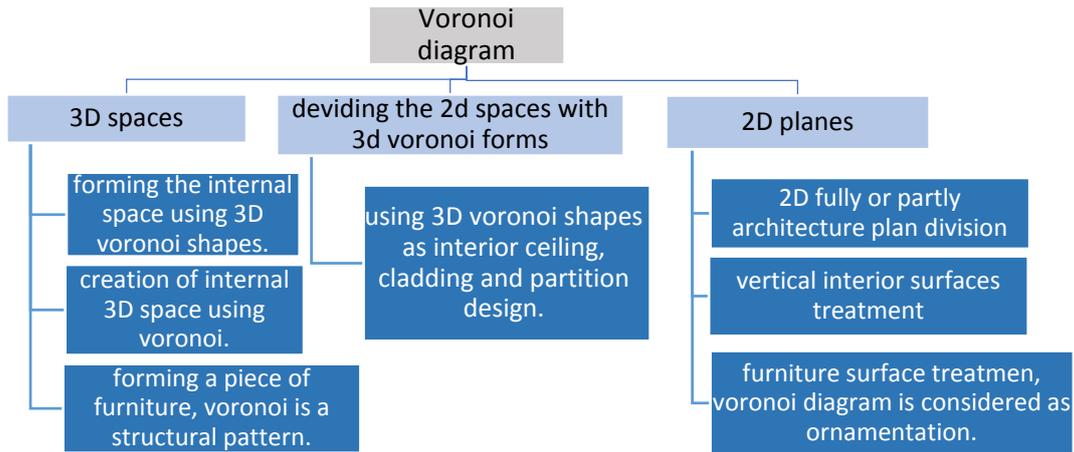


## 2 contemporary design

Design is an activity done by a person who has the capabilities and skills, in order to reach a certain result and achieve specific objectives. For instance, artwork could be described as a kind of design, it has a result that could be seen and perceived by others moreover, this results forms a personal experience of the artist. Interior design is a type of the applied arts that ends with a product either it is an object or three dimensional space, it is judged by others. People varies in their design perception, consequently, some will appreciate a specific design when others may criticize it. What some will see distinctive may be seen by others as traditional and beyond excellence, but what shall not vary is the space component satisfactory to the activity and requirements. Therefore, we find that contemporary design is a variable concept that cannot be measured by the need or achieve the goals or even the time dimension, but is a combination of these factors. Design must combine several factors to become contemporary features and modern materials, even goals that match reality and the time period of output Design.

### 2.1 Voronoi diagram application in interior design

The Voronoi diagram is widely used in both architecture and interior design, embodied in several axes by the practical application of the Voronoi design theory. As mentioned above, the Voronoi diagram is able to divide unconventional surfaces and spaces. There are many applications in the field of interior and furniture design that reflect the use of the Voronoi application, from the formation of the space to the structure and furniture ornamentation. The unconventional output has led designers to use the Voronoi diagram to present designs bearing future attributes being unfamiliar and represent linear relationships that generate innovative space divisions.



### 3 Voronoi diagram samples

#### 3.1 Voronoi Clinic / designed by Blend Design designer: Helen Brasinika 2015:

Inspired by the Voronoi diagram, a cosmetic and physical therapy clinic to reflect unconventional internal activity contrary to common practice in health clinics. The interior surfaces were divided by Voronoi subdivisions and colors and illuminations were used to express the clinic's function of cosmetic surgery. The furniture stems from the spatial composition of the place using the Voronoi diagram to form three-dimensional shapes from which the furniture is formed.

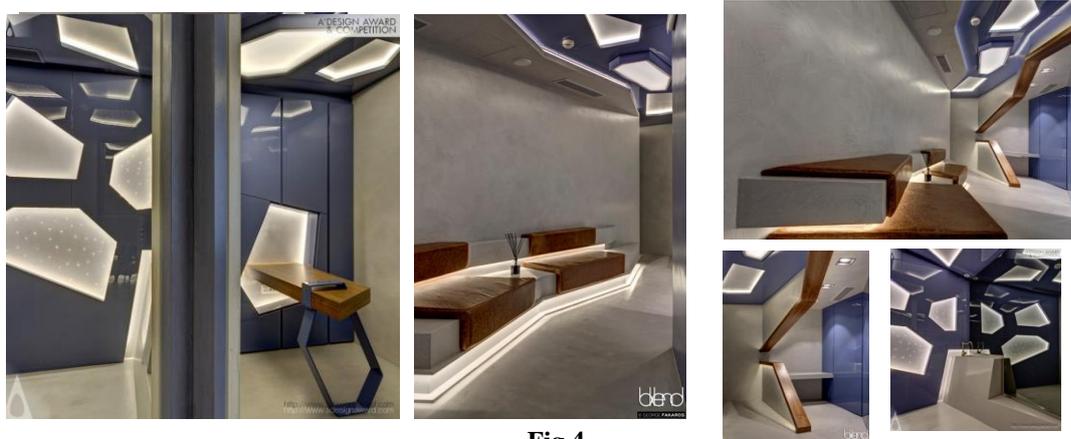


Fig.4.

Voronoi Clinic / designed by Blend Design designer: Helen Brasinika 2015:

#### Conclusion:

Linking the different fields may help the designer in the journey of searching for a new source of inspiration, which results in unconventional design results. Voronoi diagram is an essential mathematical application that can be used effectively in interior design and furniture. Moreover, it offers a more significant opportunity to learn about modulation, model analysis, and output and final shape control possibilities. In another hand contemporary is a complex concept that is not limited to the theme of character or design, but that keeps the style up to date with all developments. Computer applications have an important role in the creation of geometry, in particular its complexity, which enables the designer to construct unusual contemporary design forms.

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