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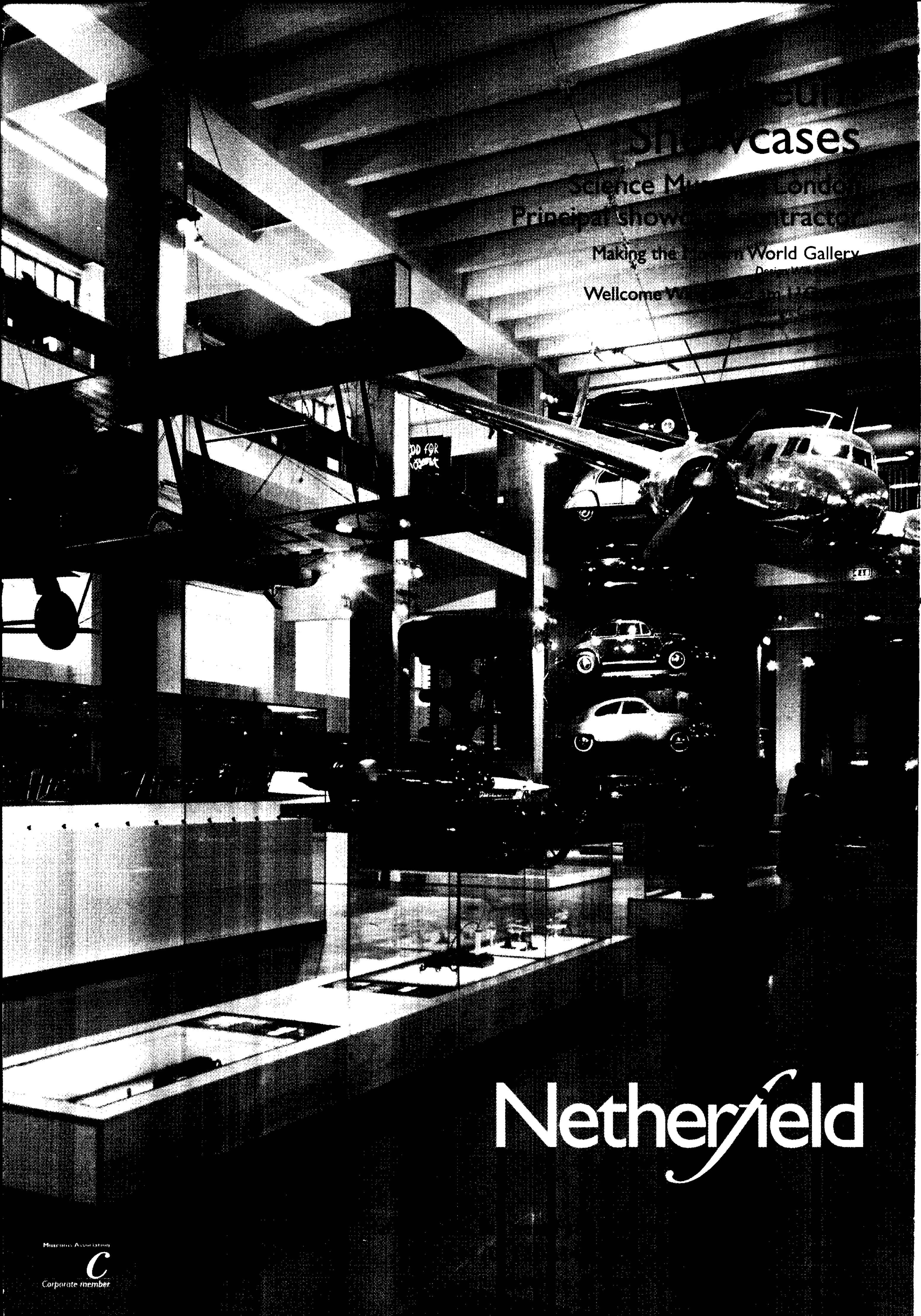
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C O N T E N T S

No. 4, October – December 2000

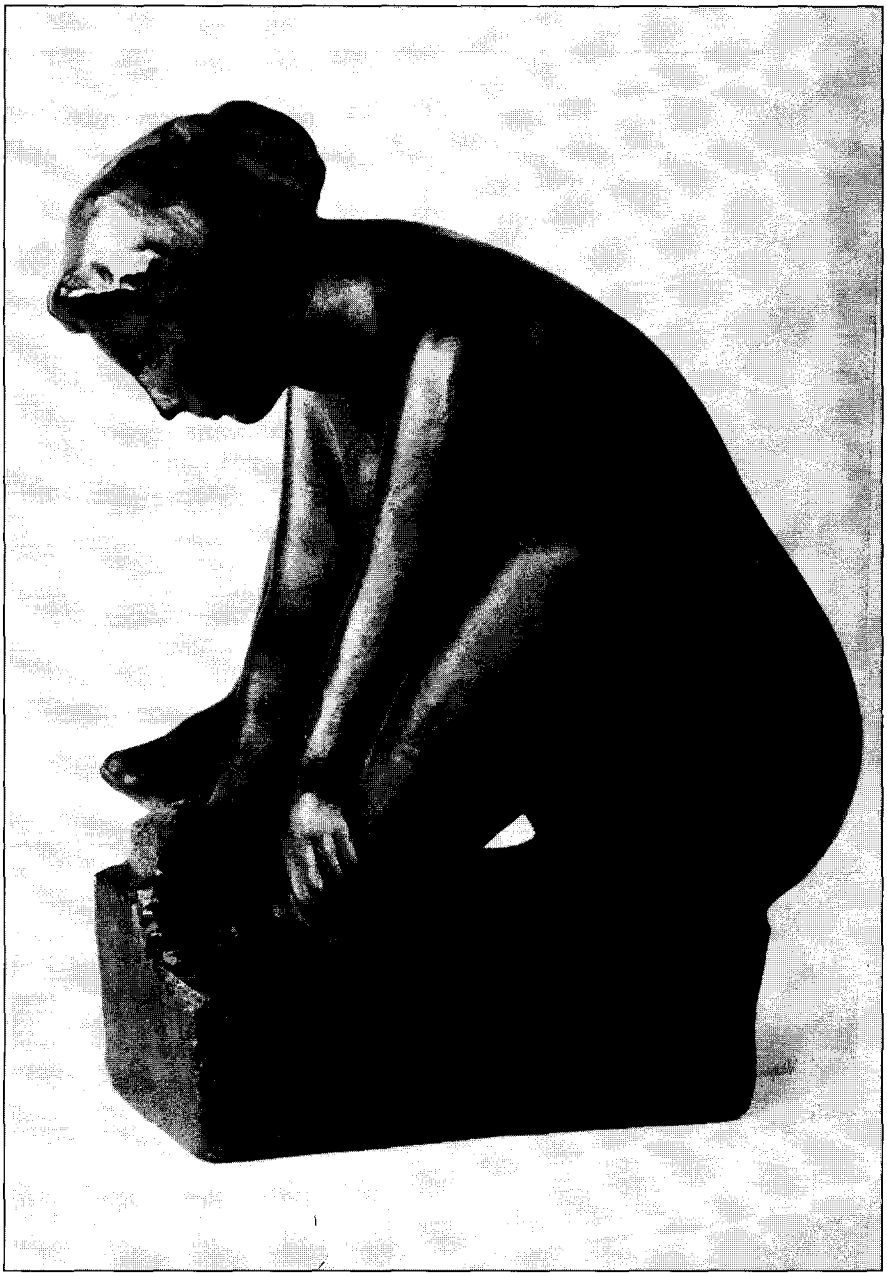
Cover

The moon within reach, at the Palais de la Découverte in Paris. © J. Duhamel/Palais de la Découverte, Paris

Published for the United Nations Educational, Scientific and Cultural Organization by Blackwell Publishers.

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)



STOLEN

Bronze statue by Maillol entitled La femme à l'épine, *created in 1921 and cast by Alexis Rudier. Inscriptions on the base: '3/4' and 'M' for Maillol along with the signature of the founder. Height 17 cm, width 16 cm, depth 10 cm.*

Stolen from a museum in Paris, between July 1998 and 26 February 1999. (Reference T 7613/MAL Interpol France.)

Photo by courtesy of the ICPO–Interpol General Secretariat, Lyons (France).

Editorial

We've arranged a global civilization in which the most crucial elements . . . profoundly depend on science and technology. We have also arranged things so that almost no one understands science and technology. This is a prescription for disaster.

Carl Sagan (1934–96)

A grim prophecy, indeed, by a man whose death 'robbed the science world of one of its most creative researchers and articulate spokesmen.'[1] The note of urgency Carl Sagan struck was at the heart of the World Conference on Science for the Twenty-First Century: a New Commitment, organized by UNESCO and the International Council of Scientific Unions in June 1999 in Budapest.[2] Gathering together some 1,800 delegates from 155 countries, it was a unique opportunity to take stock of the natural sciences today and, more important, to chart a path to the future that would irrevocably link scientific advance to both social expectations and the challenges posed by human and social development. Among the central issues highlighted by the conference was the need to improve, strengthen and diversify science education, formal and non-formal, so as to integrate science into the general culture and open scientific matters to public debate and democratic scrutiny.

It was clear that an increasingly scientifically oriented society needs science popularization to promote an improved understanding of science and orient public perceptions and attitudes. Emphasizing this point in its Declaration on Science and the Use of Scientific Knowledge, the conference proclaimed:

> Science education, in the broad sense, without discrimination and encompassing all levels and modalities is a fundamental prerequisite for democracy and for ensuring sustainable development. . . . It is more than ever necessary to develop and expand science literacy in all cultures and sectors of society as well as reasoning ability and skills and an appreciation of ethical values, so as to improve public participation in decision-making related to the application of new knowledge.

The conference went further, adopting a concrete Science Agenda – Framework for Action setting out specific engagements and recommendations. And it is here that museums were singled out: 'National authorities and funding institutions should promote the role of science museums and centres as important elements in public education in science.' Reflecting UNESCO's commitment to this process, our special dossier aims to show that science and technology museums have a major part to play in enlightening the general public and sensitizing it to the crucial scientific/social questions of our time. What is more, they can define and stretch the limits of what is popularly called 'scientific literacy', providing access to resources, equipment, materials and feats of imagination that few individual schools could ever hope to match. Increasingly, they serve as a locus of communication between science and society, enhancing their mutual involvement and helping the layperson develop a perspective on science and technology that becomes part and parcel of everyday life.

How important is this? An answer may be found on the 'Yes I Can! Science.' website of York University in Canada:

> A basic level of scientific literacy is required in order for individuals to function in a scientific and technological culture and for a nation to compete more effectively in the industrialized world. There are advantages to political decision-making from an informed citizenry. . . . There are intellectual, moral, and aesthetic benefits, in addition to economic ones, to the public understanding of science. It is a means of 'empowering' the average citizen. To be scientifically literate is to have a sense of efficacy when dealing with issues scientific and to be discerning about technology and its attendant risks and benefits. It is critical to understand the world in which we live.[3]

This is assuredly one of the most important challenges facing science and technology museums in the coming years and one that will test their capacity to relate as never before to the communities that surround and support them. For providing insight on this question, our thanks go to Michael Dauskardt, director of the Westfälisches Freilichtmuseum Hagen in Germany, and Chairperson of the ICOM International Committee of Museums of Science and Technology (CIMUSET).

On a personal note, I would like, on the eve of my retirement from UNESCO, to thank all the readers and contributors whose enthusiasm and support were so deeply appreciated.

M.L.

Notes

1. *Scientific American*: www.sciam.com/explorations/010697sagan/010697explorations.html

2. Information on the conference may be found at www.unesco.org/science/wcs/index.htm

3. www.yesican.yorku.ca/home/sci-literacy.html

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Reinventing the science museum: the Museum of Science and Industry in Manchester

J. Patrick Greene

Constant adaptation and renewal are the hallmarks of Manchester's Museum of Science and Industry, as explained by its director, Patrick Greene. He is chairman of the European Museum Forum (organizers of the European Museum of the Year Awards) and president of the Museums Association. He was, until recently, president of ICOM's International Committee of Museums of Science and Technology (CIMUSET). His doctorate is in archaeology, based on research into medieval Norton Priory in Cheshire, the excavation of which he directed from 1971 to 1982.

All museums must evolve in order to remain fresh and relevant. For science museums there is a particular necessity to embrace change, as science itself is in a constant state of transformation. So, too, is industrial society in the so-called post-industrial age. The Museum of Science and Industry in Manchester is relatively young, having first opened in 1983, but a phased development programme has enabled us continuously to re-examine our objectives and techniques. This is our mission statement:

> The Museum of Science and Industry in Manchester will use its remarkable site, the world's oldest railway station, and its collections to create a museum of international standing which has as its overall theme the industrial city, thereby capitalizing on Manchester's unique past, contributing towards its future prosperity and fostering the pleasure of understanding for a broad public.

The first years of the twenty-first century will see the culmination of two decades of development, and the adoption of a strategy that will ensure that the museum does not fall into the trap of being considered 'finished'. There will always be the necessity of modernizing exhibitions, adopting new techniques of presentation, communication and management, and responding to changes in society that are difficult to predict. If the museum is successful, it will continue to reach its goal of 'fostering the pleasure of understanding for a broad public'. If it does not innovate, it will be regarded as irrelevant, and the high level of public support it enjoys now will diminish.

The starting point for the museum is its commitment to 'use its remarkable site, the world's oldest railway station'. When the museum started we were faced with a daunting prospect – a collection of imposing listed buildings of great historic and architectural interest, but which were in an advanced state of dereliction. It was clearly going to be a challenge to develop

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One of our demonstrators/interpreters talks to visitors in the exhibit Fibres, Fabrics and Fashion.

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a master plan within which buildings could be repaired and brought into use, at a speed largely determined by the availability of money. We adopted a phased approach so that the redevelopment could be broken down into many components. Each of these could be undertaken as finance became available, all contributing to the goal 'to create a museum of international standing'. In the first phase, in 1983, there were 4,511 m^2 of gallery space. Further phases increased the exhibition area to 11,146 m^2 by 1998. A further massive expansion started in 1999 that will result in a total of 19,053 m^2 of exhibitions being available to visitors by 2003. Some of the exhibitions have already opened. In addition, of course, there are all the support facilities ranging from collections stores to a restaurant, a shop and a conference centre.

The five historic buildings are one of the museum's greatest assets. Not only are they important in themselves, they also provide an atmospheric setting for exhibitions. The warehouse dating from 1830, for example, is a very significant building in the history of railways. Our strategy to rescue it from a ruined state, adapt it for public access, and use it for exhibitions has resulted in a historic environment capable of accommodating contemporary displays. Indeed, the historic use of this pioneering warehouse gives added value to the two major themes of the exhibitions: *Communications*, and *Food for the City*.

The railway was opened in 1830 to provide a rapid way of getting raw material imports, finished goods exports and people between the port of Liverpool and the manufacturing region of Manchester. The station buildings are, therefore, the ideal context in which to create a museum 'which has as its overall theme the industrial city, thereby capitalizing on Manchester's unique past'. As the first industrial city of the modern age, Manchester's story is of wide interest. It provides an ideal linking theme to bring coherence to the many topics to be found in a science museum. Thus *Fibres, Fabrics and Fashion*, which opened in 1997, deals with the science and processes of textile production that are not found in many museums. We also discuss Manchester's role as a centre of trade in cotton goods – so dominant in world markets in the nineteenth century that it became known as 'Cottonopolis'.

It is impossible to understand Manchester at the beginning of the twenty-first century without an awareness of its roots in the textile trade. The magnificent warehouses, modelled on Italian palazzi, stand as reminders of Manchester's textile past but they are also where the reinvented city of today began. Conversion of these fine structures into hotels, loft apartments, design studios, bars and pubs, offices of computer software houses, radio stations and restaurants is part of the reinvention of Manchester. The Museum of Science and Industry in Manchester has provided a model for such adaptation of historic buildings to deliver the mission statement goal of 'capitalizing on Manchester's unique past, contributing to its future prosperity'.

That is not the only way in which we serve contemporary society. In common with most science museums, we place education high on our agenda. Our new Learning Centre provides us with the facilities to extend our service to schools (80,000 visits by children a year) to adults as part of national initiatives on life-long learning. Our Digital Access Centre allows visitors to try for themselves the technology that is developing at breakneck speed to transform all our lives.

An exterior view of the main visitor entrance to the Museum of Science and Industry in Manchester.

The economy is also a beneficiary. It is calculated that for every pound sterling spent by visitors at the museum, twelve pounds is spent elsewhere in the local economy. With 355,000 visitors spending £1.5 million in 1999, the contribution to the prosperity of the region was £18 million. To this can be added the goods and services purchased by the museum from local businesses, the employment of 120 people, and the investment in new exhibitions and building work. Many museums can claim a similar impact, but few do so – the cause of museums generally would be strengthened if there were greater awareness of their economic benefits.

It is the cultural impact of museums that is their most important characteristic, however. For a science and industry museum, collections that enable its customers to gain insights into these fields are central to its mission. Science, in particular, suffers from the aversion of those who found physics difficult at school, or who think of it in terms of genetically modified foods or the nuclear industry. Yet science underlies all contemporary society, so it is important that people have scientific awareness as a vital part of their understanding of the world we inhabit. Two new galleries are planned to meet this challenge. Manchester Science will look at the practice of science in the context of one city. This is an approach that I do not believe has been attempted elsewhere, and it will bring home to visitors the fact that science does not exist in isolation from society. Manchester is the city where John Dalton expounded his atomic theory, where James Joule conducted his experiments into thermodynamics, and where the first stored-program computer was developed. We have some good stories to tell! Our new Interactive Gallery will replace the Museum's Science Centre, which opened in 1988. That was a year that saw many science centres open in Europe, inspired by examples in North America, Singapore and India. The approach which we adopted was to create exhibits that helped explain basic principles of science through a process of self-discovery. It proved successful and popular, but at the Museum of Science and Industry in Manchester we have decided to reinvent our strategy. The Interactive Gallery will place exhibits more firmly in the context of the experience that visitors bring to the museum, and will make explicit links with the other exhibitions.

Science and technology are international in their practice and application. They are also the products of people of many cultures. There is therefore an opportunity to stress the roots of science in many societies in our galleries and in our changing exhibition programme. *China, Cradle of Knowledge* was staged in collaboration with the China Museum of Science and Technology in Beijing, and involved many people from Manchester's Chinese community. Future exhibitions will include

Ancient Cultures and *Forest and Me* produced by Heureka, the Finnish Science Centre. Another planned collaboration will take place with colleagues in India as part of an Anglo-Indian Science Festival. International networks, such as ICOM-CIMUSET, ECSITE[1] and the European Museum Forum are vital to make such collaboration possible. So too is the Internet, as an effective means of reaching a global audience. The museum launched its website (www.msim.org.uk) in 1993 and it has been received with great acclaim.

For the Museum of Science and Industry in Manchester, reinventing its role is an evolutionary process. As our major expansion occurs over the next few years it is our intention to take a global approach to our mission while still reflecting on the significance of science and technology to Manchester. We believe that this will allow us to communicate with people of our region, and also to fascinate visitors from further afield. ■

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Volunteers explain the history of computers to visitors.

Note

1. ECSITE: a professional organization of science centres, now consisting of almost 200 members from 35 countries (www.ecsite.net) – Ed.

Technology museums: new publics, new partners

Günter Knerr

Museums in general, and science and technology museums in particular, must borrow and adapt the notions of customer service and the methods of project management, market analysis and fund-raising that have proved their effectiveness in business and industry, in the view of Günter Knerr, director of the Deutsches Museum in Munich. He is well-versed in new communication strategies, in particular, multimedia operations, and is head of the Department of Craft and Industry as well as the museum's Chemistry Project.

