The Mathematical Exploratorium

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Introduction

In the June/July 1999 issue of the Notices of the AMS, I wrote an article in which I made a suggestion for a concept I called The Mathematical Exploratorium. This idea is closely related to the goals of the Maubeuge Colloquium, so I feel that it is fitting for me to explain here, in more detail than was possible in my Notices article, how I conceive of the Exploratorium, and how I think it might be organized and run.

If there is time, I would also like to take you on a mock-up tour through a small part of the Exploratorium.

Rationale

Every six months or so, I have been using various search engines to seek out and inventory mathematical art and visualization resources on the Web. I am sure you will not be surprised to hear that these have been increasing rapidly in quantity. But more importantly, the number of high quality sites has also been growing, and some of the material at these sites is truly outstanding. When I looked recently, in preparation for this conference, I realized that are are currently so many sites, that it is no longer feasible for me to evaluate them all with any care. In fact, a Google search for "mathematical visualization" found 1800 pages, and "mathematical art" elicited 1690.

Rationale (Cont.)

There is something attractive about the untrammelled freedom of the Web, but it leads to a varied, unwinnowed mixture of wheat and chaff. In the real world too, we sometimes enjoy seeing art by gallery hopping, and it is exciting to occasionally discover a gold nugget amid the dross. But sometimes we are in a mood to see the very best art that has been selected and collected for us, and then we go to a fine museum. The problem with Cyberspace is that **there are only galleries, and no fine museums.**

What is it?

The Mathematical Exploratorium will be

An Interactive Virtual Museum.

The exhibits will consist primarily of high quality:

1) items of mathematical art

and

2) visualizations of mathematical objects,

that will be selected (and perhaps commissioned) by panels of experts.

Who will the audience be?

My hope is that it will appeal to **everyone** with an interest in mathematics. An ideal exhibit will be designed with layers of sophistication: the outermost, visual layer should be easily accessible to young and non-expert visitors, but it should also excite their curiousity and motivate them to look further into successive layers of provenance and documentation that will gradually provide a fuller appreciation and logical comprehension of what their eyes see. And the innermost layer should have something for the expert mathematician to think about.

What are the Goals?

1) To exhibit the highest quality graphic art and sculpture that is based on mathematical objects or that illustrates mathematical concepts, and to encourage the creation of such art.

2) To promote the development and use of excellent software tools to aid in the visualization of complex mathematical concepts, and to display the best visualizations produced by such software.

3) To educate non-mathematicians concerning the aesthetics of mathematics and encourage them to appreciate the deeper logical beauty that underlies "pretty" mathematical pictures.

Principles.

I) The Exploratorium should be international.

As a web-based virtual facility, the Mathematical Exploratorium will anyway exist in Cyberspace. Like Mathematics itself it should be thought of as belonging to all mankind, and for this reason I would like to see it mirrored in many countries, and the primary site could even rotate among the mirrors.

Principles (Continued)

II) The Exploratorium should be language neutral.

While pictures speak to us in a universal language, it is extremely important for the provenance of a piece of art to be clearly stated, and for a mathematical visualizations to be carefully documented. Since English has become the *de facto* common language of both mathematics and the Internet, it is likely that a majority of exhibits will be documented first in English, but all the documentation should be translated into a variety of languages, and a visitor to the Exploratorium should be able to choose a favorite language upon entering.

Principles (Continued)

III) Where it is possible and useful, the exhibits in the Exploratorium should go beyond the static display of a mathematical object and use techniques of animation and virtual reality to permit the visitor to interact with and better understand the object.

Principles (Continued)

IV) The Exploratorium should **not** be a mere collection of hyperlinks.

The Exploratorium will contain links to other websites that have galleries of mathematical art and of mathematical objects, but in order for the governing committees to maintain quality control, it is essential that all of its main exhibits be physically located on the main site and the various mirrors.

