

# FRACTAL DESIGNED PRIMARY SCHOOL

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## 1. Abstract

Fractal Geometry is the key for creating eye soothing and distressing spaces due to its Psychological effects on human brain. From the heart beats to the entire galaxies, fractal geometry is everywhere. The nature sustainability and processes are all designed and planned in a rhythmic harmony that God created in form of fractals. Motivated Perception is a phenomenon which simply means the way we see the world. Our perception is often biased, selective, and malleable similarly our mind needs something which creates interest. Efficient learning in today era needs technology as a main source for which the learning is bounded to the structure based spaces having roof over it and having digital gadgets for more mind growth of learning individual with more exposure for creating interest leading to loss of connection of learning individuals from nature feelings and senses. The primary school will be best implication of fractal design. Based on these factors why not to bring the fractals as design elements in the primary school as fractal designed spaces by nature replicating processes which gives senses as same as nature without real nature inside the space. Fractal Designed school would be a space where learner could learn without any sort of boredom and get relaxation vibes always.

## Key words:

Fractal Design, Fractal Geometry, Primary School, Nature, Sustainability, Psychological effects.

## 2. Introduction

**Fractal geometry** “the hidden form” of the nature proving the GOD a super mathematician. It is the study of shapes which are having never ending cascade with self-similarities proved on the basis of mathematical rules and formulas. It is the basis of nature and its forms. The world we see today is full of fractal forms but for noticing these observations is required and for proving it mathematical approach is required. The bigger the structures are, the back is cluster of tiny fractals. The self-similar scales and the golden ratio are the best proportioning tools for functional and aesthetical designing. Fractal (inspired from latin word Fractus which means “Broken”) coined by mathematician **BENOLT MANDELBROT** in 1975. He said to not think of what you see rather to think what it took to produce what you see. He has proved in his seminal work “The fractal geometry of nature” that each form can be fragmented by splitting into parts, where each unit is a scaled copy of whole set.

The forms and shapes generally illustrated in 2D and 3D considering all in **Euclidian geometry** which is having constant D values 1,2,3....etc. Illustrated in fig.(A.1) But **Fractal form /Geometry** is which are having their D values in fractions such as  $1/n$ ,  $2/n$ ,..... etc. Illustrated in fig.(A.2)

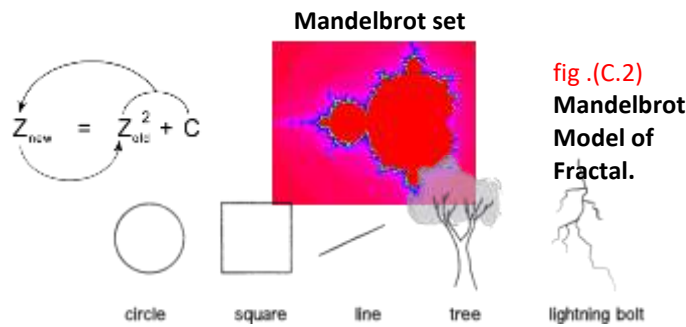
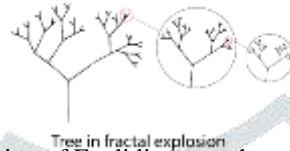


fig.(C.2)  
Mandelbrot  
Model of  
Fractal.

**fig.A.1-** Illustrating the Euclidian geometry of general shapes such as circle, rectangle, tree, lightning bolt etc.  
Illustration Credits- Zannah Marsh.



**fig.A.2-** Illustrating the Fractal explosion of Euclidian tree shape showing natural growth pattern of tree.  
Illustration Credits- Zannah Marsh.

Motivated Perception is a phenomenon which simply means the way we see the world. It has been a topic of curious research in psychological field. It is like -Eyes see what they wish to see. It keeps a person away from reality .Our perception is often biased, selective, and malleable.

Multiple stages of the visual system are present that range from collection and acquisition of data by eye to process of this data in higher parts of brain mainly frontal lobe .The frontal lobe has stimuli senses which are fractally placed and shaped by nature only. So Fractal patterns can also produce a relaxation and soothing affects as these matches with process of brain working. This relaxation can also be caused by architectural and landscape patterns.This is how vision and brain works and how stimulations are generated. So the options to study for this open in many fields to improve performance and individual capability for any work.

Technology is changing the design of learning spaces bringing the vast exposure of world into 4 walls through technology and gadgets which is leading to loss of connection of learning individuals from nature feelings and senses. According to studies, the environment where one learns so the learning environment must be capable for adaptation of mind to concentrate, relax and learn. Learning of 21<sup>st</sup> century is not possible in nature as institutes are being designed as multi-disciplinary with various fields of study for which equipment and technology varies for each. One can't have senses of nature stimuli's for mind relaxation in these areas. For these senses , why not to bring the fractals as design elements in the learning spaces as fractal designs which are made as same as the nature made itself.

