

Forum Discussion: Presentation of the *Atractor*

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The project to which I recently devoted myself in an intensive manner, and that I am going to describe briefly, is a little bit marginal with respect to the theme of the *Forum*: it is not about the teaching of mathematics, at least in the school sense of the word, and art is not present in a systematic way. What it has in common with other initiatives mentioned in this forum, is an attempt to generate interest in mathematics by means which are not necessarily perceived by the public as having a direct relation with mathematics.

Knowing the genesis of the project will help to get a better understanding of the form taken by its realisation. In 1993, under the initiative of a physicist, a group of professors of the Faculty of Sciences of Porto met to try to lay down the foundations of a future museum of sciences. The intention was that the museum would be characterized by a high degree of interactivity. Although at the time, there was general scepticism about the possibility of creating "interactive" realisations that would be interesting at a mathematical level, I joined this group at the outset since I was convinced that something could be done, and that it was desirable that mathematics should not be absent from such a museum.

My presence in that group has been very important (for me!), not so much for the work which has been done – in the first temporary exhibitions which happened in 1994 mathematics was only represented in a rather modest manner – but because since this date, though preparing other things, I always kept in the background the desire to explore this path. I took notes, I got some ideas, and I participated in several annual organization which coordinates the European scientific museums) and I visited a several scientific interactive museums. The first impression I kept from these visits was the fact that in general mathematics was not much represented in these museums. And gradually, my conviction became firmer that matters could be different. In my Faculty, for several reasons, the project of the museum of sciences has not advanced as rapidly as was expected at the beginning. On the other hand, I became convinced that there should be enough material to realize a Centre entirely devoted to Mathematics. Meanwhile, a building in Ovar (between Porto and Aveiro) has been put at our service, and, in 1998, I sent a general circular invitation. The reception was excellent and several university institutions (Aveiro, Coimbra, Lisbon, Porto), the *Sociedade Portuguesa de*

Matemática, the *Associação de Professores de Matemática*, and also the city of Ovar joined into an Association (formed in April 1999) for the creation in Ovar of an Interactive Centre devoted to mathematics: the *Atractor* (see <http://www.fc.up.pt/atractor>). A small group of colleagues got interested in the project in an active way. Also, the Ministry of Science and Technology decided to support it financially, and to integrate the future Centre into its network of *Centros de Ciência Viva*. On its side, the Ministry of Education came to its help by arranging for two teachers to work on the project at full time. During the years 1999 and 2000, several interactive exhibitions were organised in different cities. A big impulse was given to the realisation of the project in the form of an invitation from the Ministry of Science and Technology (Division *Ciência Viva*). Confirmed in March 2000, this invitation called us to organise, in November 2000, in the *Pavilhão do Conhecimento* (the Knowledge Pavillion) in the city of Lisbon, an Exhibition integrated into the setting of the commemorations of the World Mathematical Year. It was a great challenge to be taken by the *Atractor*, because of the media importance of the place, of the fact that it was the first exhibition in the *Pavilhão* entirely conceived in Portugal, and because of the importance of the financial means put at the disposal of the *Atractor*.

The challenge has been accepted, in spite of the short allowance of time for the preparation of this exhibition. Its preparation, which held us during all these months, had a very good secondary effect on the *Atractor*: a certain number of colleagues, who previously had not contributed to the project, joined us, bringing ideas and work. The support of the *Atractor* has been considerably enlarged. The Lisbon's exhibition will remain open for several months. All its content will be later integrated into the permanent exhibition of the future Ovar Centre, which will open its gates after the indispensable work of renovation and of adaptation needed by the building.

The philosophy of the *Atractor* project is first not to choose the topics according to their presence or absence from the school programs: the aim is not to create a kind of mathematical laboratory to support the courses given in the school institutions. That settled, an important part of the visitors of the exhibitions will be young pupils and their teachers. One has been able to notice that among the latter, some strive to relate certain "modules" of the exhibition to the content of the programs of their pupils, thinking about new visits they will make later. These teachers often used to judge the interest of the "module" according to its proximity to the programs. This first reaction, somewhat natural, was followed in most cases by a new mental receptivity on the philosophy of the exhibition when the purposes of the *Atractor* were better understood.