Museums are influenced by developments in society, although they ignored this fact for a long time. With regard to science and technology museums, this becomes especially clear in three areas: their functions, their relationship to visitors (target-group orientation) and their association with industry.

When he founded the Deutsches Museum in 1903, Oskar von Miller, a recognized pioneer in high-voltage technology, wanted to create an educational institution for everyone, where fundamentals of science and technology could be imparted by encountering their masterworks. By associating history with current events, people were supposed to be better able to cope with an industrialized world. This all took place in a period that was very technology-oriented, in which technical innovations were welcomed by all.

Only gradually, and particularly after the Second World War, did the threats, advantages, and disadvantages of science and technological innovations become ever more obvious, especially in the area of ecology. People felt the lack of dependable information, particularly from the business sector. Therefore, institutions that were considered competent, independent and trustworthy gained increasing significance. Technology museums that fulfilled these requirements became places of enlightenment. For example, this became especially clear after the catastrophe at the Chernobyl reactor or the dioxin accident at Seveso. Visitors saw museums as important places for information and discussion in a world becoming ever more complex. Companies perceived museums as partners in improving the acceptability of technological innovations.

The functions of education and enlightenment required a more serious approach. But already in von Miller's day, the playful element was very important. Play was not an end in itself, but rather a means for imparting principles and fundamentals of science and technology. Starting in the 1970s, the proportion of leisure-time visitors climbed – particularly younger people and small groups. They wanted to be informed, but also entertained. The decisive factors for accomplishing this are media and design, a pleasant atmosphere, and an adequate framework for group dynamic processes – particularly for small groups. The logical conclusion is that technology museums are increasingly becoming service centres that maintain a comprehensive range of educational, informative and entertaining offers, from which visitors can select freely in accordance with their expectations, needs, and interests.

In the Deutsches Museum – as in other technology museums – visitors played a rather more subordinate role for a long time. If it was done at all, planning was aimed at a type of average visitor, an interested or educated layperson. A sort of curriculum was created, which had to be worked through. However, visitors are rarely willing to do this. For this reason, a target-group-oriented approach is the one preferred today, similar to that of company marketing and public-relations strategies.

Empirical investigations are necessary in order to do this: prior to creating an exhibition in order to find out what visitors know and would like to see; during its construction, particularly in the development of media; and after its opening, in order to determine whether the communication network and design were actually effective. In this way, visitors are included, at least indirectly, in monitoring results. A basis for targeted optimization is

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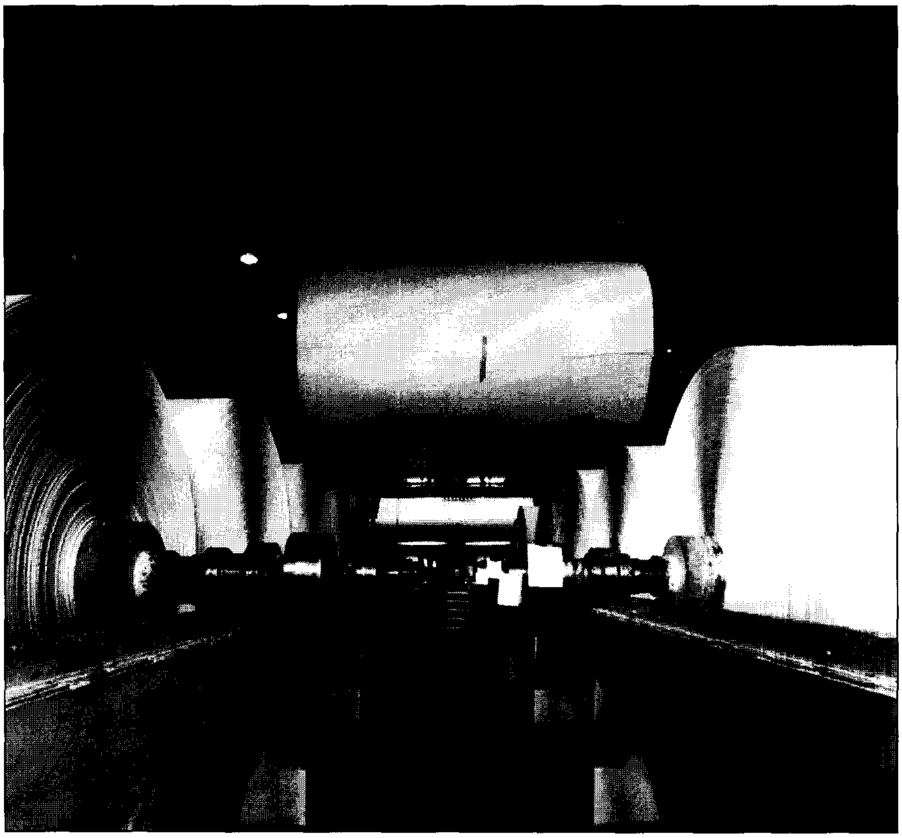
created and findings are available to partners from the business world who can document the success of their financial involvement.

In the future, government funding for cultural purposes will be less abundant, and partners from the business world must therefore be found in order to maintain exhibition activities at their usual levels. This is not new in the Deutsches Museum, where this practice has been expanded over the past ten years. Industrial methods of project management, market analyses and presentation techniques for fund-raising were borrowed. This makes for easier co-operation and communication with the business world because both speak the same language. In addition, there are numerous incentives for industry participation: the innovative power of museums, which can be seen in the target-group approach and the use of digital media, which presents a modern image; the dependability of the planning, signalled by quality-oriented conceptions as well as sophisticated timing and financial plans as indicators for modern exhibition presentations; the long-term nature of the partnership, with permanently structured co-operative ventures that correspond to the companies' medium- and long-term marketing strategies, and an attractive catalogue of credits and benefits.



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Introduction to the Paper Gallery.

A fresh approach to content

Social developments necessitate logical consequences in the areas of content, communication and design, as well as in project management. Since we are dealing with various target groups in the large museums, differentiated content must be created, which also requires new ways of thinking. Content should be integrated, current, targeted and dynamic. Integrated means that social, cultural, economic and ecological aspects come into play alongside scientific and technological aspects; it is a useful basis for addressing groups that are still under-represented today in science and technology museums, such as female visitors. Since science and technology museums have become places of education and enlightenment, they must take up current pressing issues in addition to these traditional (that is, historical) topics, and explain their technical and social relevance. The structure of this type of exhibition can be represented as a three-dimensional matrix consisting of the topical structure as well as comprehensive and historical aspects. Here, it should be kept in mind that history also includes the modern period. Exhibitions are not unchangeable documents; they must rather be seen as works in progress and continuously updated with regard to newly arising socially relevant issues, and optimized according to visitor wishes and expectations. Visitors can take in only a small number of central ideas. Therefore, when designing the scripts, a few primary messages must be defined and communicated in various ways that take into account both scientific and technological requirements as well as the preoccupation of future visitors as revealed by market analyses.

In this day and age, communication has special significance. Visitors enter into relationships with the material substance of exhibitions – originals, models and media, for example. However, they also seek out conversations with staff, request information on organizing their visit, ask for explanations and evaluations, or need other kinds of assistance. In order to keep visitors in our exhibitions and connect them with the museum on a long-term basis, their self-interest must be mobilized and reinforced. Significant elements for doing this are as follows: unity of head, heart, and hand; interactivity; decentralization of communication; individualization of content; mixture of individual and group content; and personalization.

Exhibitions cannot be permitted to deal only with objects and information that address the head, that is, the intellectual side of visitors. People are best informed when a unity of head, heart, and hand is achieved. Event areas – in so far as they are well planned and implemented – can achieve this unity. Dioramas and staging, playing with light and projections, films and videos, as well as figures and pictures, speak especially well to visitors on an emotional level; in our Paper Department, we attempt to do this with a paper landscape. Likewise, the use of multimedia can be helpful, with a screen design that reflects the topic and encourages visitors to act. Originals can have an experiential effect on some visitors, if they are familiar to them. All these elements, combined with an attractive ambience, make it possible for visitors to get into the right emotional mood. Their degree of attentiveness and interest increases, and it becomes possible for them to identify with the topic.

With regard to developing self-motivation, the opportunity to act is of special significance. Trying things out, discovering, experimenting, and playing challenge visitors, and – through multiple sensory experiences – make their visit thoroughly stimulating and entertaining. However, action alone is not sufficient; in their interaction with the media, visitors want to turn their own ideas into reality. In this way, they liberate themselves from a passive attitude, which increases their self-motivation. Interactive media are thus particularly meaningful when they make it possible for visitors to deal with a topic by acting to influence the course of events, to develop their own ideas or to discover their own solutions, as well as receiving feedback from their actions – as directly and immediately as possible. It is also important that visitors use as many of their senses as possible in order to acquire information. A successful example of this is the interactive table in the Paper Department.

Decentralization of communications means, on the one hand, creation of multiple forms of encounter and distribution of textual and visual communication surfaces over the entire space. The laminated drawings and texts sunk into the floor of the new Paper Department reveal 'amazing facts' while at the same time serving as important navigation elements. In addition to the informational materials on the floor, changing pictures and texts in our multimedia system or traditional projects makes it possible to rectify visual and textual communication.

The goal of adapting the content to the expectations, needs, and interests of the public requires sophisticated preparation of the information so that visitors find what is appropriate for them without problems. Individualization takes place in many ways: the principle of a successively deepening approach (implemented in media layering) allows visitors to find the information that interests them at a level that corresponds to their knowledge. Multimedia systems are not only the means for developing content interactively, but also for individualizing content so that visitors can select the desired content packages. Our currently planned Multimedia Individual Escort System (MiB) goes even further. It records visitors' individual activities and, based on this information, provides changing content packages.

In addition to new media, pictures are also suitable for individualization. In the Printing Technology and Paper Departments, they will be an independent medium for getting visitors into the right frame of mind by illustrating things and making them more comprehensible. It is just as important to optimize traditional media, for example, texts. Alongside hierarchically structured texts, which have become customary in museums, new forms can also be found, such as 'amazing facts' in the form of comic strips, or projected texts that impart primary messages in a targeted way.

More and more small groups are visiting the Deutsches Museum. Their goal is to deal with the content in museums and exhibitions and to inform themselves in an entertaining way. Aspects of group dynamics are at least equally important: jointly planning their path through the exhibitions, while balancing differences in interests and needs, doing things with others, chatting with their partners, or sharing their own feelings are pleasurable activities in small groups. This situation is currently not yet sufficiently taken into account in museums. Frequently, socially interactive media are lacking, that is to say, experiments that require the participation of at least two people, multimedia competitive and co-operative games, jointly usable experience areas, and the opportunity for visitors to create things themselves in a group and take them home. For these small groups and individual visitors, personal contact with staff working in the collections is of decisive significance. In the Deutsches Museum, the docents can help visitors in their selection of a path and topics or in carrying out experiments, explain exhibit items in individual conversations, or offer

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'People become informed best when a unity of head, heart and hand is achieved ... In our Paper Department, we attempt to do this with a paper landscape ... [where] laminated texts sunk into the floor are important navigation elements.'

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Interactive table in the Paper Department.

demonstrations and presentations. Currently, things are moving in the direction of computer-aided presentations which permit adequate responses to visitor wishes as well as live hookups to companies with the possibility of a dialogue between the visitor and a presenter at the location.

Architecture and design

The level of architecture and design must be interconnected with the levels of content and communication in order to achieve a unified presentation. Together with the objects and the media, the design must create orientation, ambience and stimulation.

In order to find their way in exhibit halls, visitors should be able to draw conclusions about the underlying content and communication systems from the visible physical structure. It is only with comprehensive and sophisticated spatial and design arrangements that visitors are able to choose their path and content in accordance with their own wishes, and to interact with the objects and media that are interesting to them. The ambience of a museum is a phenomenon that is difficult to describe. It is created from the effects of the overall space and smaller spaces within the museum, from the exhibit architecture, illumination and colour design and the exhibits themselves – objects and media – as well as their combination. It is a decisive criterion for how visitors decide, upon entering an exhibition, whether they will stay or leave.

Museums must not only take pains to ensure that there is a pleasant atmosphere, but also that visitors have surprising experiences again and again, that they can choose among goal-oriented content packages, or be stimulated to deal more intensively with the exhibits. The elements of content, communication, and design noted above, and their interconnection, create the indispensable preconditions that enable visitors to seek out the topics that are suitable for them, and to deal with them at a level that they find appropriate. In addition, they lead to significantly longer visits, which is an important prerequisite for the fulfilment of educational, instructional and informational demands made on technological museums, and for the integration of industry.

Project and quality management

There are also changes in the area of project and quality management that are at least just as important. A primary basis for this is a computer-supported approach to work, with a system that is comprehensive, flexible, user-friendly and open, using inexpensive basic software. The advantages for project management are manifold: the work can be set up more effectively, time can be saved, and costs can be lowered. Hand in hand with heightened effectiveness is an increase in the quality of the products and procedures of work; communication is better, because all of the participants are always fully informed, which is an important prerequisite for the professionalization of the overall team.

For me, there is no question that quality management will come to museums, if only for the reason that partners from the business world, whom we will need in the future even more urgently than today, are pushing for it. Companies have an interest in seeing that a high-quality product is created. They perceive exhibitions as brand-name products that are suitable for longer-term marketing, so that the funds they have provided are actually worthwhile. If exhibitions are to earn a particular status within companies' marketing concepts, there must be a sufficient amount of commitment in their planning and implementation, and the appropriately scheduled and costed process must be precisely recorded and controlled. This requires modern project management with careful attention paid to process and product quality in the exhibitions.

Outstanding exhibitions in notable museums are interesting for the business world because they fulfil a number of goals. If they have preserved their authority and independence, museums can transmit messages that are otherwise impossible to impart, or can only be imparted at greater expense. Museums have the clientele – particularly young people – that are also the primary target group for industry; they deal more intensively and longer with content packages than do other advertising and marketing media, and they possess a catalogue of credits and benefits that are in demand on the open market. Museums have only limited leeway independently of close co-operation with commercial companies. If quality criteria are not developed by the museums themselves and actively communicated to the external world, they will be imposed upon us from the outside and we will have to accept them. We thus must ensure the highest standards in exhibition themes, communication, architecture and design so that these partnerships will be fruitful for all concerned. ■

Science in the service of society: the Israel National Museum of Science

Nitsa Movshovitz-Hadar and Drora Kass

Science as a cornerstone of nation building is a guiding principle of the Israel National Museum of Science, which caters to a culturally diverse public of all ages. Nitsa Movshovitz-Hadar is director of the museum and professor at the Technion–Israel Institute of Technology and former head of its Department of Education in Technology and Science. Since 1986, she has been academic director of the Israel National Pedagogical Center for Mathematics. For more than ten years, she was mathematics consultant to Israel Educational Television, which produced 'DraMath', a series of sixteen videotaped dramatic programmes in mathematics that won the 1985 Japan Prize International Contest of Educational Video Programs. Drora Kass, a psychologist by training, heads a consulting firm that assists institutions to enunciate goals, conceptualize programmes, devise strategies and raise funds. For more than thirty years she has been active in the promotion of peace between Israel and its neighbours and has won numerous awards on behalf of this work. Her previous positions include: director of Public Affairs and Resource Development Division, the Technion; special consultant to the Israeli Minister of Education and Culture; and director of the US Office of the International Center for Peace in the Middle East.

Israel can win the difficult battle of survival only by developing painstakingly, the intelligence and expert knowledge of her young people in the field of technology.

(Albert Einstein)

Scientific achievement, rather than military might, will determine the future of states and peoples.

(Shimon Peres, former Israeli Prime Minister)

In 1923 the father of the theory of relativity visited Palestine, where he planted a palm tree in the courtyard of the Haifa-based Israel National Museum of Science – then home to Israel's first institution of higher education, the Technion–Israel Institute of Technology. More than seventy-six years later, that palm tree still graces the magnificent landmark edifice, designed by renowned German Jewish architect Alexander Baerwald. It serves as a much-needed daily reminder of the assertion made by Albert Einstein many years ago.

At the gateway to the new millennium, Israel is poised at the technological cutting edge. Per capita, it is one of the world's five largest investors in research. Dubbed 'the second Silicon Valley', the country boasts more than 3,000 high-tech companies and has 135 engineers per 10,000 persons (compared with 85 per 10,000 in the United States).

Israel's need to develop its own defence systems has induced a massive leap in a broad range of areas, including electronics, image-processing technologies, radar and telecommunications. Years of defence needs have also resulted in an environment where innovation is the rule, and local research-and-development is reputed to have superior outcomes in a fraction of the time for achieving such results elsewhere.

There is no doubt that in an age in which, as former Israeli Prime Minister Shimon Peres has asserted, military prowess has given way to scientific and technological achievement, Israel's standing in the global marketplace will be determined by its ability to maintain an edge in development and innovation in these fields. But to do so, it must reach youngsters, spark their interest, inspire their creativity and help channel them, in ever increasing numbers, to careers in the sciences. This is no mean task in an era when students everywhere are increasingly shifting away from the exact sciences and engineering towards professions perceived to be more immediately lucrative, such as law, business administration and the media.

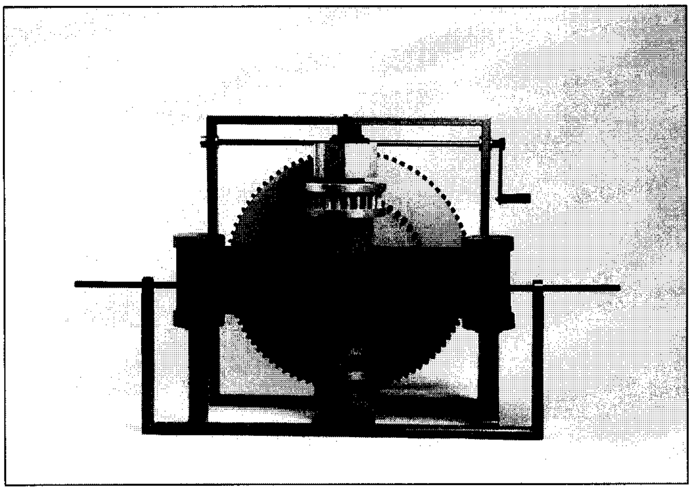
Moreover, analyses of the Third International Study, conducted by the International Association for the Evaluation of Educational Achievement (IAEEA), show that at junior-high-school level, Israel occupies a relatively low place in achievement in the sciences compared with other developed countries. Out of forty-five countries, Israel comes twenty-fourth in science achievements of eighth graders;[1] in mathematics, it ranks twenty-first.[2] While formal Israeli high-school curricula allow students to take up to ten to twelve hours of science studies a week (mathematics/biology/chemistry/physics/computer science), only 5 per cent of eleventh and twelfth graders pursue this fortified science curriculum. And given the high matriculation scores required by universities, students are prone to be exam-driven and teachers geared by the need to cover that curriculum.

Demystifying science

Founded in 1984, the Israel National Museum of Science seeks to alter the

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)



© Avraham Hay/The Israel National Museum of Science

A device to convert motion with a friction belt. From the interactive exhibit Leonardo da Vinci – Scientist and Engineer.

