Advanced Modeling Techniques

Fractals (Mandelbrot, Voss, Musgrave, Hart, Peitgen, Jurgens, Saupe, ...):

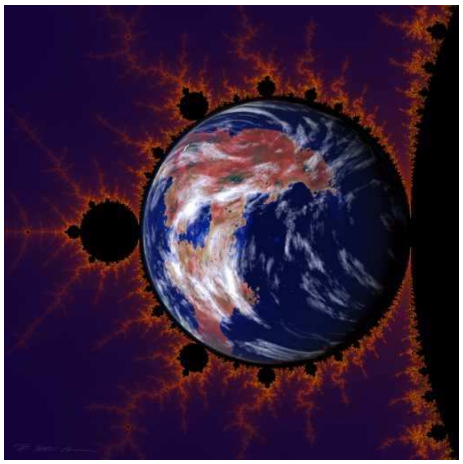
self–similarity

non–unit dimensions

often used to describe natural objects

Examples:

The Mandelbrot



Fractal Mountains:

Advanced Modeling Techniques (con't)

L–systems (lindemyer & Prusinkiewicz)
- **–rule based grammers for describing natural objects**
- **–great for plants, trees, shells**

Particle Systems (reeves, Sims)

- **– simple rendering**
- **–large numbers of small particles**
- **–physics controls their movement**

Procedural Models (Ebert, Perlin, Hart Musgrave)

Implicit Models (Wyvills, Hart, Blinn)

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Fractals

– From the Lantin frangere "to break"

– History

Late 19th Century and Early 20th Century
Many mathemeticians investigated these "mathematical monstors" – functions that defied normal mathematical principles.

Georg Cantor 1883 – Cantor Set
Construction: Start with Unit interval, remove middle 1/3 open interval repeat

Waclaw Sierpinski – 1916 Sierpinski Gasket
Construction: Filled Equalateral Triangle. Connect midpoints of each side. Remove middle triangle. Repeat.

Helga von Koch – 1904 Koch Curve
Construction: line
Divide into 3 parts. Replace middle third with 2 edges of right triangle. Repeat.
Length: original = L
After 1 step = 4/3 *L
After 2 steps = 4/3*4/3 *L

Mandelbrot: Thought of these formulations as describing nature. He found that these formulas could be imbedded in a geometry describing natural forms.

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Fractal Dimensions

Power law : a = 1/s^D

a = number of pieces
s = reduction factor
D = self–similarity dimension

Yields: D = log a / (log 1/s)

Example: Divide square into 9 pieces
D = log 9/ (log 3) = 2

Example 2: Koch Curve
D = log 4/log 3 = 1.2619