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Comment

History of the museums, the mediators and scientific education

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Before analysing the role of the mediators in relation to scientific education, I deem it important to provide a short overview on how scientific museums evolved from the early curiosity cabinets to the modern web cast. Although the term "museum" is no longer adapted to the new structures employed for the diffusion of scientific and technical culture, the evolution of the means of presentation has indeed led to several forms of human mediation. This is of course the main topic we are going to take into consideration today, as it is an important element for the impact our exhibitions may have on the public. Decisions and choices vary from structure to structure for reasons that are sometimes justifiable but that are more often than not economic in nature, since wages, which are in any case very high no matter which country plays host, come to bear heavily especially on the budget of small and medium-sized structures.

The evolution of scientific museums from the curiosity cabinets to the web cast studio

I have consciously chosen for this journey through two centuries of scientific vulgarisation the collection of objects and the little experiments with the curiosity cabinets on the one end, and the transmission of images through the Net on the other, thus ranging from a situation of close contact with the objects to a virtual one characterised by distance. These situations might appear in sharp contrast at first sight, but they are in fact very similar, as in both cases mediators have to introduce and explain whatever is going on, such as amazing experiments, object analyses, conferences, etc.

In the 17th and 18th centuries curiosity cabinets used to be kept in middle and upper middle class households, where they were made available to so-called scientists who carried out experiments to entertain and amaze an audience that was generally limited to a small number of people. During a web cast, on the other hand, unique experiments are often made in front of thousands, not to say millions, of Net surfers from all over the world. The San Francisco Exploratorium, together with the NASA, has been a sort of pioneer in this field. In 1998 they established a direct connection to the astronauts in their space station, and in August 1999 the team of mediators they had sent to the Caribbean enabled a number of spectators, and among them visitors of scientific museums, to witness a total solar eclipse live.

The difference between the curiosity cabinet and the web casting is obviously a matter of progressive evolution of the technical means available, for the new IT and communication technologies have also helped provide a new impulse for the circulation of scientific knowledge. The major difference, however, lies in the relationship to the actual object: whereas curiosity cabinets involve a real, physical contact, the distance web casts interpose between the observer and the object under analysis leads observers into the virtual domain.

The first scientific museums were the museums of Natural History, which are aimed at preserving the traces of all the vegetal and animal species that ever existed, as well as mineral samples from all over the earth and those from space which have become available to us over the past three decades. The museums of Natural History were not meant to be accessible to the wider public, and their collections were rather for the use of researchers and teachers. One of these was the Muséum National d'Histoire Naturelle in Paris, which had its origin in the Jardin du Roi (the King's Gardens) in the first half of the 17th century

and which was subsequently opened to the public in 1789, at the time of the French Revolution. It is now a public institution under the authority of the French Ministry of Education which has several research labs, and which also provides higher education courses.

Museums were usually frequented by researchers and scientists. It was only in the 80s that France began to take into serious consideration the circulation of scientific culture, and a cultural service was set up in order to promote students' visits to museums, which thus became a pedagogical tool at the teachers' disposal.

In approximately the same period when museums of Natural History made their appearance, similar establishments began to be devised for the preservation of technical objects. That is how it came about in 1794 that upon Father Grégoire's initiative a museum was annexed to the Conservatoire National des Arts et Métiers (the National Academy for Arts and Crafts), where engineers were trained. All sorts of technical objects and scale models are to be found there, along with Cugnot's steam engine, automata, irons, and the first Tv set. These Technical museums, which were first opened to the public around the early 1800s (the museums for Arts and Crafts did so in 1802) house priceless treasures that allow visitors to follow the technical and technological evolution of our society. In these establishments, however, there are few human mediators, and the objects most often on display in the cases are accompanied simply by explicatory notes. Despite the subsequent implementation of pedagogical support aimed at turning such places into useful tools for students, their original purpose was altogether different.

The Natural History and the Technical museums were developed throughout the 19th century in many European countries, and particularly important examples are the National History Museum and the Science Museum in London, and the Deutsch Museum in Munich.

It took scientific museums more than a century to start evolving for real. In 1937 Jean Perrin, the Nobel Prize winner for Physics, presented in Paris a new form of scientific knowledge circulation that materialized in his Palais de la Découverte (Discovery Palace). His idea was to "take science out of labs while retaining the same degree of reliability". Experiments meant to highlight "science in progress" thus began to be carried out in front of the public gathered in the Palais. They were usually great, spectacular experiments, and some of them are still presented to this day by demonstrators or by lecturers. The characteristics of these lectures will be analysed in more detail further on, which will also provide a good opportunity to better outline how the role of the mediator has evolved over the past few years.