Principles (Continued)

V) The contributors to the museum will retain the copyright to their works. They would only give the Exploratorium a non-exclusive license to make the item available for viewing on its primary site and mirrors.

Logical Organization.

The Exploratorium will be divided into a number of "wings", that are further subdivided into Galleries, Alcoves, etc. Each wing will have a steering committee, consisting of experts in the relevant field, charged with selecting and commissioning exhibits.

Logical Organization (Cont.)

1) The Mathematical Art Wing.

Devoted to the display of mathematical sculpture, paintings, etc. The steering committee will consist of artists who have made major contributions to the field. The Art Wing will be divided into Galleries, each devoted to a particular type of art, and these Galleries may be further subdivided into "alcoves" exhibiting the work of individual artists.

Logical Organization (Cont.)

2) The Mathematical Visualization Wing.

Devoted to the visualization of mathematical objects of all types. The steering committee will consist of mathematicians interested in mathematical visualization. In addition there will be subcommittees of experts in the various specialties (surfaces, curves, ODE, PDE, fractals, conformal maps, etc.) represented by a Gallery within the wing. These Galleries may be further subdivided into "alcoves" exhibiting the work of individual mathematicians.

Logical Organization (Cont.)

3) The Museum School Wing.

Devoted to the education of those who would like to learn more about mathematical art or visualization. There would be online tutorials in the use of various mathematical visualization software packages, lessons on the techniques of documenting mathematical art and visualizations, the discussion of advanced algorithms for mathematical computer graphics, etc. The steering committee will consist of mathematicians and artists with experience in programming, web-site construction, computer graphics, documentation, and mathematical visualization.

Administration.

The Exploratorium will be governed by various committees that will operate much as do editorial boards for electronic journals. To keep expenses low, these committees will normally "meet" electronically, using email and private bulletin boards.

Administration (Cont.)

There will be an Executive Committee having financial responsibility and overall oversight of the Exploratorium. It will have five members, each serving five years (with a limit of two terms), with the fifth year member serving as Chair. A retiring or resigning member will be replaced by someone elected by the Executive Committtee. The steering committees of the various wings will be appointed by and report to the Executive Committee. There will be an Executive Director, appointed by and serving at the pleasure of the Executive Committee, and responsible for the day to day operation of the Exploratorium.

Financing

I wish I could end this description of the Mathematical Exploratorium by telling you that it will cost next to nothing to set up and maintain. Unfortunately, that is an unrealistic hope. One substantial expense that seems unavoidable to me is the salary and expenses of the Executive Director. I expect that this will require on the order of ten hours per week of effort. This is too much to expect anyone to handle on a pro bono, volunteer basis, and it will be important for the success of the project to have someone who has good administrative abilities and is also knowledgeable and respected in the worlds of art and mathematics.

Financing (Cont.)

Another non-trivial cost will be for web-design. It will be important to have a design that not only looks attractive, but one that is easy to maintain and that scales well—that is, the cost of adding one new exhibit should be negligeable. These days there are simple WYSIWYG web design tools that make it easy for amatuers to set up a reasonably good-looking and serviceable small web-site. But to create a top-quality complex site of the sort that the Exploratorium calls for will probably require considerable professional advice.

Financing (Cont.)

On the other hand I believe that those expenditures will be very highly leveraged. Most of the hard work in creating and maintaining the Exploratorium will be carried by the members of the Executive Commitee and the various steering committes discussed above, and I am hoping that, in the long tradition of editorial boards of research journals, mathematicians and artists will be happy to pitch in and contribute a couple of hours of their time each week to ensure that the Exploratorium will be a success.

A Request

And so I would like to end this talk with a request to members of the audience. In the near future I plan to post a page to the Web that will explain the goals of the Mathematical Exploratorium and request readers to fill out a questionaire asserting their interest in the project and affirming a willingness to volunteer some time to work in one or more specific ways to help set it up and maintain it. I will send an email message notifying those of you in the audience who have given an email address in your registration, and I hope you will respond positively.