An other important point is the definition of the ordinary target visitor: which *level of knowledge* do we have to assume and which *language* to use? In general, the question of the level is not so important as one might think: we have remarked that a great number of modules could be in fact valued at very different levels of understanding, and, at each level, bring something

new and attracting. The question raised by the language to be used is of a different nature, and is not easy to answer. We have a plan but it will have of course to be tested by experience: our intention is to restrain and to simplify to the utmost the printed instructions that are presented with the modules, and to insert, into a network of computers, all the necessary complement of information.

It is easy to include, inside the numerized support, texts corresponding to levels of different preparation. In this way, one allows anyone to choose easily which materials fit them the best. It also allows, in a way combined with the exhibited objects, the possibility of introducing *applets* or other interactive programs which reinforce the participating attitude that we want to encourage among the visitors.

We attribute a great importance to the integration of (interactive) objects with the presentations (equally interactive whenever it is possible) one can get on the network. When it is completely worked out, it will allow visitors: first to prepare in advance their visit which they will be able to anticipate somewhat by consulting the *site* of the *Atractor*; second, to go back in more detail to the elements that they were able to appreciate during their visit, also to lighten the points that have remained intricate.

From the point of view of this integration, we are in the presence of three types of situations:

- In the first one, the "physical objects" are present, but their interactive numerized *translation* is not yet done. Examples of such objects: a non rigid polyhedron, showing that the rigidity of the faces does not imply that of the polyhedron; or still, a great balloon and a "ring", on which one can draw triangles, measure their angles, in each case compute their sum, compare it with the one of triangles located in the plane, evaluate how the difference evolves with the area of the triangles (see [MC]1 and [MC]2 in the Appendix).
- In the second one, physical objects and interactive numerized objects are present. For instance one has polyhedra, including the dual ones that one can create and observe through trietric kaleidoscopes where sometimes they give birth to very beautiful images (see [MC]3 and [MC]4 in the Appendix).

They can be interactively handled and animated with especially adapted *applets*: see [MC]5, [MC]6, and

<http://www.fc.up.pt/attractor/mat/duais.html>

- In the last type of situation, the creation of virtual objects and their manipulations goes before the creation of physical objects; these are yet in a phase of conception, or of construction of prototypes. Example of object being in a conceptual phase: the fact that, *in order to illuminate all the points of the boundary of a convex plane figure, only three directions*

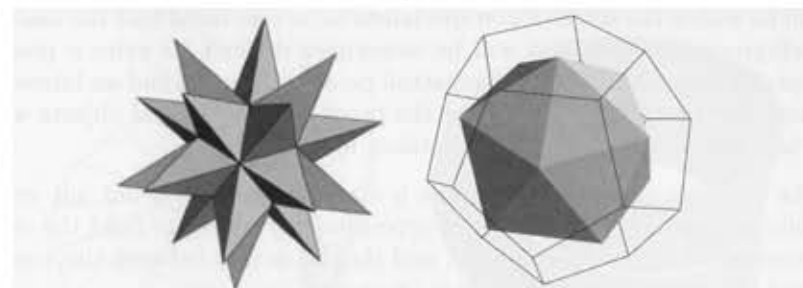


Fig. 1.

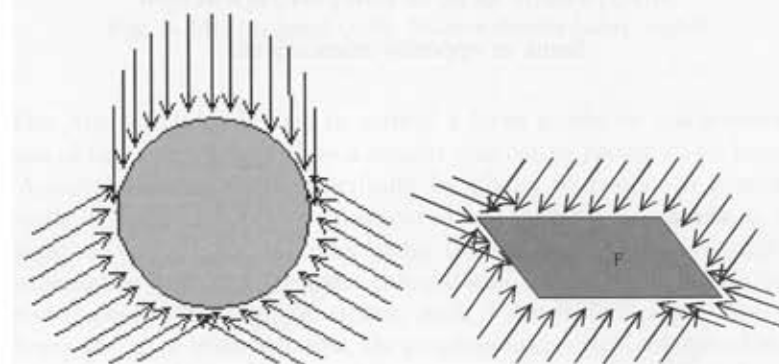


Fig. 2.