It is interesting to draw a parallel comparison between the evolution of scientific museums and that of pedagogical theories. While the objects on display in museums remind of the subjects of the "thematic lessons" as they used to be taught in schools, the early demonstrations inside the Palais de la Découverte clearly illustrated frontal pedagogy and its sole purpose of passing on knowledge.

Pedagogy subsequently evolved, and in the 60s and 70s the spirit of constructivism modified the way of teaching. The content was no longer the focus of learning, which became oriented on the students, their initial representations, and the means that enabled them to expand their knowledge. A new subject was introduced into universities to study the behaviour of both teachers and students and the way they interact, and various researches were started in order to ameliorate the educational system especially in the field of scientific education.

In the same period, in 1969, Frank Oppenheimer, who was a much more experimental kind of physicist than his brother Robert, the father of the atomic bomb, created the Exploratorium in San Francisco. The demonstrations at the Palais de la Découverte were thus followed by "interactive manipulations" that rely on the interaction between the visitor and the object on display. The latter, be it natural or artificially fashioned to answer human needs is no longer authentic, but becomes an artefact especially conceived to deliver a message to its user, the visitor.

The Exploratorium opened with 25 programs of manual interactions which rely basically on the visual and aural perceptions, namely light and sound. These elements are always fashionable and do not become dated, and many scientific centres have acquired or copied these programmes. Indeed many science centres were established during the 70s, and as interactivity has invaded the field of scientific museums a new question has arisen as to what the role of the mediator should be in the new individual approach to the museum pieces that has come to replace the group one.

One of the first institutions to draw inspiration from the Exploratorium was the Cité des Sciences et de l'Industrie (the City of Science and Industry) in Paris, the French national museum of Science,

Technology and Industry that was started as a project around 1979. Its promoters travelled around the world to get an idea of what was already available, and they were particularly interested in the Exploratorium, where they spent some time in the company of Oppenheimer himself. The establishment that was inaugurated in 1986 was however very different from the model that had inspired it, and the idea of interactivity was conveyed through a combined IT and video system that anticipated CDs by almost 12 years and DVDs by 15.

All museums and science centres have progressively started introducing multimedia technology in their exhibitions. One instance of this I would like to mention by way of example is the "Explor@dome", which was jointly created in 1998 by the Exploratorium and myself. The original project had been devised by Goéry Delacôte, a French university physicist who had been on the first team behind the project of the CSI and who had been asked to replace Frank Oppenheimer at the Exploratorium after his demise in 1985. Goéry Delacôte wanted to put to good use his experience at the Exploratorium and the guidelines that had made it an undiscussed source of inspiration for the world of scientific museums at large. His idea was to set up small structures for the presentation of "manual interaction programmes from the Exploratorium" and to guarantee their management with both public and private funds. The Explor@dome was the first scientific centre of its kind, and had no equivalent at the time. Apart from its unique economic framework it is interesting to consider for a moment the very idea that lies behind it. When Goéry Delacôte asked me to build the Explor@dome in 1997 France was lagging behind as far as the Net was concerned, for very few households had a connection to it, and the schools that could benefit from it were even fewer. We therefore decided that beside the 30 interactive environments conceived and developed at the Exploratorium the public of the Explo@dome was going to have free access to a further multimedia environment connected to the Net. The underlying principle of the Explor@dome was indeed that of combining the real and the virtual worlds to favour the acquisition of scientific knowledge, and for this purpose we decided to compound the above-mentioned interactive and multimedia environments with activities that were to be carried out in pedagogical workshops under the guidance of animators. We developed two kinds of workshops: the so-called "hands in the real world" one, which further fathoms the scientific concepts illustrated during the activities of manual interaction, and the so-called "the mind in the virtual world" one, which helps visitors become acquainted with the multimedia domain through researches in the Net, through the creation of PAOs, web sites and numeric videos, and through simulations.

When we first opened the Explor@dome we had of course to deal with the problem posed by the human mediation. Our analysis of what already existed in France and in the world at the time was as follows:

- guides and lecturers in museums
- demonstrators at the Palais de la Découverte', who put up a sort of scientific show
- ask me or wanted in certain interactive museums in North America
- explainers at the Exploratorium
- animators at the Cité de Sciences or in scientific associations

None of these words called to mind the role I wished mediators at the Explor@dome to play. It was neither about offering guided tours, nor about giving lectures, nor yet again about providing straight explanations on what principle does any given activity of manual interaction work on. That our staff should wait for visitors to approach them was also out of question, for that would have been against the competences and qualities I wanted them to develop, and experience has clearly demonstrated that some visitors do not address mediators spontaneously in order to ask them questions.