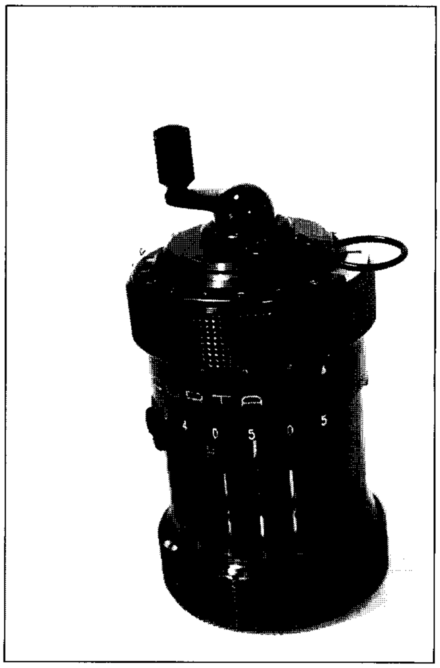
perception expressed by Arthur C. Clarke, that 'sufficiently advanced technology is indistinguishable from magic'. By demystifying science and unravelling the complexities of technology, the museum is strengthening a more rational approach to science and fostering interest by young and old alike. Our motto is, 'From seven to seventy'. Through a vast assortment of interactive scientific exhibits – almost all manufactured in-house – we want people to grasp basic scientific concepts on subjects from mechanics, electricity and magnetism to optics, acoustics, aeronautics and communication; to understand how items they use daily – radios, televisions, CD players, microwave ovens and cellular phones – function; and to experience an intellectual surprise, expressed by 'Wow!' followed by 'Why?' or 'How?' and finally, an insightful 'Aha!'

About 200,000 visitors (100,000 of whom are elementary- and high-school students) of all ages, backgrounds and geographic locations take part annually in museum activities. Youngsters who spend time in hands-on experiments in museum laboratories and demonstration rooms and operate its more than 250 interactive exhibits, leave with an enhanced desire to master given areas of science or technology, even if they have no previous background in the field. By taking home items they have made to share with their parents they immerse their entire family in an exciting science venture.

Many potentially exciting scientific subjects, such as chemistry, for example, are often negatively perceived or avoided. The museum tries to alter these attitudes through popular lectures and stimulating exhibitions. Its recent *Matter of Chemistry* exhibition features twenty interactive exhibits on chemistry and chemical phenomena. Aimed at the broad public through demonstration of chemical processes and their use in everyday life, it includes an odour laboratory to illustrate our sense of smell, blood pressure in chemistry, and the like.

The vital interaction between science and society is highlighted through broader cultural exhibits, including *Radio – The Early Days*, marking the centenary of the first Marconi transmissions; *Santiago Calatrava – Structures and Movement*, featuring models of the renowned architect's work; *Jewish Vienna through Life-size Holograms*, depicting the life of the Jewish community in Austria. Popularized one-day seminars and public lecture series explore intersections between science and society on issues such as *Avoiding the Ageing Process: Illusion and Reality*, or *Can the Brain Understand the Mind?*

The museum is dedicated not only to the universal mission of spreading the word of science, but also to a national mission: laying the foundation for the fulfilment of Einstein's vision by fostering a love of science among children and youth of all ages, backgrounds and geographic locations. It strives to cultivate excellence in science among young people, by rendering scientific and technological topics attractive and interesting, within a unique environment that facilitates effective transmission of scientific messages. In a multicultural country which continues to be built on immigration – 15 per cent of the population has emigrated to the coun-



The Curta calculator, a four-function, pocket-size universal calculator, developed by Curt Herzstark during his years in the Buchenwald concentration camp. Sold in large quantities worldwide, it was supplanted in the 1970s by the advent of electronic calculators.

try within the last ten years – the museum seeks to contribute to the immigrants' successful integration through subjects that are not language-bound. It is also sensitive to the existence of Arabic-speaking communities in Israel and to the need to reach out and nurture excellence in science among both Jewish and Arab youth from disadvantaged backgrounds and peripheral locations, whose families or educational authorities may not accord priority to science education. The latter have to be convinced of the importance of encouraging participation in such programmes and of identifying and nurturing students who exhibit special talent for the sciences. Finally, the museum desires to narrow significant gender gaps in science achievements among students.

The Museum Science Education Center develops unique curricula, teaching aids and laboratory experiments. Well-equipped laboratories – sorely lacking in most formal educational frameworks in Israel – form the centre's core learning environment. Every year, more than 2,000 classes of third- to ninth-graders participate in morning sessions of demonstrations and experiments in chemistry, physics and biology. More than 500 elementary schoolchildren – half from Israel's northern development towns, half from new immigrant communities – take part in intensive, year-long weekly afternoon workshops. Under expert guidance by museum personnel, children and youth glean first-hand knowledge of how colours come into being. They gain insight into computers, investigate the operation of electric motors, explore magnets, learn how sound waves travel and much more. Designed to meet their specific academic requirements, these activities enrich subject-matter taught within the formal education system. In order to reach children in their early formative years when they are first able to give voice to their natural curiosity, the centre will soon open a Toddler and Young Children's Wing. Here, kindergarten staff, accompanied by parents or teachers, will take part in science-made-fun enrichment activities.

The museum's annual OlympiYeda international science competition – open to ninth- and tenth-graders – aims to identify, inspire and nurture young people with a particular interest and inclination for science. The four-stage year-long competition, for Israelis and youth from North America, the United Kingdom, Australia and South Africa, opens with two screening stages – an aptitude test and one based on specially prepared study materials. Those eligible for the semifinal stage are invited to take part in a two-week, all-expenses-paid, science summer camp in Haifa. Participants enjoy a full range of scientific activities: lectures by prominent scientists and researchers, and visits to innovative research, technological and industrial facilities. Recently the OlympiYeda focused on 'Scientific Breakthroughs of the Twentieth Century'. Past topics have included energy, science in sports, sound and hearing, communication, chemistry and the secrets of the elements, and space science. A special OlympiYeda Headstart Programme is offered to high-school students from disadvantaged neighbourhoods and outlying towns – Jews as well as Christian and Muslim Arabs – who exhibit special potential for science. The programme enhances their knowledge, and self-confidence, boosting their chances of success by stimulating curiosity, facilitating learning and motivating them to pursue scientific subjects.

The museum also provides widespread

outreach activities for children who are not able to visit because of their location or the priorities of their educational frameworks. These currently comprise five extensions throughout Israel, use of museum-produced mobile exhibits in outlying towns and villages, and a mobile science laboratory, the first of its kind in the country. Fully equipped with demonstration and teaching aids, the laboratory stimulates interactive presentations, to students and teachers alike, on a broad variety of scientific phenomena and their underlying principles: how metals combust; the way air is liquefied; what goes into creating plastics, and the like. These activities have proved effective in producing significant improvement in children's performance at school and over time have resulted in a marked shift in declared role models. A survey conducted at Givat Olga – a development town with a high proportion of new immigrants – following a series of museum-initiated science programmes illustrates the change. When asked what they wanted to be when they grew up, the initial reply among boys tended to be 'a driver', and among girls, 'a nurse'. Following the science initiatives, boys tended to reply 'an engineer' and girls, 'a doctor'.

Science education: the great equalizer

In Israel the gap between the achievements of boys and girls in the sciences is one of the highest in the developed world and is growing. In fact, Israel is one of the few countries in which gender differences are statistically significant, even at a young age.[2] There are many reasons for this, not the least of which is a lack of female scientist role models in textbooks, among university faculty members[3] and in top-level managerial positions in industry.[4] While there is no dearth of foreign literature on women in science, there is not one textbook in Hebrew on the subject.

Museum experts believe girls need to be exposed to science in a positive way, before fear sets in. Its Science Education Center has served as a laboratory for a year-long experiment in which fourth- to sixth-grade girls took part in a single-sex science class – proven to be a venue for the enhancement of motivation, self-confidence and the desire of girls to continue in the sciences. The outcome was a higher percentage of girls than in mixed classes expressing enjoyment of the material learned and opting to continue. The centre has also introduced affirmative action elements which promote and encourage girls to join its programmes and competitions. In the offing is a data bank on women in science which will comprise scientific achievements and life stories of women scientists whose work has enhanced our understanding of the world – from the dawn of civilization to the present. This will be used as a motivational tool, combining biographical information on women scientists with a host of classroom activities and problem-solving experiences.

The museum operates on the premise that Russian and Ethiopian immigrant children have a greater chance of competing successfully with their peers on subjects that are free of linguistic constraints. Enrichment programmes for smaller groups provide informal educational settings that are less threatening than formal ones, in which immigrant children and their veteran Israeli-born peers can overcome social inhibitions and psychological barriers. What is more, the success of these young people in scientific fields and competitions undoubtedly radiates upon their entire community, and goes a long way

A touch of electricity: getting a sense of electrical conductivity using a plasma ball in the museum's Dark Room.

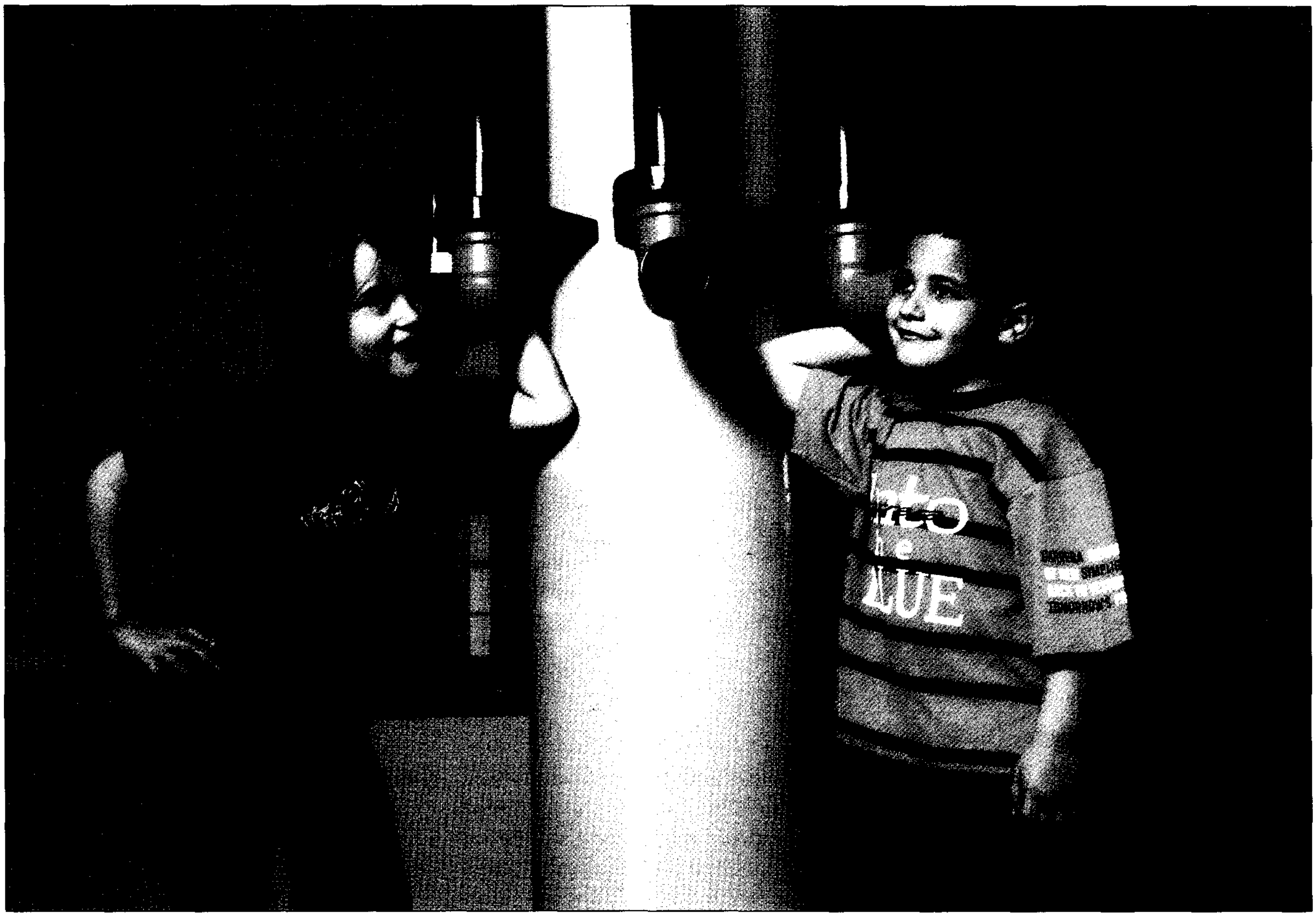
toward effacing a negative self-image, strengthening their confidence and generating a feeling of parity with their more privileged peers.

The same holds true for Arab youth. Like disadvantaged groups elsewhere, Israel's Arabs, who constitute almost 20 per cent of the country's population, are trying to change their marginal status through educational achievements. However, laboratories and physical equipment in Arab schools are, on the whole, far inferior to those found in Jewish schools. Dealing effectively with this population implies multilingual explanations, cultural adaptations and specially devised headstart programmes.

Science: aeons of cumulative knowledge

We feel it is vital that current and future generations be exposed not only to the worlds of today and tomorrow, but also to the past, so that students can understand that science developed over many years, on the shoulders of scientific giants. The museum's *Leonardo da Vinci – Scientist and Engineer* exhibition, to take one example, displays thirty interactive exhibits, designed and produced on the basis of Leonardo's specifications. The highly aesthetic large exhibits, made of wood and set on granite bases, expose Leonardo's scientific and technological curiosity and ways in which he developed ideas pertaining to machines, automation, hydrostatics, hydrodynamics and flight and their underlying principles, broadly applied to other machines.

The museum's Historic Collection also provides visitors with a sense of scientific continuity. Dubbed Israel's 'National Archive for Historic Scientific Instruments', the collection comprises a broad variety of scientific equipment that has served functions now rendered obsolete: Edison's first phonograph with matching cylinders (1904–08); a Swedish Baltic radio receiver (1927); a British manually operated vacuum cleaner (*circa* 1900); a Mignon pointer-type typewriter with Hebrew characters (1920), and more.



Children unravelling the mysteries of sound.

The collection is of interest for its historical value, for the learning it affords and as a reservoir for specific exhibitions.

The premises also create a balance between old and new. In restoring its building, the museum has remained true to the architect Baerwald's original turn-of-the-century design, an approach that called for inventive, often unconventional solutions, imposed by the structure's original features. It is one that has allowed the museum to offer its multitude of visitors an environment in which the past and the future merge, providing a taste of science and technology tinged with a historic flavour emanating from a site that has come to be synonymous with higher education in Israel. The museum has refurbished an original Technion classroom within its major building, 'selling' the 108 seats to Technion graduates. The brass name plaques on each seat read like a veritable *Who's Who* of the Israeli economy and high-tech industry, people who have become partners in the vital task of promoting scientific education among youth.

The museum also features exhibits of Israeli technological breakthroughs, such as Elscint's computerized tomograph (CT), and Simigon's computerized flight simulator – used to train both military and civilian pilots. With the unfolding peace process in the Middle East, the museum aspires to show that innovations developed under military exigency have broader civil applications. A Merkava tank and a Kfir jet fighter, both situated in the courtyard, are two prime examples of Israeli scientific ingenuity with general high-tech applications. They boast novel features, such as night vision and an ability to move on rough, rocky terrain. In recognition of the growing role of industry, especially in high-tech fields, in promoting science education, a number of co-operative ventures have been undertaken, such as a futuristic communications centre, with Bezeq–Israel Telephone & Telecommunication Company, and the *From Calculations to Computations* exhibition courtesy of Intel, to name but a few.

In our bid for universal accessibility, we have opened a unique 'Science, Light and

Sound' Project – interactive exhibits adapted for the sight- and hearing-impaired. Several displays which require sight or sound to experience their results have been altered, replacing visual elements with auditory ones or auditory features by optic components. For example, a meter measuring the electric current in one's hand has been hooked to a buzzer with variable pitches and Braille explanations have supplemented printed ones.

Finally, given Israel's world record in road accidents and the museum's high number of visitors, we feel we have a contribution to make in this regard by focusing on saving lives as well as enhancing minds. A soon-to-be opened exhibition on accident prevention, comprising twenty-five interactive displays, will enable children and youth, young drivers and seasoned ones, to experience first-hand how diverse safety apparatuses function and to take an active part in accident reconstruction.

All special adaptations, as well as the broad range of interactive exhibits, scientific instrumentation and prototypes, are developed, designed and produced in museum workshops. These afford visitors a behind-the-scenes look at how the permanent and changing displays come into being.

The transition to a new millennium is not merely chronological. It calls for the adoption of new mental structures and societal norms, in line with the meteoric speed of technological and scientific advances. We believe that societies that succeed in internalizing this revolution and using it for the well-being of all their citizens will be able to skirt the dangers of escalating polarization whereby a growing number of people, unable to understand or reap the benefits of technology, will necessarily feel left out. Conscious of disparate cultures in Israel which call for sensitivity of language and approach, the Israel National Museum of Science strives to reach Israelis of all backgrounds with the wonders of science and technology to make them feel that they, too, have a direct stake in these developments, and that they can and should partake as equals in the country's bid for position in the global economic marketplace. ■

Notes

1. Findings published by Professor Pinchas Tamir of the Hebrew University's Department for Science Education.

2. Findings published by Professor Nitsa Movshovitz-Hadar, museum director and former head of the Technion Department of Education in Science and Technology.

3. A recent study (1994) by Hebrew University sociologist Dr Nina Toren demonstrates that while the percentage of women faculty members at Israeli institutions of higher education has risen, their number in the sciences has declined. Of the Technion's 250 full professors, to take one example, only eleven are women.

4. A survey conducted for the Israeli Manufacturers' Association reveals that out of 633 senior managers in the electronics field, only nine are women; in 74 per cent of these companies, there is only one woman at middle-management level.

The 'context museum': integrating science and culture

Ivo Janousek

One of the most important tasks facing science and technology museums today is to shed the view of science as divorced from culture. Ivo Janousek explains how the history of Western thought resulted in this dichotomy and points a way forward to bring about a more integrated understanding of the world around us. The author is director of the National Technical Museum in Prague and a specialist in cybernetics, philosophy of science and culture, and contemporary art criticism. He is a member of the board of the European Collaborative for Science, Industry and Technology (ECSITE) and the Committee for the History of Technology (ICOHTECH), and is a vice-president of the Middle-European Union of Technical Museums (MUT). He is the author of numerous monographs, patents, scientific articles and art catalogues, and radio and television programmes, as well as a lecturer in logic and epistemology at Charles University in Prague.

With our entry into the twenty-first century the eternal philosophical questions arise once again: Who are we? Where are we coming from? Where are we going? From the point of view of museums, this implies a need to define our current role, to re-evaluate our former experiences, and to form a vision of how museums of the future will look. The importance of this last task, perhaps even its basic aim, is connected with the globalization of the world, with the existence of the World Wide Web, and the omnipresence of multimedia; we might even add that this current state evokes some consideration – of course only by a few pessimists – of the prospective disappearance of museums. Thus, in terms of looking forward to the future and defining the role of museums, we should begin by analysing the whole topic with a deeper philosophical attitude.

The history of humanity is connected with the establishment of branches of learning and reflection, and the separation between humanitarian and technical disciplines. However, with the coming of post-modernism (which has transformed inter-disciplinarity into transdisciplinarity) we have witnessed a global advance in the search to rediscover the lost complexity of the human mind, including the relationship between art and technology. Therefore, the idea of a new type of museum, a so-called context museum, is presented here as a mixture of an object-oriented museum with multimedia access to a wide cultural background. Such museums could produce a better understanding of history in terms of two cultural aspects, art and technology, and by integrating them would also provide a higher level of entertainment for the public.

To do this requires some familiarity with the historical developments that have led to the separation of two cultures: science and technology on the one hand, and the arts on the other. Moving from Aristotle's *Metaphysics* and the Christian Middle Ages, with its universalist understanding (of course, with the unifying ideology of religious interpretation), we find the Renaissance still characterized by an integrated awareness. The example *par excellence* is Leonardo da Vinci, an artistic genius as well as a scientist. It was only the philosophy of René Descartes, further developed by Baruch Spinoza (*Principles of Descartes' Philosophy*, 1663), and especially Isaac Newton's mathematical foundations of natural laws (*Philosophiae naturalis principia mathematica*, 1687), that brought the beginnings of a truly rational separation of science and technology from other disciplines. In elaborating his laws, Newton drew on the rationalism of ancient Greek atomism and reduced matter to solid bodies, bringing in the concept of force, and in this way laid the foundations not only of engineering but also of belief in the 'knowability' (through gradual mastery) of the world.

