POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE
Degree in Architecture
Honors theses

The fractal geometry; applications in architecture
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Scientists have always believed that the book of nature has been written in mathematical language. However it is easy to recognize that geometrical objects are rather rare in nature.

In the western tradition science has studied regular objects and phenomena, leaving other shapes out of mathematics.

But at the end of the XX century mathematics' evolution produced what has been called a "*museum of mathematical monsters*": a group of models that infringed the rules of regularity and harmony of traditional mathematical objects.

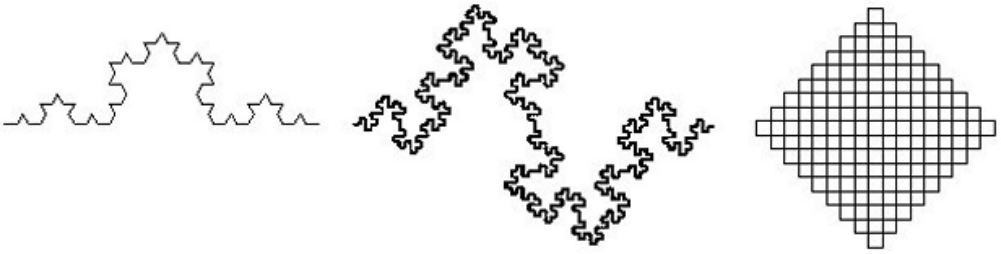

Image 1 - Koch, Minkosky, Peano curves

These "*monsters*" have been used to study objects that it was impossible to study with traditional instruments.

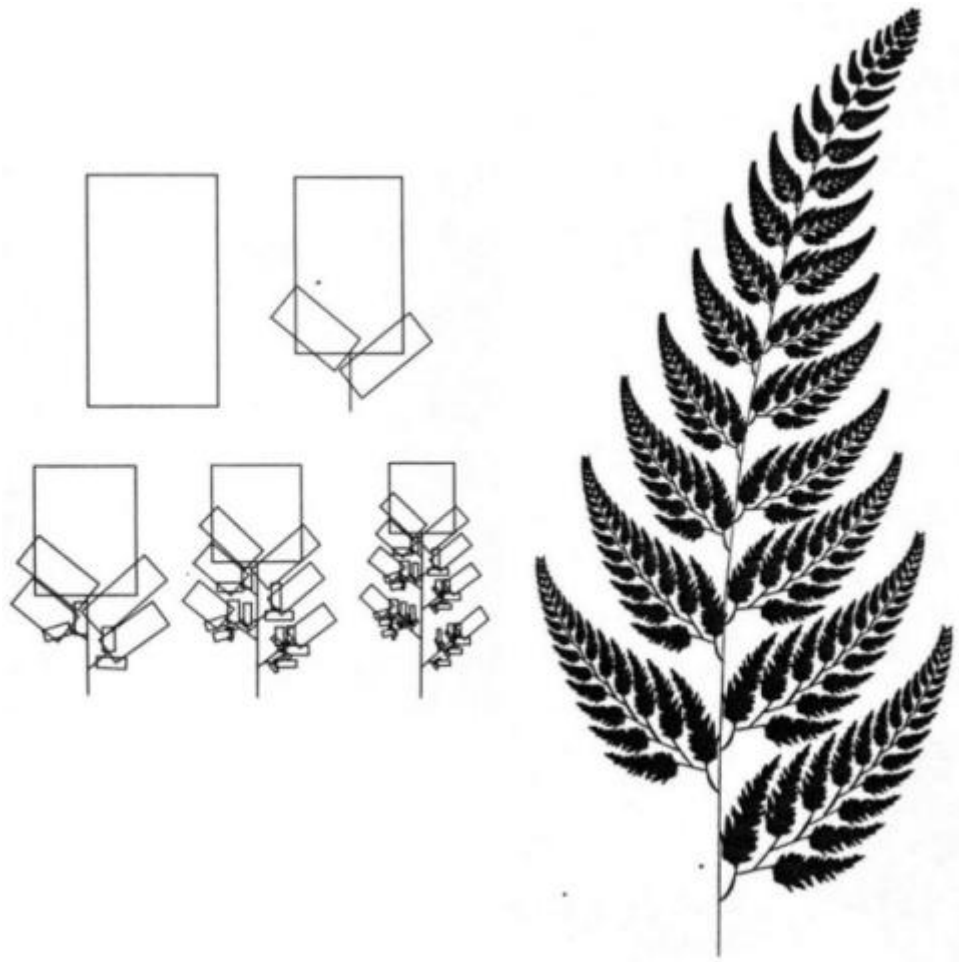

Image 2 – Barnsley fern

This work concentrates on a new tool developed at the end of the 70's: fractal geometry.
The thesis contains three sections: the first section concentrates on the evolution of mathematical thought from "Euclidean elements" to the XIX century crisis, with particular regard to those sectors of mathematics that find some applications in architecture. The second section opens with an introduction to what is considered the basis of fractal geometry: mathematical monsters. Different possible approaches to fractal objects are discussed but attention is focused on the geometrical approach that is the most interesting for architects. In the last section some specific applications to architecture and town-planning are considered. Fractals have proved to be useful in architecture to display complexity and regularity in planned or built objects. As for town-planning we discuss some recent attempts to generate fractal models able to describe morphological evolutions of cities.