What I really wanted to do was conveying the idea of a kind of escort, an idea which was furthermore popular with the pedagogical principles of the time, and that is why I decided to call our mediators "facilitators". This word has in my view multiple meanings, which define the role facilitators are to play as follows:

- to provide an easy access to the place for visitors
- to help visitors have a correct approach to the activities of manual interaction and their use

- to help visitors understand the underlying concepts illustrated in an activity of manual interaction

I believe this role to be of fundamental importance in a place full of activities of manual interaction, of "hands on" activities, as our English-speaking friends would say.

Demonstrations and activities of manual interaction

I am now going to compare the demonstrations, which could also be called "science shows", with the interactive exhibitions, the so-called "hands on" exhibitions, from the point of view of both museology and the relevant human mediation.

The three tables below outline the characteristics of the individual presentations, of the visitors' activities and of the mediator's role. By analysing them it will be possible to evaluate the advantages and disadvantages of each category, and presumably also to draw conclusions on their complementarities.

Table 1: Characteristics of the presentations

Demonstrations: science show	*Interactive element: hands on*
• A real experience • A show that appeals to visitors and makes them wish to know more • Experiments and creations that are impossible in free access • Materials and assembling tools that are difficult to come across elsewhere • Many different possibilities and supports • Adaptation to a "live" show for the public • The experiment becomes simpler and less of a burden	• An interactive scale model to illustrate a concept • An element that appeals to visitors and makes them wish to interact • Free access to experimentation for visitors • Elements that have been especially conceived and created for the visitors • Predefined elements that cannot be possibly adapted to each visitor • Elements that are more sophisticated and more solid

Table 2: Characteristics of the visitors' activity

Demonstrations: science show	*Interactive element: hands on*
• The visitors are in groups • Groups are often heterogeneous • You listen, see, imagine, and ask questions, answer, participate • Demonstrator / public and public / public interactions • Strong interaction within the group	• The approach is individual • You make attempts at finding the solution on your own • You investigate and experiment by trial and error in order to develop a concept • Interaction between facilitators and visitors

Table 3: Characteristics of the mediators' role

Demonstrations: science show	*Interactive element: hands on*
• An experiment is carried out in front of the public • The demonstration can be adapted to the questions the public ask according to the public's level of scientific knowledge • Explanations have an introduction and a conclusion to elucidate a concept on the basis of the public's reactions • Different supports are used: sounds, objects, images, videos, magnifying glasses or microscopes, web cams, jokes and anecdotes to favour a better reception of the message • Knowledge becomes structured through construction and organisation • Delivery of scientific contents	• Personalised mediation • Mediators stand aside without interfering, but choose the appropriate moment for each person • Visitors are helped find an answer to their questions if they have any. That not being the case, facilitators can ask questions themselves • Different supports are used to show other phenomena, to alter parameters, and to experience a real experimental approach • It is not a formal lesson, and facilitators simply adjust their actions to the visitors' ability to understand, thus making the most of it • The process is privileged over the content • A way to let visitors interact manually in the activities has to be found

Table 4: Conclusions on the mediators' role in the acquisition of scientific knowledge

Demonstrations: science show	*Interactive element: hands on*
• Pedagogic and didactical principles are applied to a real experience • Certain concepts and certain notions can be understood • An evaluation of the level of understanding becomes necessary	• Didactic tools for the experimental approach by trial and error • Discoveries have to be structurally organised to reach a better understanding of scientific phenomena • A formal structure as well as the organisation of the knowledge acquired become necessary

The two kinds of presentation and the actions of the mediators are complementary, and play an important role in the acquisition of scientific knowledge

In the end it is possible to say that exhibitions and the science centres play a definite role in the circulation of scientific knowledge and culture. However, even the best exhibitions have their limits and are indeed not enough to learn thoroughly and properly. For that, a human support still remains the best choice

Author

Brigitte Zana, director for Development and Network at the Palais de la Découverte in Paris, started her career as a physics and chemistry teacher. She taught in middle schools and high schools for ten years. In 1982, she got the opportunity to participate and contribute to the conception of the Cité des Sciences et de l'Industrie (La Villette). Then, for ten years she worked half time in the Cité des Sciences and half time as a teacher for teachers. When she left the Cité des Sciences in 1992, she got a special mission with the scientific and technology literacy for the future teachers in the Institute for Teachers Training. In 1997, she was chosen by Goery Delacôte to work on the Explor@dome project. She manages it since the opening in December 1998. In 2004, her position changed. She joined Jack Guichard at Palais de la Découverte as the director for development and networks (traveling exhibits, national and international partnerships, online museum, education and formation). She is in Explor@dome's board as vice president. Email: brigitte.zana@wanadoo.fr

Appendix 1
Demonstrations at the Palais de la Découverte

Figure 1: liquid air

Figure 2: Electrostatic