Although Newton was aware of his own reductionism (he was himself a deeply religious person and did not regard his system as a universal way of grasping reality as a whole), in practice this philosophical conception of the Cartesian/Newtonian model was established as a paradigm from the end of the seventeenth century. A separation therefore occurred, with two elements now being excluded from the developmental process: the memory of the cosmos (the cosmos was now only a mechanical system of bodies, possessing inertia at most) and human consciousness (i.e. the psyche). Their status was considered outside the sphere of scientific interest. While the subsequent history of classical science was a grandiose experiment in the reductionist ➧

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)

unification of science as a whole, from an external point of view it implied a further separation of fields and a breakdown of integrity.

One factor that contributed to this unhappy development was the division of the education system and the separation of high schools into two categories, one for classical studies and the other for mathematics. This may have increased the efficiency of specialized training, but it also produced a deformation of natural character and reduced overall possibilities of communication. Another factor making for the separability of science was Auguste Comte's positivism, in which scientific knowledge was divided into the independent disciplines of mathematics, physics, chemistry, biology, anthropology and philosophy, with art and religion lying in the hierarchically highest levels of this system. This not only provided the basis for the view of art as distinct from culture, but also – given the rapid development of science and technology during industrialization in the late nineteenth century – further differentiated individual technical and scientific disciplines, diminished communication between them and obscured their relationship to the whole.

What then is the road to repair, to a new unity in apprehension of the world and to the renewal of the integrity of the human personality? We have already mentioned the development from separate disciplines through the interdisciplinarity of the 1960s to the transdisciplinary 1970s and 1980s. Another important aspect is the inclusion of psychology into evolutionary theories of cognition. If earlier there had been a proclaimed divergence of science and culture, what is postulated today, through a search for the proximity of their characteristics, is their convergence (see a comparison between two classic writings of C. P. Snow).[1] A general need, even an imperative, has arisen for a new synthesis that should be reflected even in the formal education of the younger generation. Unfortunately, however, we continue to witness education in the form of causal-statistical reductionism.

These developments have had profound implications on the role and practice of museums.[2] Recent reflection[3] has highlighted several major shifts in our thinking, from structures to processes, from objective sciences to epistemological sciences, from parts to the whole (holism), from separation into disciplines to common subjects, from 'exact' truth to approximative descriptions, and to the use of metaphors. At the same time, new technologies and ways of working have changed the way museums operate, for example, by introducing computer databases and their standardization, networks and their applications and multimedia presentation.[4] These transformations, together with the possibilities presented by new electronic tools, have also brought about – step by step – new types of museums.

Three generations of museums … and a possible fourth

During the First Science Centre World Congress at Heureka, in Vantaa, Finland, in June 1996, our British colleagues Bruce Durrie and Chris Hutchison proposed a way to classify museums, in a contribution entitled 'Third Generation Museums'. According to them, the first generation is represented by traditional technical museums that are object-oriented; collections and exhibitions are based on selected artefacts with no presentation of a broader context. Moreover, the permanent exhibitions are usually constrained by purely professional specifications, and there are no references to developments between fields or to interdisciplinary effects. Recent advancements are generally ignored and only 'historical' aspects are postulated, thus contributing to an anachronic point of view.

The second generation refers to actual science centres. These have no acquisition activity, their effort is concentrated on elucidating the natural order, their subjects are interactive models and experiments. Again, the requirement for the mediation of broader contexts is not met. The objective is education and support of creativity through a 'game' approach, communicating to visitors through 'participation' and, in this way, making the transition from 'objects' to 'processes'. However, a negative aspect is that explanations are frequently simplified: for instance, an almost obligatory interactive station in science centres is the experiment showing that white light is composed of three colours (which is well known by everyone who has gone to school). This, however, does not convey a full understanding of, for example, the functioning of colour television. The situation thus remains that although people know how to switch on a television, they do not understand exactly how it works. And here it should be mentioned that the results of the investigation of British colleagues with regard to the use of improved computer technology in science centres showed that although visitors (predominantly schoolchildren up to 15 years of age) are at first captured by physical experiments, they soon move on to the computer stations where they spend as much as 80 per cent of their visiting time. It would appear, then, that the interactive objects (which, moreover, require good maintenance to remain in operation) are not very effective.

From these observations, a new approach has been formulated, which is being undertaken in a project at a new technology museum in Bristol, and which might be called the third generation: a museum that displays separate but freely accessible real historical objects together with explanations provided by an intelligent computer database in the form of a type of guide. Visitors receive a lightweight audio device that monitors their movement by means of sensors in space; every time they pause before an object, they are not only informed about the particular artefact and its connotation but are given options for their further progress through the museum. In this way, visitors themselves 'create the museum' and, through records kept in the database, are offered different alternatives during their next visit. In effect, the museum echoes the famous words of Heraclitus, who postulated that 'you cannot step twice into the same river'. Constantly changing, the museum provides an endless number of 'adventures'.

Returning to our analysis of development and the separation of branches,[5] we can visualize the human intellectual world and its reflection in various types of museums as a circular diagram where a general syntax (central area) can play the role of unifying separate fields of knowledge and, by so doing, reach a new integrity of mind, and even bridge the gap between art and technology. This leads to what I would call the fourth generation, or the 'context museum'. I have in mind, for example, a technical museum that would (by means of computers, a global database, virtual reality, etc.) mediate to visitors any voyage in the history of humanity, use technical artefacts to explain the development of civilization, provide an adventurous journey of 'expeditions' (not unlike the curves and paths of Tolkien's stories), and thus

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Steam locomotive 'Kladno', manufactured by Maschinen-Fabrik der Wien-Raaber Eisenbahn, Vienna, 1855.

The permanent exhibition Transport.

reveal human knowledge. The museum's database could even be connected with those of other museums (including art museums). In such a way, our future museums would be directed towards 'museums of technical culture' where the emphasis is put on the attribute 'culture', here interpreted as a continuous journey of the intellect, of humanity as a whole.

In practical terms, this would mean the creation of a museum that would include the contents of all other museums, exhibiting technical historical documents and presenting context through background and simulation (including virtual reality) by a network of computers and terminals. It is obvious that the realization of this vision will not be simple, for even though we have at present sufficient technical means to do so, there are numerous hurdles to overcome: cost will present a problem, but, perhaps more importantly, we shall need to surmount the conservative nature of people, including museum staff who are vital in attaining our objectives. In spite of all the known difficulties and obstacles, however, I urge that we begin at least to contemplate meeting this challenge. ■

Notes

1. C. P. Snow, *Two Cultures and Scientific Revolutions*, Cambridge University Press, 1959; *The Two Cultures and a Second Look*, Cambridge University Press, 1963.

2. Yaron Ezrahi, *Technology, Pessimism, and Postmodernism*, Boston/London, Kluwer Academic Publishers, 1993.

3. James Bradburne and Ivo Janousek, *Planning Science Museums for the New Europe*, Paris, UNESCO, 1993.

4. Ivo Janousek, 'Technical Museums and Science Centers – From Present towards Future', *Proceedings of MUT Annual Conference, Košice, Slovakia*, 1997.

5. Ivo Janousek, 'Transformations of the National Technical Museum in Prague: Principles and Practice', *Museum Management and Curatorship*, Vol. 14, No. 2, 1995.

You'll never know unless you go!

Paul F. Donahue

Canada's approach to presenting science and technology is strongly visitor-oriented, and geared to linking past and present in a dynamic, innovative fashion. Paul F. Donahue was formerly director-general of Collection and Research and is now director-general of Public Programmes for Canada's National Museum of Science and Technology in Ottawa. He has been the provincial archaeologist for Alberta and his interests include the prehistory of north-western North America, management of archaeological resources and collection development, heritage stewardship, and the public understanding of the past.

Canada's National Museum of Science and Technology Corporation comprises the National Museum of Science and Technology, the Agriculture Museum, and the National Aviation Museum. An operational premise at all three is that the optimal visitor experience includes both learning and pleasure, in an environment emphasizing human presence, active participation, accessibility, creativity, credibility, comfort and fun. We want our visitors to think about how Canada became the country it is and how the past is relevant to their everyday life.

The corporation is mandated 'to foster scientific and technological literacy throughout Canada by establishing, maintaining and developing a collection of scientific and technological objects, with special but not exclusive reference to Canada, and by demonstrating the products and processes of science and technology and their economic, social and cultural relationships with society'.

Its mission statement is 'to discover and share knowledge about Canada's scientific and technological heritage in order to increase understanding and appreciation of the role that science and technology has played and continues to play in the transformation of Canada'.

Our corporation collects and preserves artefacts in line with the conceptual theme of the 'Transformation of Canada'. It provides a framework not only for our research but also for our interpretation programmes and states that 'the transformation of Canada, from the period of early exploration and settlement to the present, has been marked by achievements in science and technology. There is an ongoing relationship between science, technology and Canadian society which has changed Canada, influenced its people and will continue to do so.' Three sub-themes guide our work:

- Canadian Context – Canadian achievements reflect the challenges overcome and the choices made in developing the country.
- Finding New Ways – the search for new knowledge and new ways of doing things is basic to human nature [and] science and technology play key roles in [these] efforts.
- People, Science and Technology – work and domestic lives are shaped and influenced by scientific and technological change. At the same time, individually and collectively, people shape the evolution of science and technology through their decisions and actions.

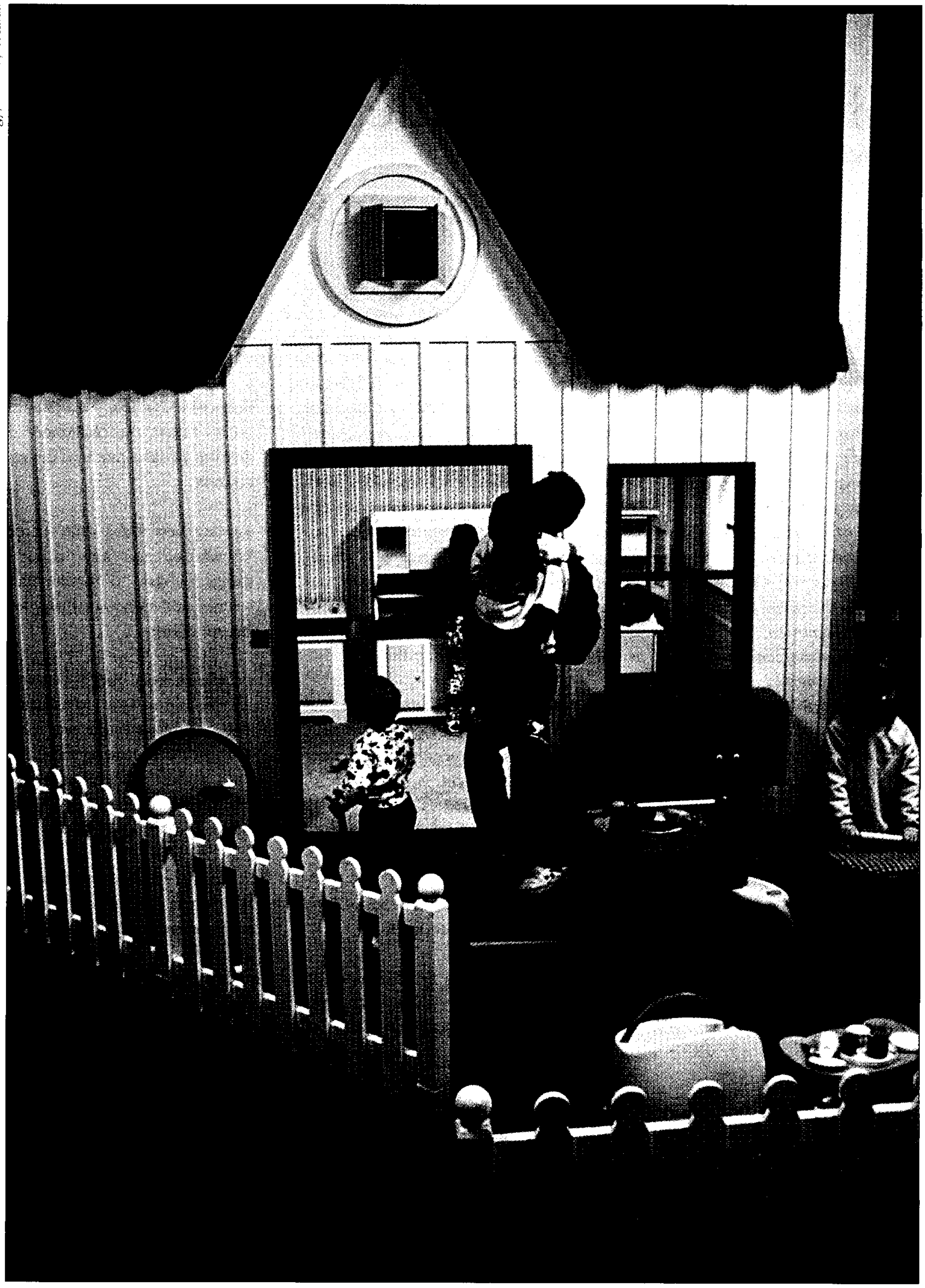
To ensure relevance, the collection development process requires curators to identify concepts and ideas fundamental to the understanding and appreciation of Canada's scientific and technological heritage. Curators produce historical assessments on the history of technology within chosen subject areas such as aviation, communications, manufacturing, natural resources, renewable resources, scientific instrumentation, and transportation. They then use these documents to identify objects that represent, typify or are significant to the subject area and that should therefore be preserved. By extension, the curators have identified those artefacts that may not merit being collected and this process allows the corporation to develop a meaningful and pertinent collection.

Creating scientific literacy

Our main reason for interpreting Canada's scientific and technological heritage is to

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

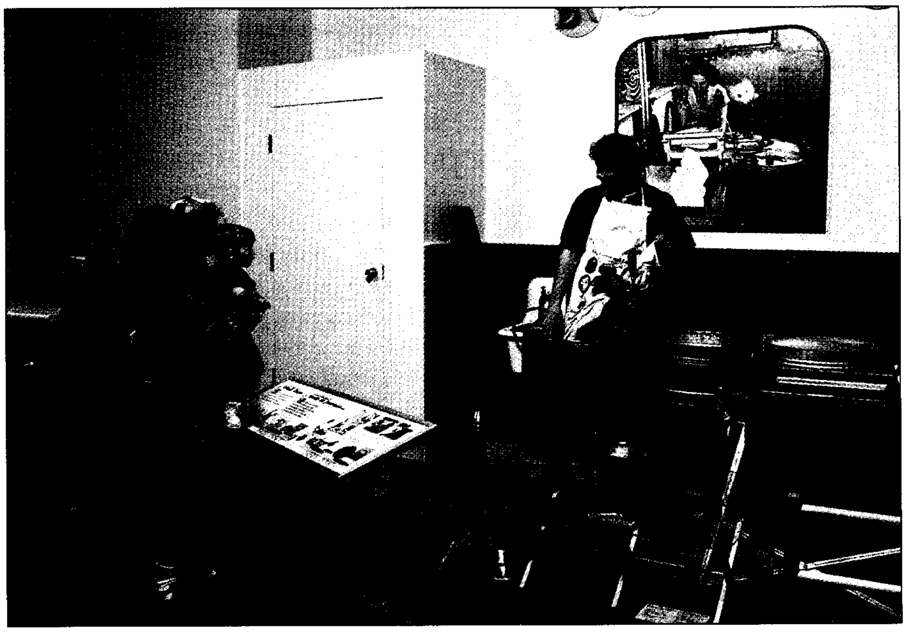
Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)



A playhouse with kitchen and yard in the Love, Leisure and Laundry *exhibition provides the opportunity for young children to role play and for parents to relax while looking at other exhibition elements.*

demonstrate to the visitor how it has transformed the lives of Canadians. The corporation strives to be the main source of information to Canada and the world on the country's scientific and technological achievements. More important, we try to make it exciting for our visitors!

The three museums develop exhibitions and programmes that provide an enriching museum experience, foster scientific and technological literacy and offer a better understanding of the contemporary issues facing individuals as members of Canadian society. In general,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Demonstrations that allow visitors to try the artefacts are very popular hands-on activities that show the changes in technology.

exhibition topics are selected based on the strengths of the collection and the range of visitor experiences they afford, that is, they must be thought-provoking, invite discovery and allow for the acquisition of the widest possible range of knowledge. In conjunction with exhibitions we offer school and public events, and curatorial publications that reinforce the intended messages of the exhibition and are adapted to different ages, levels of knowledge and interests. Exhibition and interpretation staff form the interface between the curatorial domain and visitors. By necessity and by inclination, they are aware of the literature and practices regarding visitor experiences and are able to communicate in a manner that visitors enjoy and appreciate.

Major exhibitions are based on the collection, and frequently have past, present and future sections. Curators are exceptionally knowledgeable about the past and should be reasonably well informed about the present. However, leading-edge and future-oriented research-and-development are more the domains of the private sector, and exhibitions featuring these aspects are best developed in concert with selected private- and public-sector scientists, engineers, and business people. In this fashion, we can demonstrate that we have learned from the past and offer a glimpse into the future that is more suitable to visitors and sensitizes them to current issues in science and technology.

Exhibitions are our primary products.[1] We strive to make texts as comprehensible as possible and generally offer the ability to touch and hear as well as see display elements. The relevance of the theme and subject-matter, and the levels of interactivity, are keys to successful presentations. These are normally enhanced by a broad range of interpretation activities and school programmes, as well as demonstrations, workshops, tours, and special events.

Focus on youth

Attracting children is an important aspect of fulfilling the corporation's mandate. Special attention is therefore given to developing appropriate and stimulating activities aimed at school groups (which comprise 20 per cent of our total corporate attendance) which fit into the curriculum. Meeting the needs of teachers and students is extremely important if we are to show how science and technology bear on their everyday lives. Their satisfaction translates into repeat visits and word-of-mouth publicity for the museums.

Some of the demonstrations we offer are fairly standard in technology museums and science centres and give us the opportunity to discuss applications and scientific principles. School schemes such as 'Curriculum Days', a week-long period during which we host about 4,000 students and very quickly move them through a series of curricular, grade-related activities delivered by educators, have proved a resounding success. 'Tommy's Toys', featured during the Christmas holidays for large family audiences, is a science-based fantasy that compares living in space with living on Earth (e.g. gravity versus weightlessness, inertia, trajectory). 'Guides and Scouts Nights' provide these groups with a chance to earn merit badges in science-related areas while taking some of the pressure off the scout leaders. 'Tiny Tots' is aimed at preschool children and introduces them to science and technology in an entertaining and friendly fashion. This results in repeat visits as the registrants opt for one-hour weekly sessions for ten weeks. More important, children learn early in life that museums can be 'fun' places to visit and, as they grow older, many sign up for our summer 'Space Camp'. At the Agriculture Museum, our 'farm in the city', we offer summer camps such as 'Barnyard Buddies', where children care for animals and tend gardens as well as learn how food is produced. Families often frequent such events as 'Fall Harvest', 'Dairy Days' and 'Sheep Shearing'. The National Aviation Museum has been hugely successful in teaching stories around Canada's aviation history through its 'Cadets' and 'Flight School' programmes.

How we currently produce long-term exhibitions is best illustrated by *Love, Leisure and Laundry*, a large presentation focused on the evolution of domestic appliances between 1860 and 1995 and their impact on gender roles in the home, in particular on the role of women. This exhibition takes a light-hearted and informative look at household appliances and technologies that were supposed to make our lives easier. It combines artefacts in historical contexts (a log cabin and yard from the 1870s depicting the pre-electricity period, a wood-frame house from around 1920 when electricity was introduced to parts of Canada, a 1950s kitchen, and a futuristic house with all the 'bells and whistles') as well as technological contexts (e.g. house-cleaning, cooking, cleaning) and multicultural contexts (kitchens from a Chinese restaurant, Italian and East Indian homes), an area showing the process of designing and testing domestic products for market, and a child's playhouse surrounded by a section describing the training of a domestic.