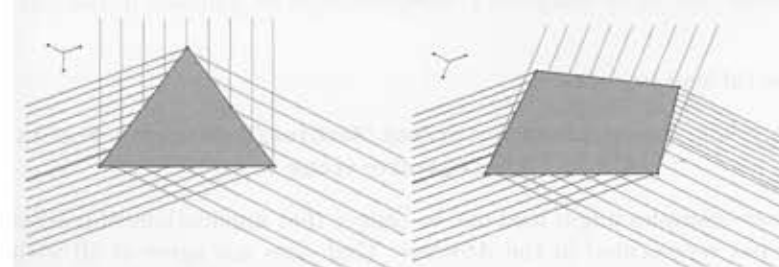


Fig. 3.

of luminous rays are sufficient except for the parallelogram where four are needed, is at first surprising.

However, through the manipulation of the interactive *applet*

<http://www.fc.up.pt/attractor/mat/GeomConv/ilumina.htm>

it will be within the scope of non specialists to be convinced that the assertion is well-grounded, even if it will be sometimes difficult to write a proof in acceptable terms from the mathematical point of view. To find an interesting manner to present the elements of the proof in terms of real objects which can be handled is a challenge to be taken up.

- An example where the prototype is already constructed but not yet exhibited concerns the concept of *orientation of a surface* (and the one of *non-orientable surface* as well), and the distinction between this concept and the one of *one-sided surface* (in space):

see

<http://www.fc.up.pt/attractor/mat/orient.html>

Same or opposite orientations?



Fig. 4.

and the tableau in:

<http://www.fc.up.pt/attractor/mat/Moebius/Construcao-Moebius.html#Quadro-icons>

These examples might lead one to believe that applications of mathematics are not represented in the *Atractor*. That does not agree at all with the reality: among some ten other modules, which already have been developed, some are concerning applications of mathematics. And, as one has to expect, one will also find these frequently very beautiful objects *attractors*, which will do justice to the name of the Institution – *Atractor*. A model of an orbit of the *Lorenz attractor* has been built by a process of stereolithography, from files prepared with some *packages of Mathematica* (see the figures [MC]7 and [MC]8).

And each visitor, by the personal creation of a point, will be able to contribute to the construction of the *Sierpinski attractor*, a large module that will be present at the Lisbon exhibition.

Non-orientable Möbius Band? Why? And if the middle circle is taken out?

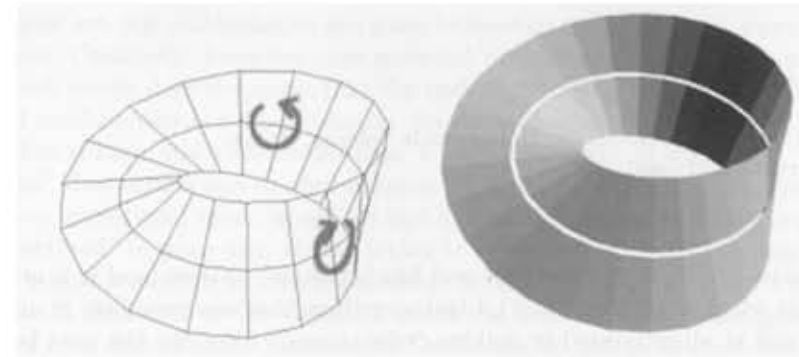


Fig. 5. Möbius band (left). Möbius double band (right).

The *Atractor* intends first to *attract* a large public to mathematics: the success of this *attraction* will be a second manner to justice to its name. But the *Atractor* also wants to contribute by giving to people in general, and to pupils in particular, a more positive image than the one which is usually propagated; also a more enlarged image than the one found in many places (“mathematics are used to make calculations”). Finally, it wants to allow interested people to learn something, and, if possible, to show also that in mathematics, as in other sciences, the progress is constant: whereas the public knows about the discoveries in other sciences, it often shares the idea, that in mathematics *everything has been done before*.

The *Atractor* is almost a new-born: thus it is yet too early to see how it will succeed in reaching its objectives that I recognize to be very ambitious.