### 3. Literature Review

#### 3.1 - Recursion

Fractal can be defined as successive application of transformation function as shown in the mathematical principle given below fig B.1.

This process is known as **recursion**.

By repeating the application for the successive results as given below.

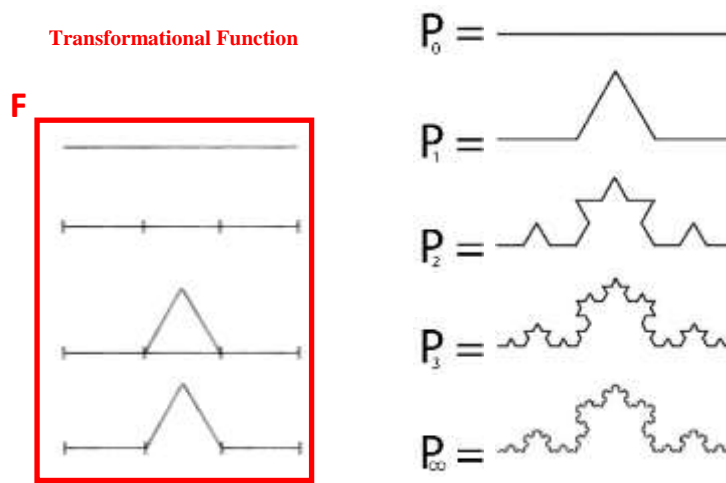
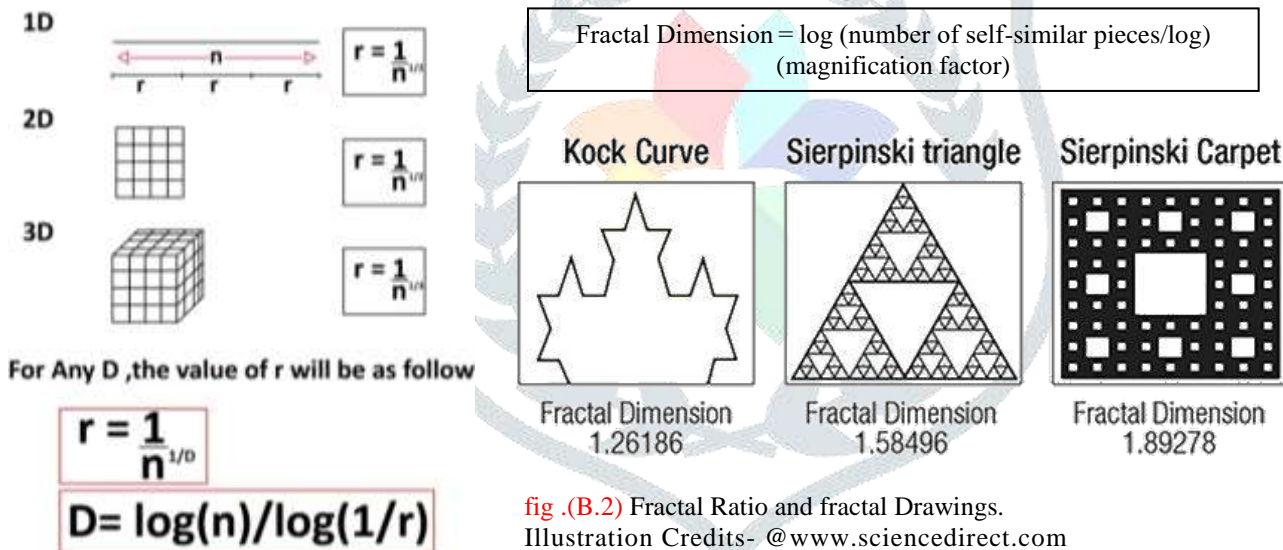


fig .(B.1) Recursion of function onto the principle.

### 3.2 - Fractal dimensioning (D)

The amount of complexities in a self-similar figure is measured under this. Basically it is the no. of point of generation is calculated in the set of figure. Here is the example of fractal works and how it is calculated. It is the measure of the progression of details of structures and forms. Fractal dimension is basically a number between 1 and 2; the more the complex image, the higher is the D value as in fig B.2.

fig .(B.2) Fractal Ratio and fractal Drawings.  
Illustration Credits- @www.sciencedirect.com

### 3.3 - Fractal Brains and Human Psychology

- Kitzbichler et al (2008) research has suggested that fractal behavior is also exhibited by the brain. With this research there can be linking of physical processes of brain and the fractals at any scale we see in our physical life effecting social relationships and Personality.
- Over the times in many ways these scales are linked with biological, psychological and social dynamics of the brains. Linking fractal Lattices and patterns of any scales with brain synchronization systems.
- The research used two measures of Data analysis and synchronization across the brain