Along with the more than 600 artefacts are videos, computer games and hands-on interactive features ranging from a 'What is it?' cabinet to a giant wedding cake bedecked with objects and an accompanying quiz about which of them would have been received as wedding presents before 1930 (answers provoke a response of humorous sounds.). Three interactive touch-screen computer games test visitors' knowledge and provide instant answers. In another section of the exhibition visitors try to open an outhouse or privy door (something many visitors, especially the younger ones, would not be familiar with) only to be reprimanded by a voice in one of ten different languages telling them that it is occupied and to bring the occupant some paper. Other large graphic panels with cutouts for head and hands allow visitors to put themselves in the picture while listening to the real-life story of a person 'hauling water', 'sweeping' or 'doing laundry'. By developing a bit of historical context, making the exhibition humorous, relating to everyday life and testing visitors' knowledge, we have caught their attention and brought their history to life.

Associated with the exhibition are guided tours, demonstrations of the 'Beck Circus' (a utility truck of the early twentieth century used in rural areas of Ontario to convince people to adopt electricity) and on how laundry was done between 1800 and 1950. Educational programmes that take place on the exhibition floor include 'Simple Machines', where children are introduced to the gears and levers involved in operating machines, or 'Old and New Ways in the Home', showing students how electricity has changed the way housework is done and how this would have affected their own grandparents. By keeping the educational experience both cognitive and affective, as well as simple and suitable to young students, we shall have made a greater impression on them and provided a more valuable learning experience. It should be noted as well that for the teachers to come to the museum, the events and the experiences we offer must be affordable and germane to the school curriculum.

Unsung heroes

School textbooks identify the Einsteins, Edisons, and Curies of science and technology but many of our national and regional heroes go unrecognized. The pacemaker was developed, in part, by Dr John A. Hopps, an engineer at Canada's National Research Council. He is a local hero who has contributed to the improvement of peoples' health around the world. Words and music were first broadcast on radio in 1906 by Reginald Fessenden, a Canadian who discovered the ability to communicate by two-way voice over radio waves one year after Marconi's wireless communication by Morse code. At the Agriculture Museum we have cows, sheep, goats, beef cattle and more that attract some 145,000 visitors each year. The museum's newest exhibition on bread is a success because virtually everyone eats a form of bread and can relate to the theme. Marquis wheat, for years the staple wheat grain around the world, was developed at Ottawa's Central Experimental Farm by Dr Charles E. Saunders. His efforts brought him recognition in Canada's Science and Engineering Hall of Fame.

Schoolchildren should come to understand that they too can contribute to their country by becoming scientists and engineers. The National Museum of Science and Technology is the home of the Canadian Science and Engineering Hall of Fame which highlights Canadians and their achievements. An upcoming exhibition, tentatively entitled *Celebrating Canada*, will incorporate this Hall of Fame and will explore as well the many unsung heroes of science and technology whose discoveries and inventions helped transform Canada. The exhibition will also acknowledge some of those findings and creations that might have gone awry.

In a country so economically and culturally aligned with the United States, it is important to let Canadians know of their contributions. When developing our exhibition on *Canada in Space*, museum staff undertook a front-end study to determine what visitors knew and wanted to know about space, and what their misconceptions were. Largely because of the news media the people interviewed were interested in the American story of getting into space, living there and walking on the moon. They knew nothing of Canada's role. They did not know, for example, that the aurora borealis and its disruption of radio waves over a very large and northward-stretching area prompted Canadians to improve upon their ability to communicate. This led to a great deal of lower- and upper-atmospheric research that eventually made Canada a leader in aerospace communications. Canada's ANIK A1, the world's first domestic communication satellite in a geostationary orbit, was launched in 1972. The exhibition we developed not only provided people with what they wanted but, more important, with what they needed, that is, an education about Canada's space story.

It is more and more recognized that visitors come to museums primarily for socialization and for safe, pleasant experiences that are culturally meaningful, rather than to learn. Dissemination of knowledge may be the first priority of museums, but if people are visiting for other reasons, then it behoves us to consider seriously what experiences we should be providing them with. Being better informed about what visitors want may mean offering more workshops, interactive exhibitions and experiences that involve the senses (sound, sight, smell, touch and taste) and the development of contexts to which they can relate. In order to foster visitors' understanding, we have to attract and hold their attention.

The goals of the National Museum of Science and Technology Corporation are to connect people with Canada's scientific and technological heritage and to depict its future promise, to promote pride of country, to show how Canada has been transformed by science and technology, to make the past relevant to the present, and to contribute to Canadian scientific and technological literacy. At our three museums, we have been successful in doing this. And, we make it fun! That is why at Science and Technology we say, 'You'll never know unless you go!' ■

Note

1. The curatorial section produces publications that reflect their research efforts and are primarily designed for specialized audiences, though some are directed at the general public.

Science museums: centres of excellence for developing countries

M. Sameh Said

The new Susan Mubarak Science Exploration Centre in Cairo is the first of its kind in the region and was designed to bring the country's children into the heart of scientific and technological progress. M. Sameh Said was its guiding spirit and he describes the formidable challenges that developing countries face if they are to join the scientific debate that characterizes our epoch. The author is a technology adviser at the Egyptian Ministry of Education and directed the national project of education technology in Egypt, including introducing technology in Egypt's schools and setting up a nationwide video conference network, as well as video and multimedia production centres. He is a professor of electronics in the Faculty of Engineering, Cairo University, and has taught at universities in the United States.

Science education in developing countries is severely handicapped by the scarcity of laboratory equipment, which has led to an ever increasing dependence on purely theoretical teaching. This rote learning has resulted in an insufficient appreciation of scientific endeavour and hence to a lack of innovation and a spirit of invention among graduates. In order to prepare new generations for the twenty-first century, it is important to plan a comprehensive approach towards making science a part of daily perception and understanding. The theme 'science for all' seems to be mandatory today and although this may be well recognized in developed countries, the need might even be greater in developing countries. The museum as a learning environment to supplement schools seems a logical solution. If laboratories, audiovisual materials and resources cannot be made available in every school for budgetary reasons, it might be worthwhile to expend funds on furnishing centres of excellence where exhibits could enrich the learning process. These centres would serve several functions. First, they could spread scientific literacy among laypeople and parents to prepare the ground for children to grow in a more science-friendly atmosphere. People from all walks of life must be exposed to some degree of scientific awareness if they are to cope with the fast pace of scientific development and its vast network of applications. Preparing the nation for scientific thinking and recognition of the value of science in everyday life is no less important than alphabetical literacy. The second function would be to incubate the talented elements who might be inspired by the exhibits and enlightened by new ideas. Finally, the centres could also serve as channels to the developed world, where technology acquisition might be feasible.

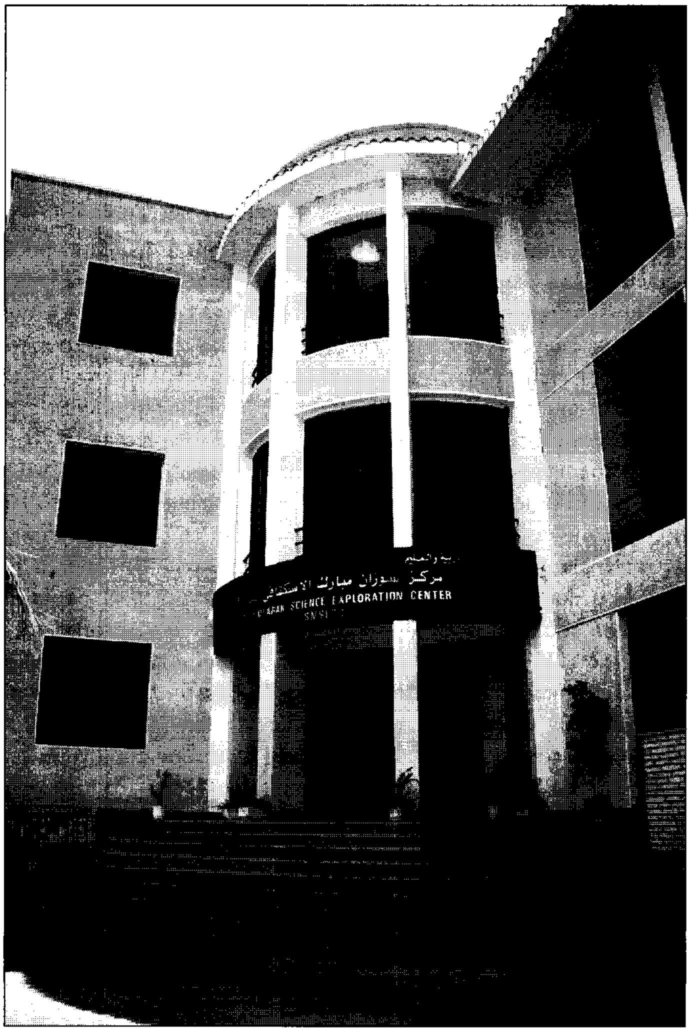
A major schism between information and application in developing societies stems from a 'hands in pocket' or 'don't touch' approach, where children are not encouraged to use their hands to explore science and handle laboratory equipment. As purely theoretical education is not suitable for the twenty-first century, it is important to emphasize a 'hands on' or 'please touch' approach, however in most poor societies it is often taboo for children to touch costly equipment. To overcome this restriction, children must be encouraged to touch, feel, explore and learn by doing. This is the only way to overcome the barrier of fear and enable children to grasp science in the palms of their hands.

Our perception of nature must change and the artificial divisions between the sciences surmounted. The interconnection between science and art is most strongly felt in the study of physical and biological systems; there is an intricate hierarchy of order in the universe, and in this order beauty is felt. It is important to stress aestheticism in the minds of science students and this may best be shown in a science museum whose artwork is an integral component of the elucidation of scientific facts.

The general impression of science as a dull and complicated subject can be countered by an array of well-designed and attractive exhibits, which not only make the scientific point clear, but present it in an impressive, eye-catching way. The interactive feature of the exhibit is a crucial element of the museum's mission and varies from simple manipulation to information-gathering to construction and, finally, to innovation. Information should be deduced as much as possible by the visitor, leading to a final and thorough understanding of the scientific facts behind the exhibit. Nothing should be left in the end as enigmatic or vague. Obscurity and magic must be removed from science and technology.

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)



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Entrance to the Susan Mubarak Science Exploration Centre (SMSEC).

The science museum should also contain a modern workshop to implement artistic designs and ensure maintenance of the exhibits. Moreover, the workshop should be used as a sort of breeder mechanism to develop exhibits for the further expansion of a chain of science museums, as has been done with great success in India, for example.[1]

It is important for the science museum to convey two seemingly contradictory messages. One is to emphasize the local contribution to science, which helps to give recognition to national accomplishments and stimulate participation in the worldwide competition for scientific achievement. However, by the same token, science knows no boundaries or nationalities and it is equally important to stress the fact that it is a collective enterprise, both in geographical and chronological terms. No one can score the goal alone; it can only be done when the whole team plays well. It is thus of paramount importance to understand how the leadership in scientific development was handed over from one nation to another over time. For developing countries, the fact that there is room for all boosts morale and raises hopes for a better future, and this is further underlined by the realization that science was nurtured in what may now be called the 'Third World'. It is essential, therefore, to be familiar with the savants of ancient times who paved the way for modern science as well as with scientists from the sixteenth century to the present. The interaction between civilizations is a continuous process, and peoples of developing countries can find in this notion encouragement to acknowledge that, once again, they can join the race for scientific development and can make contributions. In this way, the gap proves to be surmountable after all. Such confidence building is an indispensable step toward better East-West or North-South relations, and is an impetus toward international peace and understanding.

The increasing disparity between the developed and developing worlds cannot be in either's favour. For the latter, the creation of a scientific environment can spur growth and eventually help raise the standard of living. This also serves the interests of the industrialized countries, who seek markets for their technological products. But readiness for technology acquisition can be achieved only through helping Third World countries improve their science education. It should also be pointed out that quite often these countries export their best educated men and women to the industrialized countries, where they may become pioneers in scientific research, thus enhancing the economy and progress in already advanced nations. It might, therefore, be worth while for these countries to help developing nations give priority to scientific expansion.

One of the best ways to do so is to create the proper environment for scientific awareness – and it is here that science museums can play a crucial role. In the process it is important to show how science could solve basic problems for the developing nations in a way that would change the standard of living for average people and prepare them to cope with the new norms of twenty-first-century technology, without which they would be cast aside and left out.

Egypt's Exploration Centre: breaking new ground

A new interactive science centre has recently opened in Cairo, the first of its kind in Egypt, Africa and the Middle East. Called the Susan Mubarak Science Exploration Centre (SMSEC), it was envisaged and designed by the author and implemented through his vision and direct supervision of a team of technical experts and staff from the Ministry of Education and the Administration of Educational Buildings, archaeology and geology authorities, colleges of education, science, medicine and engineering and the applied arts. The centre focuses on a 'please touch' strategy and its theme is the philosophy of exploration. It emphasizes that exploration is in harmony with human nature in the quest for the unknown, with the diverse phenomena of nature, and with humanity's journey on Earth, and shows the three phases of exploration: first, identifying physical phenomena; second, formulating these phenomena into laws; and third, attempting to make use of these laws in the form of inventions, hence giving birth to technology.

The centre is geared toward simplification and popularization of science for young people from 5 to 20 years old, through interaction and touching. In this way, learning is mixed with enjoyment, and scientific thinking is planted through arousing curiosity and searching. It also aims at changing the emphasis of science teaching by stressing practical experience, tying theory to application, underlining

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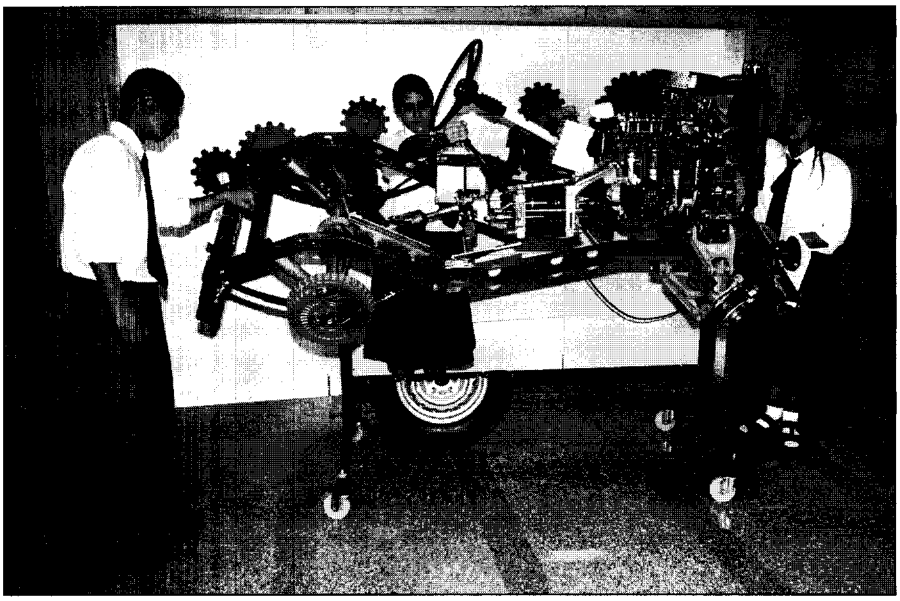
The Balancing Court contains a collection of experiments to explain the concept of balance.



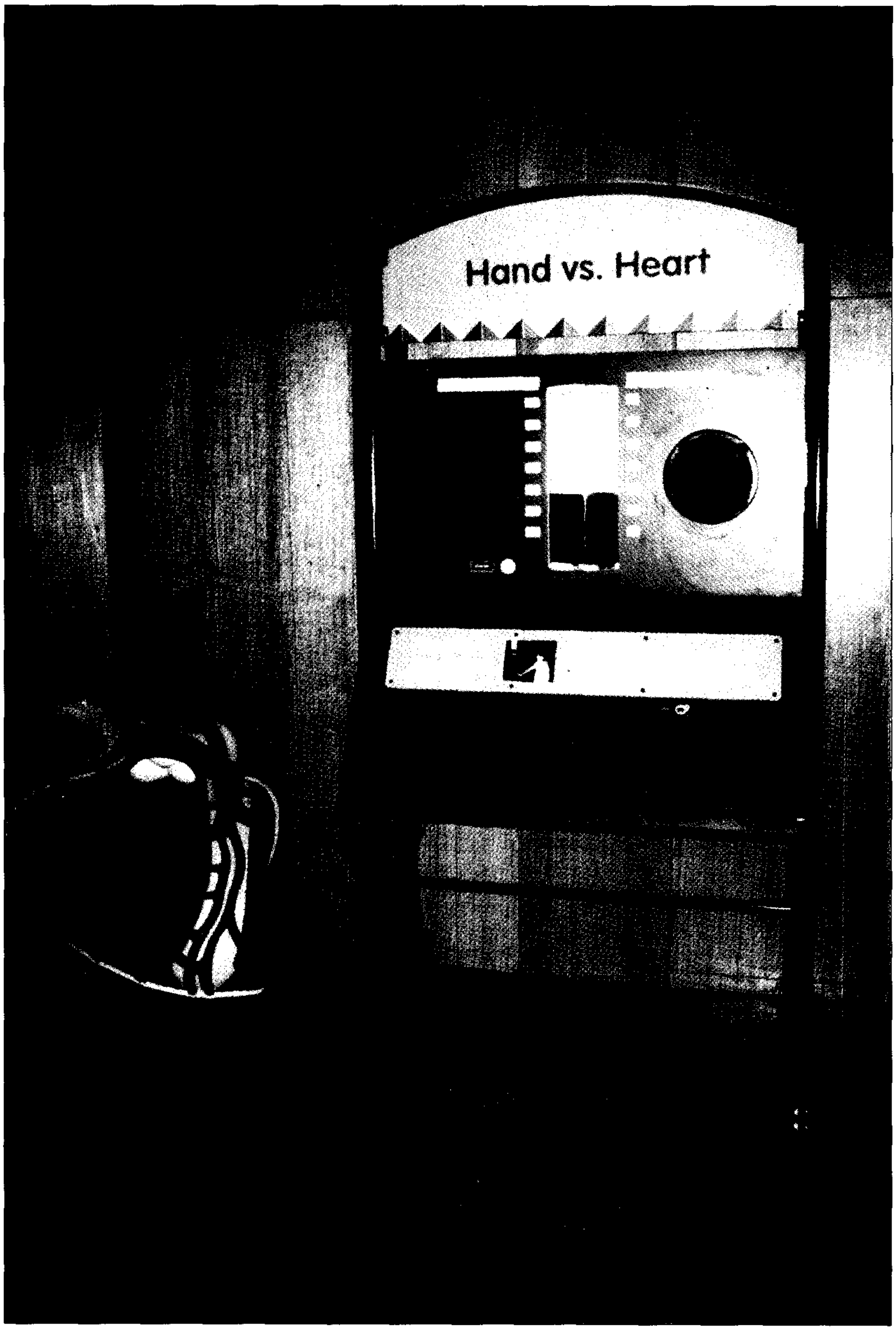
The Hall of Motion, displaying an open working model of an automobile.

the collateral interconnection of the sciences, and demonstrating how science can be used in solving many of the problems confronting humanity, noting that there is no unique answer to any given question. The centre underlines the sense of belonging by showing how the meetings of civilizations (Egyptian, Greek, Arab, Oriental and Western) produced what is today modern science. It sheds light on the feature of continuity in the flow of scientific discovery and highlights the pioneering role of contemporary Egyptian scientists in various fields.

