Industrial Design Strategies Knowledge Engineering in View of Fractal Geometry

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Summary

- **Overview**

Nature has had a great share as a major focus of attention for explorers and researchers, and they are still studying the design of nature so that they establish new science bases and scientific theories (e.g. Ecology - Biomimetic - Chaos Theory - Fractal geometry - etc.). This research is creating a data base about fractal geometry which could help designers to take generative design Systems as leaders in their inspiration to create creative designs without damaging nature, and how Computer capabilities can be used in programming that depends on the method of solving the problem through algorithms, through a set of mathematical and logical sequential steps that have the same fractal properties necessary to solve a problem and generate bio-designs based on the strategies of nature, natural self-regulation processes and generative design methodology.

- **Phenomenon of the Research:**

Nature has had a great share as a major focus of attention for explorers and researchers, and they are still studying the design of nature so that they establish new science bases and scientific theories (Fractal geometry.).
This research is connecting nature inspiration with industrial design and architecture by building the suitable knowledge about fractals (The study of Generative Systems).

- **Claim of the Research:**

Claims that the relation of fractal engineering and industrial design strategies and methods, can support industrial designers to be able to find solutions of product designs.

- **Objective of the Research:**

Build-up knowledge related to the relationship of industrial design and fractal geometry, in view of the development of industrial design strategies.

- **Problematic of the Research:**

There is a relationship between nature and new technology, and between the environment and industrial products this opaque relation need to be clarified and proved with evidence. The research raises the question “How the nature can contribute with a new addition to industrial design strategies through fractal geometry, based on new technologies in the 21th century?”

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- **Methodology of the Research:**

Exploratory curriculum.

- **Plan of the Research:**

To prove the prosecution, we must follow a plan to reach the goal:
human thinking when faced with a problematic, if some information concerning problematic for the seeker, based on this information and more may be required to reach the unknown elements of the problematic, and pass on this in the language of logic by saying: the thinker moving from the introductions to the results, this is inferred. So, the conclusion in general is a mental process which is done by her transition from the unknown to the known. Firstly, the research identifies the term "fractal geometry" then clarify its relation to "industrial design".

Key-words:

Fractal Geometry, Generative Systems, Three-dimensional printing.

• Thesis Abstract:

1- Definition of fractal geometry "fractal":

In 1975, the French-American researcher (Benoit Mandelbrot) developed a new engineering that is radically different from traditional engineering and called it Fractal Geometry.
This term is derived from the Latin origin "franger", which means fracture or crack.
Of the fractious adjective that has the meaning of irregularity, breakage and fragmentation, Mandelbrot wanted to combine these two parts in the word "fractal".
The first part is natural fractals, these forms and things related to nature and linked to science that can be inspired and activate their formal and aesthetic values in the design process of a design.
The second part of mathematics, which is concerned with the study of a group of molecules that often have roots in Chaos Theory.
Where fractals are known as "those regular engineering structures, which their dimensions are complemented by the division of the basic shape into small parts, and each part is a thumbnail of the basic part or shape.

2- Algorithmic systems:

It is the basis for all Generative systems
Whereas, 1978 Stiny and Gips defined the algorithm as an explicit statement of the sequence of operations needed to perform some tasks.
Computations are the act of performing those operations which are not necessarily performed by the computer.
In fact, the use of computers in the field of industrial design is not new, however, the use of modern computers allows the industrial designer to overcome time constraints as well as the rapid introduction of various design solutions.
By combining the speed of modern computers with creativity and intuition from industrial designers, we can create strong synergies that allow us to achieve better designs.
An example of a well-known algorithm is the relationship of the golden section and the generator of logarithmic spiral, where shapes and organizations can be seen in nature as the final products of internal growth laws - such as snails and fractals - mixed with external forces acting on them as energy such as the sun, wind, and water.

In such method, such models are simulated digitally by writing their algorithms as corresponds to the laws of regularity of natural shapes, so that it is then possible to apply growth visualizations and biological organism, i.e. the model, to industrial, architectural and interior design.

3-Future design programs and development strategies:

There are simple ways that a computer thinks of shapes, and there are more sophisticated methods.

If we have to arrange a design approach from the simplest to the most adaptive and smooth process, it can be arranged as follows:

The simplest engineering imagery operations will be paper sketches, mesh surface models, or solid models.

These design ideas describe a fixed and simple form, and are worth speaking a few simple descriptive words.

Next comes the design software that can handle parametric designs, and it's a little bit more adaptive. These programs allow the user to define generalizable geometric shapes that can change according to a few parameters.

After this stage we move on to the world of the future, the following types of design languages are largely experimental, and are often found in research laboratories and other modern design experiences.

In one technique called (design like programming), a computer describes a form as a sequence of steps in a specific order, almost like describing a cake by listing its recipe and not its final form.

This is followed by a more sophisticated approach offered by what we call (obstetric systems) such systems literally developing a shape of a grain, according to a specific set of rules.

Finally, the most complex and fluent future design sketches will be (interactive charts), designs that modify themselves to suit the conditions in which they will be used.

Where the interactive electronic charts program is dynamic.

The interactive diagram system represents how nature works, as the DNA does not clearly define the final shape of the plant. Rather, it sets a set of rules that will govern how the plant grows in response to any particular circumstance.

Engineering programming requires a different kind of thinking, a different kind of imagination and a different kind of designers, the resulting objects are much more sophisticated than what can be designed with traditional signal-and-click design tools.

In engineering programming, it is easy to describe duplicate shapes and semi-periodic structures that differ slightly among themselves but are often similar, and hierarchical structures that consist of smaller sub-structures that can also be described, for this reason engineering programming provides great efficiency and effectiveness for the human designer when designing complex, made of many parts or even small patterns.

4-Results

The thesis comes up with many of the results:

4-1. Computer capabilities can be used in programming that depends on the method of solving the problem through algorithms, through a set of mathematical and logical steps in a series that have the same fractal properties needed to solve a problem, and the generation of biological designs based on nature strategies, natural processes of self-organization and generative design methodology.

4-2. The development of materials, and technologies such as 3D printing, as well as recent design studies that implement the characteristics of "Fractal Geometry and Complexity", have allowed the overcoming of limitations and boundaries imposed by "Euclidean Geometry", in addition to formulating new strategies and approaches at the world of industry, design and creation of new products that have future forms.

4-3. The research confirms the effectiveness of simulating natural systems with the possibility of merging between nature and technology and exploring its capabilities using the analytical approach for the study of nature as a tool and methodology for design and its implications for the development of the production process for complex designs through the 3D printer.

5-Research Recommendations:

5-1. The necessity for the industrial designer to pay attention to nature simulation, fractal geometry, its stages, inputs and outputs due to its great importance on the design process.

5-2. Complete the study of "fractal engineering" and benefit from it in the design process, and complete the study of methodologies related to fractals in particular and design in general and its methodologies ... such as "algorithm systems", "generative design" ... etc.

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