- the phase-lock interval
- the lability of global synchronization
- ✓ The **phase-lock interval** - It is the interval of time which is consumed by different brain chambers performing same task together and the time of amount which is consumed during data synchronization. It is a measure of brain system co-ordination timing.
- ✓ The **lability of global synchronization**- In brain system synchronization, It is the amount of shifts globally occur. It is a measure of space shift (Amount of broadness and shift) while data synchronization.
- In research analysis aside from lot of great technical details, they proved that these measures forms fractal patterning stating that syncing of brain is branchlike and fractal which provide instant reactions with short and long linkage time.
- These evidences provide a clear-cut picture of brain organization and its working which proves the human psychology and brain working is linked.

### 3.4 - Fractals and Stress Research

With the tool Functional magnetic resonance imaging or functional MRI (fMRI) along with Quantitative electroencephalography (qEEG) it is proved that people have a connection resonating to the natural processes which are planned and functioned naturally as fractal processes. The spectator's abilities are studied under fractal fluency (Resonating concentration, resonating functioning and coherence) with brain and eye working processes for the fractal designs, arts and concluded that fractal fluency optimizes the spectator's capabilities and creates an eye appealing experience along with reduction in the physiological stress-levels. Stress reduction occurs due to physiological resonance of nature inside the eye and brain.

Mathematically proved relation of stress and concentration with nature- The fractal patterns/geometry with values ( $D = 1.3 - 1.5$  measured on a scale between  $D = 1.1$  for low complexity and  $D = 1.9$  for high complexity) are the main role players in visual relaxation because human vision has resonance with these natural patterns. So the visionary items with  $D = 1.3-1.5$  are relaxing and anti-stress affect. Many experiments shows that the nature fractal geometry tends to reduce stress up to 60%.

#### Experimental Proof-

The phenomenon was experimentally proven by a mathematician, Richard Taylor and Caroline Hägerhäll, a Swedish environmental psychologist. Richard Taylor was working in the field of number theory whereas Caroline Hägerhäll had specialty in human aesthetic perception. Their experiment proved that images with a low to mid-range  $D$  (between 1.3 and 1.5.) were enthusiastically preferred by people. These images made people overwhelmed. They used EEG to measure people's brain waves while viewing geometric fractal images in order to find out if that dimension induced a particular mental state. It was discovered that in  $\alpha$  waves were produced by frontal lobe of subject which made feel good and in wakeful and relaxed state in that same dimensional magic zone.

### 3.5 - How nature effect the learner's behavior

American School Districts were in search to find solutions for dingy performance of students in standardized tests in 1990. Different experiments were done with various curricula, various teaching methods with new textbooks, new and better teachers, smaller classes. A firm based in California of architecture has inspected various elements finding natural light as one of the important factor which can improve learning experience. In research study of 21,000 students had found that "classrooms which are having more of natural light have scored approx. 25 percent higher marks in standardized tests comparing to students in the same school district. "It has proved that children learn far better under illumination of skylights better than bulbs. Classrooms which



have nature elements had positive effect on learning of students. The study by incorporating plants in classroom layout had proved that there is improvement in grades of middle school students, reduced sick leaves of primary school students. The nature makes students and staff more comfortable and satisfied proving fractals are the mood makers have a great influence on learners behavior.

Studies also had proven that

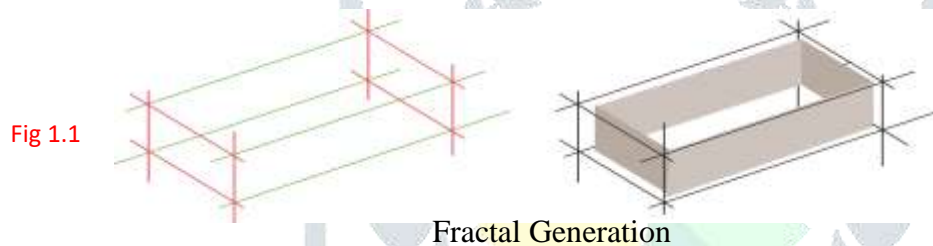
- 72% of outdoor learners have scored higher than the learners of Indoor environment.
- The stimulations of outdoor spaces is more likely to prevent learners obesity, attention deficit disorder, anxiety and depression comparing to indoor entertainment.
- Fresh stimuli from the balanced nature help to improve memory skills.

### 3.6- Fractal designs related to interiors and furniture

#### 1) Munich Fractal Arena designed by Dear design

MUNICH, the fashion and sports footwear firm showroom based in Valencia .