The centre hosts group visits from schools in Cairo and other municipalities. In addition, it features – for the first time in the world – a sophisticated video conference network based on fibre optics, satellite links and a dome camera network scattered throughout the centre so that students in far municipalities can follow what is going on in the group visits. This elaborate network is used mainly to improve teacher training, with exhibits serving as illustrative models. The centre is also connected to the Internet, where students can acquire answers to questions about science, and boasts a unique collection of books, videotapes, CDs etc. With a jukebox and a video server, these resources can be made available over the network. Special clubs have been formed around specific topics, such as science, electronics, environment, natural history and mechanics, and a toy library allows children to borrow their favourite playthings. These activities are presented in special summer programmes that not only foster manipulation of science exhibits and kits, but also encourage art related to science, such as painting, song and drama. A well-equipped auditorium serves the community by promoting scientific awareness through seminars, plays, and cinema. The centre's workshop takes part in creating decorations and dioramas as well as some of the exhibits. It will eventually 'feed' a chain of additional centres to be set up in all twenty-seven administrative regions of Egypt. Finally, a virtual reality showroom, theatre and production studios are part of the centre's facilities as are studios for producing videotapes, animated graphics, and multimedia materials to popularize science. A network of touch-screen PCs allows visitors in any part of the centre to obtain information at the level of detail they need.

From solar system to outer space

The first section of the centre deals with the origin of the universe and features a painting of the Big Bang, models of the solar system, drifting continents and a volcano, as well as a diorama of Cretaceous Park, illustrating life at Bahariya Oasis in Egypt 100 million years ago. Next is the Geological Treasures Cave, which contains a time scale, or a geologic column of fossils, rocks and minerals from Egypt and the rest of the



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world, acclaimed as the first complete set of its kind in Egypt. This is the stage on which humans first found themselves. They had to learn the rules of the game, namely the laws of nature, the first of which was gravity. Gravity Hall provides experiments such as downfall on an inclined plane, a gravity well, coupled and chaotic pendulums, and features background posters of the solar system and the leaning tower of Pisa to refer to the alleged Galileo experiment. Next, people learned to balance themselves against gravity. We have, therefore, the Balancing Court, which contains a collection of experiments including a balancing stick, a reaction time test, a balance test, a water spinner and a Bernoulli blower.

Yet humanity was not only at balance but also in motion. The Hall of Motion displays an open working model of an automobile, a bicycle gyroscope, and a set of gears. The concept of pressure is introduced in the Fluids Circus, which contains hydraulic systems and pumps, a gas model, a model of the heart, and an exhibit showing the difference between hand pumping and heart pumping. An essential feature is the linking of seemingly unrelated exhibits, which is why a heart model is used in conjunction with a pumping model. At the end of the Fluids Circus, a bubble wall demonstrates the concept of pressure and surface tension. In the background, posters showing the capillarity effect establish the relation in the visitor's mind. The next section, Energy Alley, demonstrates how motion can be realized. Here, the visitor is acquainted with thermal, electric and magnetic forms of energy. The Waves Booth explains waves as a mechanism for energy transmission and various experiments on waves are performed against a back projection of a ripple tank, lit by an overhead projector. The following section is the Hall of Light, with an assortment of exhibits showing reflection, refraction, colour mixing, etc. Between the Waves Booth and the Hall of Light, a Cybercafé serves the need to communicate with other science museums in the world through the Internet.

In the Fluids Circus a model of the heart shows the difference between hand and heart pumping.

After attempting to discover phenomena around us, can we understand ourselves? The Human Gallery displays all systems, organs, and cells of the human body. The next section features an Odyssey in Space where a platform with a mesh of springs and foam allows visitors to simulate a walk on the moon, bringing to mind the famous Apollo landings. A working model of a space shuttle is displayed. Next is the Small World, exploring the new frontier of genetic engineering with the use of a 'Cyberscope', DNA models and a microscopic camera. The Education Tract section contains models of a Pharaonic school (Ber Ankh), an Islamic school (Sultan Hassan), and a School of Tomorrow. The Forest exhibit permits the habits of insects to be studied in a forest ambience. The Hall of Fame contains ninety-nine portraits of Arab and Western scientists throughout history, all ready to narrate their findings through a touch-screen PC. A Laser House, where properties of lasers are explored. Situated outside the major exhibit hall is a Foucault Pendulum, library, planetarium and the activities clubs.

When the Exploration Centre is extended throughout Egypt, the workshop will manufacture most of the exhibits and will transform the centre into a major production facility, especially for virtual reality, graphics, video and animation. It will also act as a significant resource base for teacher training through the use of the communication network. It already produces video programmes, some of which are broadcast daily on Egyptian television, and larger time slots on the Egyptian satellite (Nile Sat) are anticipated. Use of virtual reality and motion-capture techniques are foreseen to upgrade the level of science programmes for children. A plan for the production of books, CDs and audiovisual materials is already under way and it is hoped to establish twinning protocols with major science centres around the world.

In the preparatory stage of the Susan Mubarak Science Exploration Centre, UNESCO sponsored a one-week visit by an expert from the Exploratorium in San Francisco. This provided an opportunity for a case study and helped define international standards for science museums. Yet, in no way is SMSEC a replica of the Exploratorium or any other existing science museum. From the outset, it created an Egyptian flavour all its own. ■

Acknowledgments. We wish to thank all those who helped in the realization of SMSEC, especially UNESCO and the Exploratorium, and the experts who visited us, particularly Peter Richards of the United States and Saroj Ghose of India, as well as the other Egyptian and foreign experts whose remarks were highly esteemed and of great value in implementing this project.

Note

1. See 'The Growth of Science Museums in India', *Museum International,* No. 193 (Vol. 49, No. 1, 1997). – Ed.

Innovation in Catalonia: technology in its social context

Eusebi Casanelles

At the heart of an unusual decentralized system of independent museums, each recounting a part of the whole history of industrialization in Catalonia, lies Terrassa's Museum of Science and Technology. Its singular philosophy – and how it evolved – is described by Eusebi Casanelles, director of the Museum and executive president of TICCIH (The International Committee for the Conservation of the Industrial Heritage).

In 1976, a year after the death of General Franco, when Spain was beginning to look forward to the possibility of future democracy, the Cultural Committee of the Association of Industrial Engineers, of which I was secretary at the time, decided to publish a proposal for the creation of a Museum of Science and Technology of Catalonia. The ultimate purpose of this proposal was for our country to acquire an establishment to conserve the appliances and machines that the vertiginous pace of change in society had rendered obsolete. Another intention was to popularize technology and its progress, because we took the view that our culture was failing to give sufficient attention to this phenomenon. Indeed, we felt that in a world of all-pervasive technology, the existence of a technological culture was imperative to create new specialized vocations. We took as our model other museums of science and technology established in Europe, for example, in Munich and London.

The museum did not become a reality until 1984 when the Government of Catalonia acquired the premises of the former Aymerich y Amat factory, built in the modernist style at Terrassa, a locality 30 km to the west of Barcelona, one year after I had begun to work professionally on the project. With the passage of time, the scope of the museum had changed and it now focused on industrialization. The change was far-reaching and gave much greater depth to the concept. The central objective was no longer technology and its evolution, already covered by the major technological museums of the day. Instead, the main focus became the relationship between technology and society. Scientific and technical museums, normally directed by people with technical qualifications, have always tended to have an educational purpose and failed to give much attention to the social and ecological impact of technology. We began to envisage a museum in which the different technical elements relating to production would be placed in the general context of the industrialization of Catalonia.

That new option, which helped to illustrate a particularly important aspect of Catalan history, seemed far more interesting to me, because the museum would now help to strengthen the identity of our country. After all, Catalonia, as we know it today, does not trace the roots of its identity solely back to the Middle Ages when its language and culture were shaped and acquired, but also to the period of industrialization. This not only brought Catalonia into the modern era but also helped to ensure that our language and culture were not lost, as happened in other regions of Europe that were submerged by a different official culture.

This alternative had another great advantage by comparison with the classical approach – the fact that we were able to create museums different from those already existing elsewhere with identical or similar purposes. This is not the case with traditional technical museums or 'science centres', because technology, science and their respective histories are the same all over the world. Despite the efforts made by individual museums to acquire a distinctive character, they are ultimately obliged to explain the same concepts. The differentiation between the technical objects produced by the same process in different parts of the world resides less in technology as such than in its implantation, the use that is made of it and the social environment of its users.

A second important choice of the museum was to preserve buildings as well as

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

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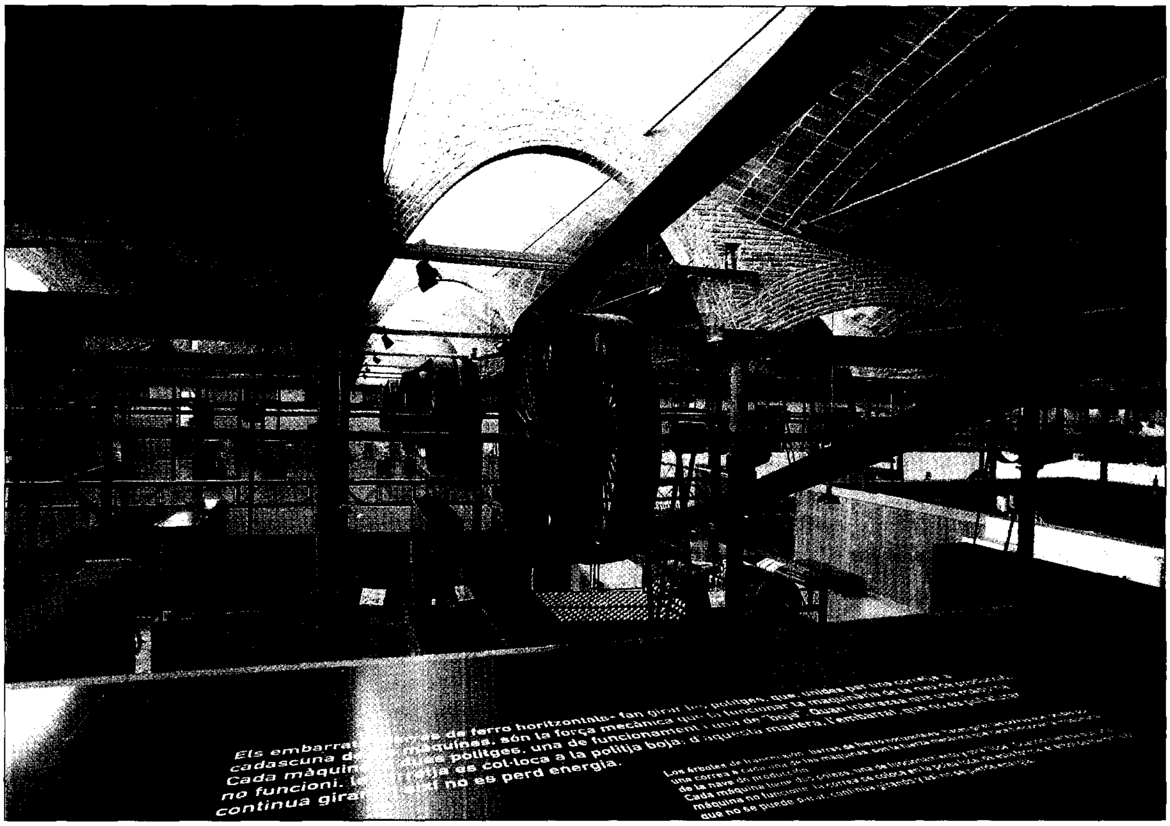

Interior view of the exhibition The Textile Factory, *with the transmission belts in the foreground.*

objects (machinery and tools). Activities were therefore put in hand to develop an awareness of our industrial heritage, to prepare an inventory of the properties existing in our country and to promote their conservation and re-use. In this way, the museum reached out beyond its walls and came to regard the entire territory as a possible field of intervention. The elements of industrialization were to be revealed as a living testimony of our past which the population would come to regard as an integral part of our cultural heritage. In consequence, this would help to enhance the richness of our national heritage. This derives its quality from the character conferred upon this territory by culture, as an expression of the depth of time, which is one of the main features of any testimony to history. In that sense, the heritage can be regarded as the fourth dimension of the landscape.

A third and related major option was to adopt a decentralized museum organization and so reflect the different aspects of Catalan industrialization. Specific productive locations were to be given a museum identity, instead of putting objects on show outside their original environment. With that end in view, a museum system was organized.

A new form of territorial museum structure

The museum project that I have outlined consists of the headquarters in Terrassa and twenty theme museums throughout the territory of Catalonia, fourteen of which are already open to the public. Each of these museum projects is different from the others. Taken together, they are called the MCTC System. The word 'system' is used to set this museum concept apart from hierarchical organizations, which are intensively structured, and also from associations or networks designed simply with communication in mind. Systems have a specific purpose. They are made up of separate parts, each of which has its own function, and is governed by laws and patterns of behaviour that enable the system to attain its general objective without any one part imposing its


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The steam engine of the Aymerich mill built by La Maquinista Terrestra of Barcelona in 1897.

superiority over the others. The best-known systems are those encountered in animal physiology, for example, the digestive or nervous system. In general, systems have a co-ordinating centre, such as the brain in the case of animal systems.

The purpose of the MCTC System is to explain the industrialization of Catalonia while each of the museum centres deals with one specific thematic or regional aspect of this process. The co-ordinating centre is the central museum of Terrassa and the governing rules are the programmes approved by the Committees of Directors. There are various programmes, some compulsory such as conservation, dissemination, restoration, education and creation of an institutional image; others are voluntary and concern tourism and the environment. Each museum enjoys statutory independence and must make an official request to join the system once it has accepted the overall programmes.

This type of organization has the advantage of being better able to illustrate the complexity of industrialization and the

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View of the Museum of Science and Technology of Catalonia.

implantation of technology. A productive establishment cannot, of course, be understood without taking into account the globality of the process, the relations existing with other productive centres and the means of communication available at the time. Every museum makes a reference to the global industrialization of the country, thus enabling the reason for the existence of this activity in the general context to be better understood.

The non-hierarchical structure giving broad autonomy to each centre places no constraints on the individual liberty of the directors, but enhances their sense of responsibility and creativity. This naturally implies the creation of a flexible management which is adaptable to circumstances instead of a rigid system based on a hierarchical model. An outside observer may easily get the impression that there is a degree of anarchy here, but this is not so. In reality, there is a resemblance to what biologists call 'determinist chaos': this is the 'organization' made up of many initiatives originating from different decision-making centres whose purpose cannot be recognized by observation at one particular point in time. With hindsight, however, the organization can clearly be seen to have been advancing in a single direction. I am personally convinced that greater progress can be made in this way than with a hierarchical organization.

With this territorial structure, the Museum of Science and Technology, officially recognized as one of the three national museums of Catalonia, accomplishes one of its functions, which is to structure scientific and technical museology in the Catalonian context with the preservation of a new heritage, that of technology and industry, as its ultimate objective. By doing so, the elements of the country's identity will be strengthened and the value of its landscape enhanced.

Four questions and three values

When we explain our philosophy and the change of direction taken by us to people working in the field of technical museology, four main questions are often put to us. I shall try to answer them below.

Do you really make no attempt to present the evolution of technology?

The different themes that have been covered by the museums up to now explain technological evolution in one way or another; they highlight the human inventive spirit, but always with the intention of explaining the social significance of innovation as a function of its impact on society and specifically on the world of work.

Do you pursue a policy of creating collections? If so, do you think that these collections are nothing more than archive material or are they intended for exhibition?

The objects in the collections are normally used for temporary exhibitions. They are also shown in the displays of the central museum in Terrassa where technical exhibitions are held on specific themes. In our system, there are museum sections or specific museums based on collections such as the Sils Motor Museum and we anticipate the creation of others in the future. Since the bulk of the collections at our disposal represent the last two hundred years, the guiding purpose of these exhibitions is to show concrete aspects of the industrial history of Catalonia. This of course has links with the rest of the world and includes a reflection on its impact on society.

Has science no place here?

Close ties naturally exist between science and technology, but we felt that the creation of a wider interest in technology should be our overriding objective. In Barcelona, there is already a Museum of Science, which illustrates scientific experiments and is highly active. We therefore did not think it necessary to have a purely educational room, though we do not rule out the organization of temporary exhibitions based on science and are currently preparing one dedicated to the chemical elements. We regard science as essential to an understanding of aspects of technology. For example, part of the monographic exhibition on energy, which we organized in the Terrassa museum, is dedicated exclusively to an explanation of the meaning of energy, the main laws governing it and the way in which the earth functions seen from the standpoint of energy. We believe that motors cannot be understood without familiarity with the laws of thermodynamics and an understanding of the origins of the energy that we use.

What role do the active and interactive elements play?

The reply is similar to that given to the previous question. The objective of the museum is not to display didactic elements, as is done in science centres, except in so far as they are a way of understanding technology. In that sense they have the same function as audio-visual media, which have no meaning on their own, but are used to make the exhibited objects intelligible.

I always insist on the fact that an exhibition is a conceptual cocktail in that the receptacle determines the space and resources available. In our case, the ingredients are objects, social history, the explanation of innovation, teaching, spectacle, interactivity, stage-setting, etc. For each exhibition, we choose the necessary ingredients and determine their respective proportions. That is why the museums and the exhibitions are like the works of an author. The author (or authors because there may be several) makes the choice as a function of his/her (or their) interpretation of a particular theme. I stress this aspect because unfortunately those who criticize exhibitions seem to think that there is only one completely objective way of dealing with a particular theme – in other words, of course, their own favoured approach.

Over and above the technical ingredients, each author has certain values which will pervade the entire exhibition and they all have one thing in common – the fact that the exhibition communicates the subject that it seeks to explain. I personally try to put across the three values that Albert Einstein described as guiding his entire life. They also apply to museology: truth, beauty and goodness.

In our case truth is authenticity. I am totally convinced that museums must do their utmost to ensure that the exhibits reflect the maximum historical veracity. We must avoid the temptation of invention and always remember that the exhibition must mirror reality. Our policy therefore promotes the transformation of productive places into museums with the least possible intervention and interpretation. We believe that authenticity is one of the values that gives greatest satisfaction to visitors.

We might say the same about the objects on display. Authentic objects have the added value that they played a role in history. We nevertheless believe that it is totally valid to show copies, lifesize or on a reduced scale, when they are necessary to explain a concept – for example, the evolution of a technology when the real objects are not in our possession or when the great bulk of the original piece obliges us to make models.

The second value is beauty, which in our language is translated by aesthetics. This is a transcendental concept because I believe that museums, quite apart from exhibiting and communicating, must, through every one of their actions, create works of art that help to strengthen the aesthetic currents of their age. Beauty must be reflected in architecture, exhibition design and also in more ephemeral products such as publications.

The third concept is more complicated because goodness is a more ethereal concept. In our case the equivalent of human kindness, a quality that certain persons radiate, making them sought after and appreciated by everyone, would be what the late Kenneth Hudson defines as 'charm' in a recently published article in the ICOM Study series, though I personally would envisage a broader dimension for this concept. Charm has aesthetic and authenticity components, but not all museums with strong design elements transmit authenticity and share this value. Charm is an atmosphere that is created and exerts a magic attraction on the visitor. It is a sentiment, a state of mind.

I always ask the directors of our museums and exhibitions to make sure that these three values are part of their philosophy. Authenticity and beauty, even if it is subjective, are palpable, but charm is hard to convey because there is no school in which it is taught and no precise definition. It is a product of personal sensitivity. ■

A palace to reconcile man and science

Bernard Blache

Science museums are a special part of the museum world, dealing as they do with the stuff of everyday life and appealing primarily to reason rather than to aesthetics, according to Bernard Blache. They have a distinctly social role to play by narrowing the gap between scientists and citizens who have the responsibility of taking the decisions that scientific progress imposes. The author is director of communication and visitors at the Palais de la Découverte in Paris and is co-chairman of ICOM-CIMUSET. He is an executive member of the French National Committee of ICOM and treasurer of the Association of Museums and Centres for the Development of Scientific, Technical and Industrial Culture (AMCSTI).

