

SCIENTIFIC VISUALIZATION : A WAY TO RECONCILE ARTISTS AND SCIENTISTS ?

A o f e

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A virtual experimentation is defined as the association of the **solving** of the equations of a scientific model and the **exploitation** of the produced results. Apart from some exceptional cases, these results are too numerous to be read alpha-numerically and must be given to the users (scientists or engineers) as **animated synthetic pictures**.

Thus, picture synthesis is :

- a tool for validating and "debugging" the models,
- a help for communication and for understanding abstract concepts,
- a tool for manipulating invisible or inaccessible objects
- and finally a fantastic discovery means.

When visualizing an air plane wing, a car or a soap box, an engineer has not many choices to display the shape of the modeled objects. But unfortunately, it is not uncommon that the virtual experimentation results do not exist as natural objects (a pressure for example) or again have no right to be visualized (in quantum mechanics,...). Then, in "scientific visualization", picture synthesis must be used with care to avoid :

-visual artefacts (four classes of optical illusions have to be defined : geometrical, luminance, real colors and false colors) and

-dangers ("a picture is only one point of view", the problem of choosing the colors, moving dynamical objects,...).

The base of a methodology can be proposed and followed ; it is inspired by the work of painters of the past centuries (geometrical proportions, chromatic equilibrium,...). Scientists must be put on their guards against **non informative aestheticism**. Thus, picture synthesis is one of the best way to concile (or better, to reconcile) today Art and Science : for example, Art need high-scientific tools to produce realistic pictures, and Science need artistic advices to produce the most useful images.

WORK 1 :

IMPOSSIBLE COMPUTATIONS

For many years a strong idea is that everything is computable : it suffice to write a program, to run it on computer, and to read the results. In fact **it is absolutely false for non linear processes** as I discovered it during 1992. This fact is illustrated with the well known **Lorenz Attractor** ; this beautiful 3D object is stereo displayed on the slides 1.1 (left eye view) and 1.2 (right eye view). But it relies on a system of non linear differential equations. The integration of this system (with any numerical method you like) is easy to do on a computer ; for that one have to write a program. One of my goal is the so-called **portability** (ie. the development of programs that are machine independent). Thus the same program was run on three different computers :

IBM RS6000 (the *red* computer),
IBM ES9000 (the *green* computer), and
Silicon Graphics Indigo XS24 (the *blue* computer).

The results obtained are superimposed (with the color code described earlier) thus giving birth to the stereo pictures 1.3 (left eye view) and 1.4 (right eye view). From the beginning of the computation till the time 4800 it could be said that the three computers are "in step" (and the results are the good ones). But a time 4800 appear the firts discrepancies ; at time 4980 it appears a clear separation of green from red and blue ; and at last, at time 5060 there is a start of separation between red and blue. The three sets of results are false, and there is no way to compute the good ones (I have designed a general method for the detection of such a case, but unfortunately it does not give the true results...).

The conclusion is very strong : for non linear systems one can be confident with the results obtained during the first time steps ; after a particular instant (depending on the system), the computation must be stopped for it is no way to obtain reliable results.

WORK 2 :**JULIA SETS IN THE QUATERNIONS**

The slides 2.1 and 2.2 are made of 64 stereo views obtained during a journey around the Mandelbrot set in the quaternions. For each of the 64 sample points extracted from the trajectory, the Julia set in the quaternions was computed, and a 3D slice was displayed. The slides 2.3 and 2.4 show two very interesting close-up views over these beautiful objects (an actual sculpture of the both of them is currently in progress).

WORK 3 :**NATURAL SHAPES**

Many natural shapes are describable by the means of the fractal geometry. The slides 3.1 and 3.2 show the evolution of the such model with the slight variation of one of a few parameters.