A stadium like space shaped by metal structure as a outer skin which surrounds the walls with a short distance offset as shown in fig 1.1. It has fractal designed metal lattice which is used for exhibiting the shoes. The fractal for designing is inspired from letter x as shown on fig 1.2 which is deformed and then scaled and repeated which is made along the periphery of the store by making it in Iron finished in white lacquer.



Inspired from monogram and then scaling, repeating and shaping it as per concept.



Credits-Xavier Mañosa

Credits-Xavier Mañosa

#### Analysis-

- Fractal could be anything (like alphabet X in this store) which could make a vast pattern just by repetitions in specific orders which could make anything designed very aesthetical as well as functional.
- Fractal designs could be made in any material just by simplifying the geometry of shapes you want.
- The process of designing and inspiration could be replicate into furniture designing also.
- Instead of structures we can only make skins for those in fractal forms to enhance the design factor.

## 2) Agri Chapel by Yu Momoeda Architecture Office

A Japanese-wooden chapel in Nagasaki inspired from gothic style and designed in fractal geometry of a tree. Main motive was to create a spiritually uplifting space by readapting Japanese traditional joinery skills of timber as shown in fig 2.1. The site is heart of national park beside the sea. In Japan it is known as “Ohura-Tenshudou”. A pendentive dome by piling up like tree unit that extends upward by shrinking and increasing as shown in fig 2.2. The fractal pillar similar to tree as in fig 2.3 which keeps on stacking on top of each other at joints to form forest layers and replicating growth of tree branches.



**Fig 2.1** The one-room, 60-seat Agri Chapel is a cube approximately 30 feet in length, width, and height.  
Credits-Yousuke Harigane



**Fig 2.2** Interconnected cedar structure supports the chapel's flat roof painted white.  
Credits-Yousuke Harigane



**Fig 2.3** Each tier, the trunk-like pillars multiply in number—first 4, then 8, then 16 while shrinking in size by a factor equal to the square root of two.  
Credits-Yousuke Harigane

### Analysis-

- The nature itself makes the living things self-supportive as per its fractal repetitions.
- The growth of living things is also a fractal process which can be interpreted with the mathematical calculation.
- Materials selection could be as such which could fit the functional requirements of the designed space.
- The functionality of space must be filled without compromising the concept of designing.

## 3) Fractal.MGX

It is a coffee table made by fractal designing by studying the growth of trees. The Geometrical interpretation of making organic growth pattern of tree branches from which this table may have been inspired as shown in fig 3.1. The detailed branching of epoxy resin 3d printed table which is quite unorganized at the bottom but gets organized reaching quasi top as shown in fig 3.2.



**Fig 3.1**  
Credits-Wertel Oberfell



**Fig 3.2**  
Credits-Wertel Oberfell

### Analysis-

- 3d printing is the best solution to make the replica of natural forms which are complex and impossible to make without it.
- With 3d printing the material wastage is very less as compared to other method of production.
- Complex shaped furniture are very hard to maintain in terms of hygienic and pest control.

#### 4. Methodology

Buildings built in the industrial revolution are ill-equipped. These spaces do not consider the entire spectrum of learner success. In this digital age, spaces are falling short of making good learners for a global economy. The only applied element of fractal in this field is through only technology in the form of Artificial intelligence, gaming, Smart learning and graphics. The proposal for the fractal designing is to applied in interior field along with some architectural implications which is not done before in any of educational building.

Below are the identified problems:

- Clustered Interior Spaces
- Furniture Disturbances
- Visual boredom
- Lack of attractive spaces
- Nature contact
- Environment discomfort

For making learning more efficient the solutions below are being adapted by institutes

- Artificial intelligence
- Virtual reality
- Physical subjects
- Interior landscaping
- Robotics
- Smart systems
- Extra-curricular activities
- Wellbeing activities
- Congenial environment
- Graphic learning interiors
- Comfortable interiors

These all above affect the senses of body to adapt learning environment. Out of all the senses, body is having the vision as the most dominant to get feeling of relaxation and excitement which can help to develop interest in the study. As fractal design is the best suite to develop the interest through vision as psychology is dominant to vision.

The proposal will be having these elements to applied in this-

- Fractal designed Furniture
- Fractal layout of Learning spaces
- Fractal designed partitions and screens
- Graphic illustrations in fractal Geometry
- Fractal designed ceiling and flooring

#### 5. Conclusion

As mind develop its interest in early learning of childhood and the learners tend to seek for a comfortable space where his/her field of interest is being taught. A space without boredom and anxiety elements having well planned and zoned layout is the need for education centres.

As fractals are related to mental health and abilities to deal relating to stress and psychology so making the spaces more of fractal deigned at this stage can makes the student more creative and efficient to learn. **Primary School** will be best for the implication of this proposal where observations can be made over the students because studies have proved that the best learning age is 4 - 12 showing the strongest will of learning new skills where effects were measured by the raw RT difference scores.



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