Nowadays, the fact that the individual cannot develop his or her full potential in society without a scientific culture is universally acknowledged. But how did collections of technical objects first come to be put together and, later on, scientific experiments grouped in a single building, to facilitate the general public's access to sometimes abstruse knowledge outside the normal educational framework? The different types of establishment pursuing this goal use all kinds of teaching methods and tools. The example of the Palais de la Découverte in Paris illustrates this approach. In particular, a recent temporary exhibition about dinosaurs reflects the efforts to put across the work of researchers through spectacular settings. The question then arises of the role to be assigned to scientific and technical cultural establishments if they are to create a greater awareness in all categories of society of types of knowledge that are useful in everyday life or may influence the individual's own future.

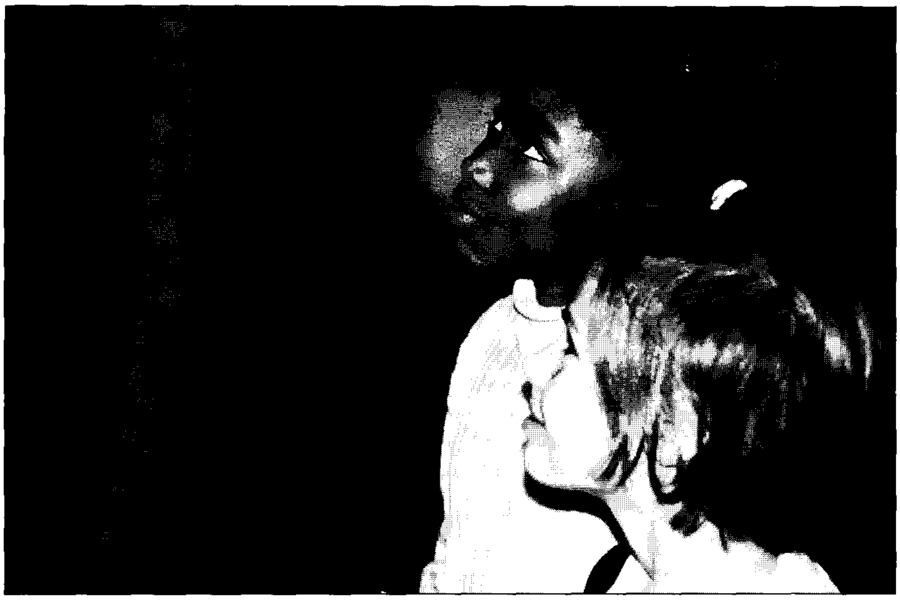
We lack the space here for an exhaustive review of the different establishments that preceded our present institutions. Instead, we shall try to highlight a few phases: the great private collections of the sixteenth and seventeenth centuries (for example, that of Sir Nicolas Claude Fabri de Peresc, a keen astronomer who corresponded with colleagues all over Europe to exchange such items as descriptions of exotic animals unknown at the time) gradually gave way to university museums and 'seminars', so much to the liking of our friends in Quebec, who collect illustrations for the courses given to their students (in the form of optical benches, stuffed animals, fossils, reproductions and paintings, etc.). Museums also made their appearance at this time. The Royal Garden of Medicinal Plants, the ancestor of our National Natural History Museum, was created under Louis XIII by Guy de la Brosse, the king's physician, 'to allow medical students and apothecaries to supplement their culture derived from books by practical studies of plants'. The eighteenth-century 'cabinets of curiosities' presented surprising experiments often involving audience participation. This was essentially a source of amusement for polite society, and spectacular effects took precedence over explanations. Watching alcohol distilled from wine catch alight on the tip of a sword, or the simultaneous shock felt by soldiers of a regiment joined together by a metal conductor, certainly did not solve all the questions that the audience might have put about the circulation of that mysterious fluid, electricity.

The technical museums of the nineteenth century were designed to illustrate progress. They presented a future in which machines were omnipresent in factories and everyday life but not yet perceived as rivals to manpower. Examples are the Arts and Crafts Museum founded in 1794 at the Abbey of Saint-Martin-des-Champs in Paris (due to reopen early in 2000 after refurbishment) or the Deutsches Museum in Munich, whose first exhibit opened on 12 November 1906.

Then there was the concept of science museums illustrated by the great precursors: the Chicago Museum of Science and Industry opened in 1933 in the Palace of Fine Arts (the last remaining structure of the 1893 World Fair) with its emphasis on experiments performed by scientific demonstrators, and later the San Francisco Exploratorium founded by Frank Oppenheimer in 1969. In parallel, the Museum of Science was established in Barcelona, the Science and Natural History Museums in London, the Experimentarium in Copenhagen, Heureka in Vantaa, Finland, the Cité des Sciences et de l'Industrie in Paris,

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)



'Enjoyment, the pleasure of understanding and the joy of passing on what we have understood are undeniable contributory factors to the motivation of the mediators and their audience.' Here, the Solar System Hall.

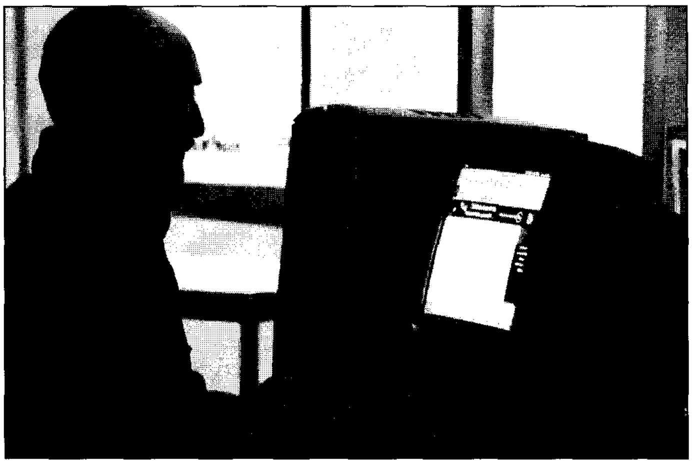
Questacon in Canberra, Australia, the Manchester Museum of Science and Industry, Papalote, the Children's Museum in Mexico City, all the museums organized by the National Council of Science Museums (NTSC) in India and their travelling exhibitions, the Chinese Museum of Science and Technology in Beijing and its extension which is now being built, the Polytechnic Museum of Moscow, and many others that I have not named for lack of space.

Typology and tools

Following this brief historical outline, an attempt may be made to classify contemporary establishments by type and by the instruments that they use to enlighten their visitors. Technical museums have two key roles: (a) preservation (despite the paradox that putting an object on display is generally prejudicial to its proper conservation) and (b) explanation of the origins of these objects, their uses and the progress that they have brought about. These exhibits come in every size, from the smallest mechanical device to a railway train, aircraft or submarine. The organization of such museums is based on the itinerary proposed to the visitor and on explanations that enable the logical evolution to be followed object by object, so moving beyond simple juxtaposition. Museums are based on the presentation of collections: animals, minerals, plants, fossils, etc., with an increasing presence of living beings (aquariums, terrariums) and a focus on ecosystems and the idea of a global planetary environment. 'General' scientific museums often try to highlight, through interactive experiments, specific fundamental laws and to report on recent scientific advances in areas ranging from physics to astronomy, through chemistry, biology (human, animal, vegetable), the earth sciences and mathematics.

Specialized museums, which in France include the Aerospace Museum, Space City, Nausicaa, the Sea and Water City, Oceanopolis and Vulcania dedicated to volcanoes which is due to open in the Auvergne region in 2001, have all chosen to focus on a particular theme that gives visitors the impression of a complete exploration of the subject. Still in France, the CCSTI (Centres for Scientific, Technical and Industrial Culture) are medium-sized structures in terms of floor-space and staff. They play an important role in the large regional cities. They host or put on exhibitions, organize lectures and provide local solutions to explain science for everyone's benefit. Lastly, there are centres like the ecomuseums, museums of society and libraries which do much, through their activities, to improve levels of scientific knowledge.

The instruments may differ widely as a function of the style and zone of influence of the museum, its resources and objectives: they include stationary or working teaching models, explanatory panels and notices (for which in Europe the problem of multilingualism increasingly arises), objects, experiments either interactive or controlled by a demonstrator, multimedia and the Internet, planetariums, IMAX and OMNIMAX cinemas, simulators in which the audience becomes an integral part of the experiment, for example, by being brought to a potential of several hundred thousand volts, shaken in an earthquake



© C. Rousselin/Palais de la Découverte, Paris

Informatics for all ages in the Cybermétropole *exhibition.*

chamber, placed on an inertial roundabout or simply invited to visit the inside of a model of a human heart or a coal mine, the torpedo room of a submarine or the luxury saloon of an imperial steam train. Video conferencing, catalogues, specialized journals and scientific toys are also part of this panoply, as is the bringing together of all these resources in a temporary or travelling exhibition.

The Palais de la Découverte: 'a social role of apprenticeship'

The Palais de la Découverte (The Palace of Discovery) was created in 1937 by Jean Perrin, the 1926 Nobel prizewinner for physics for his work on atoms, with several aims in mind: first, a social role against the background of future reductions in the working week which were expected to give the general public more leisure time and hence the opportunity to study the great discoveries; second, a contribution to the recognition of the scientific world for which the presentation of work done in laboratories, 'science in the making', was a first step towards a status confirmed by the opening of the CNRS (National Centre for Scientific Research) in 1939; and finally, the creation of new vocations in the field of scientific research, as illustrated, for example, by Pierre-Gilles de Gennes, Nobel prizewinner for physics, who said: 'I personally learnt a great deal in the Palais de la Découverte as it was in the late 1940s. I took my children there, and soon I will be going back with my grandchildren. I am convinced that the flame is still burning brightly.'

The fundamental idea was and remains the presentation of science by experiments performed by (or in front of) the audience and explained by scientific intermediaries capable of adapting the level of their discourse to their audience: young children, school pupils, students, engineers or pensioners, as the case may be. Today, the Palais de la Découverte is a public establishment with a scientific, cultural and professional bias attached to the Ministry of National Education, Research and Technology. It covers a floor space of 17,500 m^2 (14,500 m^2 being open to visitors) in the Grand Palais in the heart of Paris. It employs 210 staff and has around 600,000 visitors a year.

The temporary exhibition *The Twilight of the Dinosaurs* currently on show illustrates one interesting aspect of the problem posed by popularization of science for the general public. It consists first and foremost of a set of spectacular robotic models of dinosaurs controlled by computers and set in motion with compressed air. Manufactured by the Japanese company Kokoro and on loan from the Natural History Museum of London, these models are the main attraction of the presentation. Each scene is accompanied by a popular scientific consideration of the major questions arising in connection with the life of these animals: for instance, their method of reproduction (did they brood their eggs?), their movements (alone or in herds and at what speed?), their remains and what can be deduced from them (what sounds did they make?), their environment (what other contemporaneous species have survived?), their food (were they hunters or carrion eaters with a dental system that had no molars?), their modern descendants (birds?), the reason for their disappearance (the secondary effects of volcanoes, a meteorite impact?). The intention is to attract a large number of visitors through a spectacular exhibition to which wide attention is drawn in the media, without ever sacrificing the content

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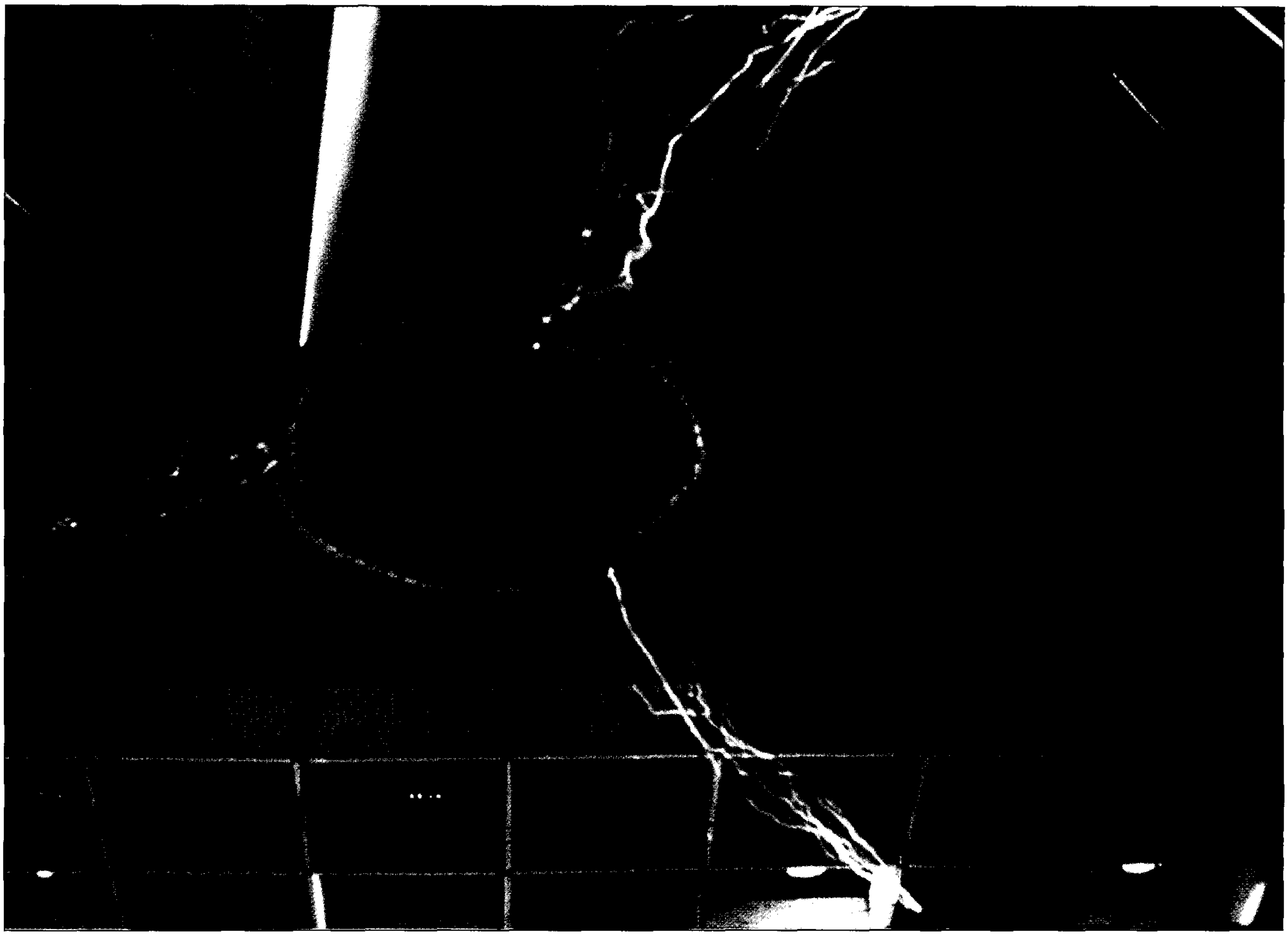


1,500,000 volts in the Tesla transformer simulator.

prepared by an ad hoc scientific committee. A particular attempt is made to correct preconceived ideas during the visit.

In the museum community, science and technology museums play a special role. The subjects with which they deal are the backdrop to our daily life and part of the basic fund of knowledge of every educated person. The elements enabling a visit to be appreciated differ considerably from museums in other sectors; the appeal here is almost entirely to reason and not to a sense of beauty, appreciation or taste. The unique nature of a masterpiece which creates emotion in the viewer of a painting or sculpture is often much less pronounced, except in special cases, in the presence of an object or experiment of which one of the key features is reproducibility. One particularly important aspect is to place the memorized elements in context. They must be properly structured, with particular reference to the history of sciences, if they are to become an effective part of a cultural approach.

Do we have grounds for pessimism, as Michel Hulin, the former director of the Palais de la Découverte, seemed to believe when he wrote: 'Vulgarization, popularization, awareness creation (and incidentally also education) cannot claim to enable us to perceive science and technology in their totality and authenticity: they put across an image and a representation, but hardly represent a model.'[1]

Enjoyment, the pleasure of understanding and the joy of passing on what we have understood are undeniable contributory factors to the motivation of the mediators and their audience. People who have not had the impression of penetrating the mystery of the links between two facts, two parts of a reasoning and above all of discovering that they had in their possession all the elements needed to solve a problem without hitting upon the idea of bringing them together, cannot have any concept of the intellectual satisfaction which this 'ray of light' may procure. Our museums have to play a social role of apprenticeship different

© Natural History Museum, London

The Twilight of the Dinosaurs *shows spectacular robotic models of dinosaurs controlled by computer and set in motion by compressed air.*

from that of traditional education. Scientific education is based far more on mathematical modelling, which has two major disadvantages: first, the lack of recourse to an attempt at a direct interpretation of the observed phenomenon (by way of example, how many students working on the solution to a problem of mechanics do not try to find the right equation and then make a calculation without bothering about the credibility of the results obtained?); and, secondly, failure in mathematics at school almost inevitably results in a total rejection of all kinds of science.

Initial training has ceased to be sufficient in a constantly evolving world of work in which the bulk of the population will have to pursue three or four different careers in succession. An important contribution can be made here by museums that help to create an awareness of different activities (for instance, computing or multimedia) and serve as a gateway between courses. By narrowing the gap between scientists and visitors, these establishments lead the latter first and foremost to a better understanding of the job of the former. For instance, what are researchers? Do they do their research only in the office or also at home and at night? Do they think all the time? What tools do they use? Are their tools always gigantic pieces of equipment co-financed by several countries or do they simply use a ballpoint pen from time to time? What is their approach: is it always based on the cycle of hypothesis, experiment, theory? What about mistakes and falsifications?

The media very often put across raw information in a highly condensed fashion. The public needs to obtain clear answers to their questions. They also need a few basic certainties on which to develop their reasoning. Once again, the vocation of the museum and its staff is to satisfy this legitimate wish. Finally, the museums have a central role of facilitating decision-making: they must train citizens to make technological choices and enable them to understand, behind all the propaganda, what is at stake in a policy, be it genetically modified organisms, the cost of a vaccination campaign, medically assisted procreation or the adoption of an energy strategy and its consequences on the environment. The difficulty no doubt resides in a clear separation between the irrefutable scientific elements and the opportunities for debate to enable each individual to form a reasoned opinion.

Museums of science and technology, therefore, have many opportunities for action. They must (faithfully!) translate scientific facts for all strata of society, regardless of the educational level of their visitors. This is a very heavy responsibility, because it is not simply a matter of educating or training but also of handing over the keys to enable responsible citizens to make their own choices for the future. In the long run this will perhaps give the lie to Victor Hugo's lines in *Les Contemplations*: 'Progress is a juggernaut: crushing bystanders under its weight, still it moves on.' ■

Note

1. Michel Hulin, *Le mirage et la nécessité*, Paris, Presses de l'École Normale Supérieure, 1992.

Discovery Place: dazzling the public

Freda Nicholson and Jim Hoffman

The Discovery Place family of museums in Charlotte, North Carolina, includes one of the most outstanding hands-on science centres in the United States. Visited by more than half a million people from all over the country each year, it provides ever-changing facilities that foster experiences in areas that range from life science to space exploration. Freda Nicholson is president and chief executive officer of Discovery Place, Inc. She has been in the museum field for more than twenty-five years, having served as past president of the Association of Science-Technology Centers and a board member of the American Association of Museums. She has also been a long-standing member of ICOM-CIMUSET. Jim Hoffman is director of marketing and public relations at Discovery Place and is editor of the museum's publications. He is also a freelance writer, focusing on issues related to family, education and travel.