The study shows how fractal geometry can describe objects which have been traditionally excluded from mathematical treatment. For this reason fractal geometry is today applied in many fields of mathematical and technological research. It is now possible to extend research to objects and models with intermediate characteristics between the strong Euclidean order and apparent disorder.

Mandelbrot's approach, qualitative and free from stiff schemes, has supported many applications even if the mathematical theory is not yet completely developed. For this reason we preferred to examine applications as research lines rather than with regard to the validity of results.

The noteworthy delay of architectural applications is only partly due to a sort of mistrust towards mathematical models: excluding the hypothesis that fractal geometry cannot be applied to architecture, we note that the attitude of latin architectural culture prefers pragmatism and planner's skill rather than mathematical considerations.
However we assert that fractal geometry can be used in many ways in architecture: the most obvious is instrumental support to a program contained in a standard CAD packet that lets generate and estimate fractal characteristics in planned or built objects, by numerical checking. This kind of instrument could be an efficient aid to planner's personal judging capabilities and creativity.
However it is at the town planning scale that fractal geometry shows all its power with respect to traditional models; fractal geometry allows to build models that are contemporary iconic and mathematical. We believe that in the near future progress in research will allow planners to give information about the future state of real systems depending upon their town-planning choices.

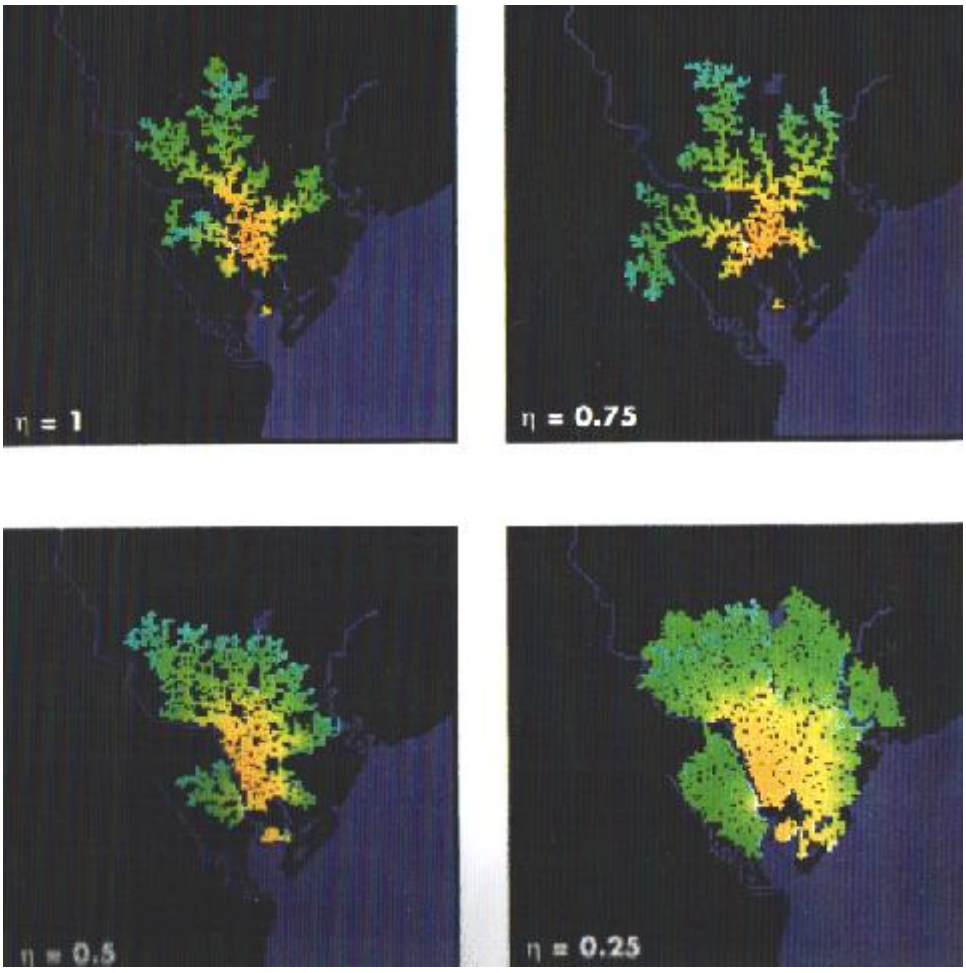

Image 3 – Simulation of Cardiff growth

However a big effort in research seems necessary, and ultimate results are not available.

Mandelbrot's intuition and computer technology have given us a powerful instrument: it is now necessary, especially in architecture, to produce a big research effort but above all is is necessary that pioneering turns into normal science.

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