Worldwide excitement over science museums continues to grow and staying on top of a rapidly changing technological environment is becoming increasingly difficult for museum professionals. However, institutions in the United States are accepting the challenge of remaining on the cutting edge of science with as much zeal as ever before. They have a fundamental stake in the educational achievements of their citizens, which are essential to the civic and economic health and well-being of the country. Professionals in museums of all types, therefore, have an important role to play in ensuring that every child receives an excellent education. But recent assessments show evidence that many of our students are not keeping pace in maths and science, and that is where we in science museums feel we can have a lasting impact on the teaching and the lives of our children.

In the southern United States, education is of grave concern. A large percentage of our students drop out before completing high school to work in manual labouring and manufacturing jobs. Others may finish high school to work in service-intense areas such as banking or insurance. And therefore, a majority of the high-end technical, medical, research and other science-related jobs are left to 'transplants' with higher academic degrees.

And that makes our job even more crucial. Although students may not enter into higher education, it is essential that they grasp as many scientific concepts as possible through formal and informal learning, regardless of the level of scholastic attainment. The late Frank Oppenheimer of the Exploratorium in San Francisco stressed this when he said that learning in school enhances the museum experience and the museum experience enhances learning in school. 'When exhibits are "participatory", the initiation may happen more readily because many people are drawn into paying attention by touching, changing and activating the exhibits. But even the resultant learning is highly dependent on the attitudes and past experiences that the visitors bring to the museum.'

And that's where science museums fit in. A standard mission statement for one of these institutions will read something like ours at Discovery Place: 'To stimulate the public's interest in and understanding of science, mathematics and technology through quality educational facilities, activities and exhibits.' In short, it is our job to make visitors want to learn or to more fully understand concepts to which they have been introduced in more formal settings. While our institution, one of the earliest of science centres, is more than twenty years old, more than 1,200 similar facilities have followed suit with like themes and missions. These museums were born with the concept that they would be hands-on places. They were created as colourful, loud, exciting and fun places to be. They have become social settings for school groups, families, and even businesses and community groups. At the same time, like their predecessors, which focus on collections and research, they are also minds-on places that provide a starting point for thought, theory development and reflection of young and old alike.

But as technology has developed through the past twenty years it has become more difficult, expensive and time-consuming to conceive exhibits that are 'special'. Designers must be more creative now than ever before to come up with exhibits that are different from those students see in the classroom or that the rest of the public sees in everyday life. In short, it has

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)

become much more challenging to dazzle the public. And that is precisely the point: to remain successful they must become museums of the future.

For example, a student twenty years ago may have thrilled at the opportunity to touch a computer keyboard. Today, more than 50 per cent of American homes have computers and they are scattered all over classrooms and offices. So having computers in a museum is trite unless we can show the student the vast power of these machines. At Discovery Place we have recently updated our computer education centre to include extreme and less familiar program applications in auto-making, engineering and medicine.

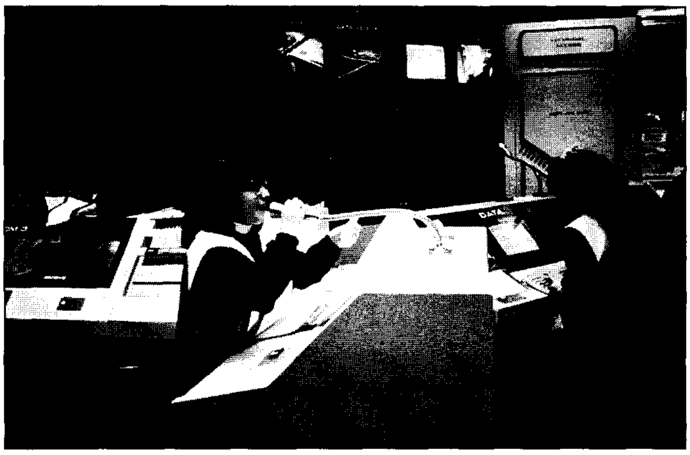
Another focus we have retained is an emphasis on live programming with an education staff that offers more than seventy ever-changing presentations each week. This format is valuable for a number of reasons and crucial to our continued success. First, visitors get to meet a scientist who comes off the pages of a textbook and conducts an experiment in front of their very eyes. The observer sees how the scientific process works and is immediately able to identify practical reasons for a particular scientific concept. Second, visitors can ask questions to clarify concepts they do not understand and receive instant gratification for being curious. Finally, the live presentations are significant because they can be altered in the short term or in the long run. This, we believe, continues to make the Discovery Place experience special. While we are in the early stages of developing educational programmes to be broadcast by video and over the Internet, there is not now nor will there ever be a substitute for this highly personalized form of exhibition and education.

© Discovery Place, Charlotte, N.C.

The museum's rain forest presents visitors with a global concern.

The future of science centres

But what about the future of these centres? In learning science we describe objects and events. This is exactly what we do within our institutions. We ask questions. We construct explanations of natural phenomena. We test these explanations and observe results. In other words, it is a scientific method, as we know it. But how do we take this concept to the next level? How do we continue to preserve the demonstration of age-old concepts while continuing to present new technology?



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All public school students in Charlotte attend a Challenger Learning Center programme.

There is much left for science centres to do if they are to continue to witness growth in attendance, which is now estimated at more than 185 million a year worldwide. The number of visitors to science museums has grown exponentially over the past several decades, but this increase is threatened by the development of other forms of informal learning opportunities and by other less educational forms of entertainment.

In his article 'Dinosaurs and White Elephants', J. M. Bradburne says that the concept is doomed because it has no long-term appeal.[1] That certainly is true if science centres are not willing to adapt to changing technology. Indeed, Bradburne is correct when he surmises that we must concert our efforts on lifelong learning. And we are, in fact, doing just that. We must continue to devise new ways to illustrate how science and technology help put society in the situation it finds itself today.

One clear example exists now at Discovery Place. At the close of the twentieth century we realized that we had never had an exhibit that represented the most significant technological advances of all times. While simple machines – gears, levers and pulleys – have been around for centuries and are major components of many larger machines and tools today, until recently we did not have an exhibit that explained them. To illustrate gears for example, we created a 3-metre tall mechanism that allows a small child (with the help of some very big gears) to spin a wheel even when opposed by the biggest of visitors. Our lever exhibit allows the same small visitor to lift a car. These are two new fun interactive exhibits that present some old ideas.

To remain a vibrant, growing industry we must continue to preserve natural science collections and produce amusing, interactive ways for visitors to learn about the species of our world. One concept that will have to emerge is bringing the visitor, especially the student, closer to the scientific process. The days of pushing a button and seeing a resultant reaction are ending. Science centres must find ways to involve visitors more fully in experimentation and show them how things work instead of merely telling them how they work.

In addition, our educational programmes, philosophies and thinking need to reflect on global issues. After all, we are now a global society and subjects such as the depletion of our rain forests and the ozone layer, pollution and rapid use of our natural resources are more important than ever before. These problems hit close to home as visitors walk into the indoor rain forest at Discovery Place. Amid the hustle and bustle of a large city is a resting place inside our museum – a small representation of rain forests around the world. But development in our fair, growing city is actually hurting this rain forest. New, tall buildings are blocking valuable sunlight from the simulated canopy and have stunted the plant growth and its resulting beauty. To solve the problem, we are installing a lighting system to make it feel even more like an actual rain forest than it does now, but visitors will learn that saving the world's rain forests is not so easy when they view this exhibit.

Clearly, if science museums are to thrive, we must create ways to affect people of all ages, of diverse backgrounds and interests. The most effective means to create this lifelong learning experience is by exposing children first at a very young age to science and making them comfortable with technology.

At Discovery Place, the first exhibit visitors come to as they enter our galleries is KidsPlace, designed specifically for children under the age of 7. While we are by no means a children's museum and this is clearly not a unique concept, it is vital for us to provide this very special environment. It is a space where children can be safe and explore on their own the wonders of the world and their own bodies – their bone structure, their senses and more. Even toddlers have their own area where they can investigate science and nature independently, with parents or even other children.

From there, the progression of education follows naturally as the child goes through school. At Discovery Place thousands of children from our local school system attend six museum programmes required in the curriculum throughout their school careers. The school system actually provides resources for us to present these programmes and gives us input into their development.

In kindergarten, children study nature at our Nature Museum, a part of the Discovery Place family of museums. In the fourth grade, students see one of our planetarium shows. In the fifth and eighth grades students come to learn two different versions of growth and development, and in the sixth grade, each student goes on a Challenger Learning Center Star Lab Mission. In addition, our outreach programme takes Star Lab, a mobile planetarium, to each and every third-grade class.

Continued involvement in education is obviously good for the child and affects families as well. Children are proud to bring their parents to Discovery Place and explain something they have learned independently during a weekend or summertime visit. This makes the learning process even more personal, social, vibrant and effective.


© Discovery Place, Charlotte, N.C.

KidsPlace gives young visitors a chance to have fun exploring science.

The Science of Oz *takes a look inside movie-making and also stimulates ideas for study in other fields.*

Strength in collaboration

As the child grows, our job in science education becomes more difficult. We are finding great success in maintaining the personal experience through tools like the IMAX cinema experience, special programming, events related to exhibit and film openings, speakers and panel discussions. But where science museums have foundered is in tying scientific concepts to other parts of the school curriculum or to other interests that visitors might have. We have seen the creation of a number of facilities over the past few years that encompass not only science or art, but a variety of educational principles that include other areas such as sociology and character development. But we do not need to change our science museums completely to expose our visitors to notions that are not necessarily scientific but relate to science in some fashion.

The clearest example comes from 1997 when we turned the city of Charlotte into the World of Oz. The idea stemmed from our creation of *The Science of Oz* exhibit, which is currently on tour. The presentation used themes from the popular American film, *The Wizard of Oz*, not only to teach about scientific concepts such as the development of tornados and rainbows; it also educated the public about film technology. But our city didn't stop there. Fifteen local organizations formed programmes based on the Oz story. For example, the children's theatre presented the play, the choral society performed *The Wiz* and other groups developed workshop sessions that were presented to 16,000 schoolchildren in only a few weeks. These included a photo contest, writing and art.

We also collaborate regularly with other institutions. For example, we worked with a local visual arts gallery to bring the Exploratorium's *Turbulent Landscapes* exhibit to Charlotte. Half the exhibit appeared at our facility and the other half at galleries across the street. This made clear the theme of the show, that art and science definitely meet at some point.

In addition, our science museum has collaborated recently with the National Conference for Community and Justice to bring the Chicago Children's Museum exhibit entitled *Face to Face: Dealing with Prejudice and Discrimination* to our museum. While this has little to do with science, we see definite benefits in contributing to the social and character development of our local schoolchildren.

To summarize, we urge museum professionals of all types to stop for a moment in this new millennium and look at the needs of the public. The examples we present from Discovery Place may not work everywhere, but the concepts clearly transcend museum walls and national borders. Let us work together to meet that all-important challenge to improve the intellectual wellbeing of our world. ■

Note

1. J. M. Bradburne, 'Dinosaurs and White Elephants: The Science Center in the Twenty-first Century', *Public Understanding of Science*, Vol. 7, 1998, pp. 237–53.

Interactive exhibits: how visitors respond

Guillermo Fernández and Montserrat Benlloch

The burgeoning field of visitor studies can provide a wealth of information on the effectiveness of interactive science exhibits. In Barcelona, Guillermo Fernández of the La Caixa Foundation Science Museum and Montserrat Benlloch, of the Faculty of Education of the University of Vic, devised a research project to see how different categories of visitor reacted to an ingenious exhibit and here recount the results of their work.

Interactive exhibitions are thriving, encouraged by a new approach to museology developed in response to current social demand and a much more participatory philosophy involving a redefinition of the concept of the museum in general and of the science museum in particular. These new museums not only possess holdings that must be safeguarded in the tradition of nineteenth-century museums, but they also seek to preserve and transmit knowledge. The classic concept of observation has been replaced by that of participation.

Briefly, the history of the science museum began with collections held by the most powerful European families. The Ashmolean Museum at Oxford, founded in 1683 and dedicated to natural history, is considered to have been the first science museum in the world. Another pioneer in the field was the Royal Model Chamber of Sweden for which the engineer C. Polhum designed an exhibition of mechanical devices in 1700. Both museums continue to attract thousands of visitors each year.

The industrialization of Europe and North America gave rise to new technological and scientific discoveries about which the public had to be informed. The highly successful universal exhibitions of the nineteenth century led to the opening of some of the great museums in London, Prague, Vienna, Munich and Washington. The exhibition pavilions were transformed into major museums in cities such as San Francisco, Osaka and Vancouver.

The Deutsches Museum, which opened in Munich in 1903, is regarded as the prototype of the modern museum. Many museums were built on that model in the United States in the 1920s, starting a trend that was to be progressively refined throughout the twentieth century. The 1960s heralded the beginning of a new museum era. The launching of *Sputnik* alerted the American Government to the importance of disseminating scientific knowledge (the first person in outer space was a Russian, not an American). The event was a nasty but salutary shock which affected the international reputation of American scientists. The education system was reformed and science museums played the lead in a 'boom' which had far-reaching social significance.

This new museum era began with the creation in 1969 of the San Francisco Exploratorium. That highly celebrated museum opened the way for a new generation of what were known as 'science centres' and 'informal science settings', which over time proved to be of far greater educational value and social impact than had originally been imagined. Owing to their success as educational tools, these centres came to be seen as crucially important support systems for the formal education provided by schools. Experts are beginning to appreciate the remarkable results obtained from learning in informal, visually challenging contexts, especially for children, adolescents and students in general. One of the most significant services rendered by interactive science museums is the educational opportunity they offer to schools by opening up to them their own resources, which are usually far greater than those of any small school science laboratory.

In Spain the first museum of this kind was the La Caixa Foundation Science Museum in Barcelona, which opened in 1980. The next, opening its doors in 1985, was the Casa de las Ciencias in La Coruña, the first government-funded museum of this kind. In 1993 Madrid opened its Acciona centre, currently managed by the La Caixa Foundation. Tenerife followed suit the same year with its Museo de la Ciencia y el

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)

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The Ghost of the Show *exhibit drew enthusiastic crowds because of its title and the dark and slightly mysterious aspect of the cylindrical chamber.*

Cosmos. Granada made its contribution with the opening of the Parque de las Ciencias in 1995.

New trends, new research

The trend in museology towards more participatory activities has been paralleled by the development of a new branch of educational/sociological/psychological research which looks closely at the relationship between the visitor or group of visitors and the interactive exhibits. In-depth studies on this communication phenomenon are being conducted with a view to obtaining data that can help improve the instructional impact of museum exhibitions. These new studies not only present demographic or quantitative data but also contain important qualitative information, which makes them very useful to education professionals. Generally speaking, this type of research is very much in its infancy. Although it is only just beginning to emerge in Spain,[1] its importance for museum management and the organization of exhibitions is now acknowledged.

Broadly speaking, and on the basis of the type of results obtained in relation to the questions under study, the research can be divided into audience studies and behavioural studies. Audience studies are fundamentally quantitative and are aimed at ascertaining the type of public that visits the exhibition and are, by definition, essentially demographic. The characteristics of visitors are analysed with a view to obtaining information about the most frequent type of visitor, the most regular visitors, the age groups that visit most often, etc. Studies of this kind, which help museum managers plan activities and opening hours on the basis of user profiles, are the most common. Behavioural studies investigate the actual relationship between the visitor and the visit, and may be quantitative or qualitative.

Quantitative studies collect such data as length of visit, visitors' approach to reading text and duration of interaction with the exhibit. Among these studies, one of the most representative is the research conducted in 1987 by Paulette McManus at the British Museum (Natural History) in London.[2] For the purposes of her survey, the researcher randomly observed visitors to particular exhibits, dividing them into four principal groups: singletons, couples, groups of adults and groups with children. Among the parameters studied by McManus were duration of the visit, duration of the conversations elicited, reading behaviour and interaction with the exhibits. Qualitative studies analyse the interactions among people and between individuals and the exhibits. Of particular interest to museologists is information relating to the visitors' grasp of the concepts that the various exhibits are intended to convey. Illustrative of this type of research is the survey conducted by Gelman, Massey and M. McManus (1991) at the famous Please Touch Museum for children in Philadelphia, in the United States. Using a hidden microphone, they recorded conversations between parents and children in different settings in the museum. The resulting qualitative data on family behaviour were used to draw conclusions about learning in non-formal settings.

The present study is based broadly on Paulette McManus's research and focuses on one of the travelling interactive exhibitions produced by the La Caixa Foundation. Called *Ver para no creer* (literally, 'seeing, not believing' – Ed.), it is intended to show both the potential and the limitations of human perception and consists of a series of some thirty interactive exhibits set up in a space of about 150 square metres. This type of exhibition is specially designed to be installed in various public buildings in Spain, where it remains for three or four weeks. Several features make it attractive and accessible to a broad public: it takes only half an hour to visit; it is usually located in the city centre; and entry is free. In addition, to facilitate transport and allow for maximum flexibility of installation, the exhibition consists of distinct self-contained modules, which meant that we were able to look at each one separately in order to analyse the concept it is designed to transmit.

The purpose of our study was to collect quantitative behavioural data. As is customary with this type of research, visitors were observed directly, with the observer noting the comportment of various categories, focusing on specific types of behaviour. In particular, three variables were observed and subsequently analysed: duration of the visit (in seconds), duration of conversations in groups of varying numbers of people (in seconds) and reading behaviour (attention to the text illustrating a given exhibit). In selecting the exhibit to be studied, we used the following criteria: it should be so designed as to convey a self-contained idea that can be grasped without the help of external factors; it should have a high attraction capacity, a parameter defined as the percentage of visitors who stop and look at an exhibit for five seconds or more, or interact with it fully; it should have a good retention capacity, defined as the total time, in seconds, that a visitor spends interacting with an exhibit (thus showing how successful the exhibit is in practice); and it should offer the best possible vantage point for the researcher/observer.

With this in mind, and after a series of preliminary observations carried out on all the presentations on display, it was decided that the most suitable item for a study on interactive behaviour was the exhibit called *El Fantasma de la Exposición* (*The Ghost of the Show*).

The Ghost of the Show

This exhibit is designed to illustrate how images remain on the retina of the human eye. The module consists of a wall 2 metres high and 1.5 metres wide. In the centre of the wall is a circular glass window which extends into the interior, forming a cylindrical dark chamber 40 centimetres deep. It is possible to reach inside the chamber by means of a circular aperture in the glass. Inside the chamber there is a 35-centimetre-long white stick with a handle, attached to the chamber wall by a small chain. The exhibit also has two information panels – one on each side of the window – and a button on the lower left-hand side.

When the button is pushed, a projector hidden in the upper left-hand part of the chamber produces the image of a friendly ghost, which is projected diagonally towards the lower right-hand section of the chamber. At first, because there is no surface on to which the image can be projected, the ghost is not visible. To see it the visitor has to reach through the circular opening into the chamber and move the stick in a plane perpendicular to the wall. If done rapidly enough, and because images remain on the retina, the ghost will be fully visible on the trajectory described by the moving stick.

This exhibit was the one that best met the aforementioned criteria. The idea of images being retained on the retina is a complete concept in itself, meaning that it can be understood without additional information, and the exhibit has an effective attraction capacity for the general public because of its title and the dark and slightly mysterious aspect of the cylindrical chamber. For families with children, the intense activity required to move the stick and the subsequent surprise of seeing the ghost is a very entertaining experience and induces visitors to spend long periods of time with the exhibit, thus maintaining its retention capacity. Finally, because it was located near a row of seats where an information documentary was being shown continuously, the observer was able to study the visitors without interfering with their spontaneous behaviour.

Each of the two information panels serves a separate purpose. The smaller one, located on the left-hand side of the wall, gives the instructions for use, reading: 'Push the button. Shake the stick located inside.' The larger one, on the right, provides a scientific explanation of the experiment and describes what happens. It is meant to be read after trying out the exhibit, and it says:

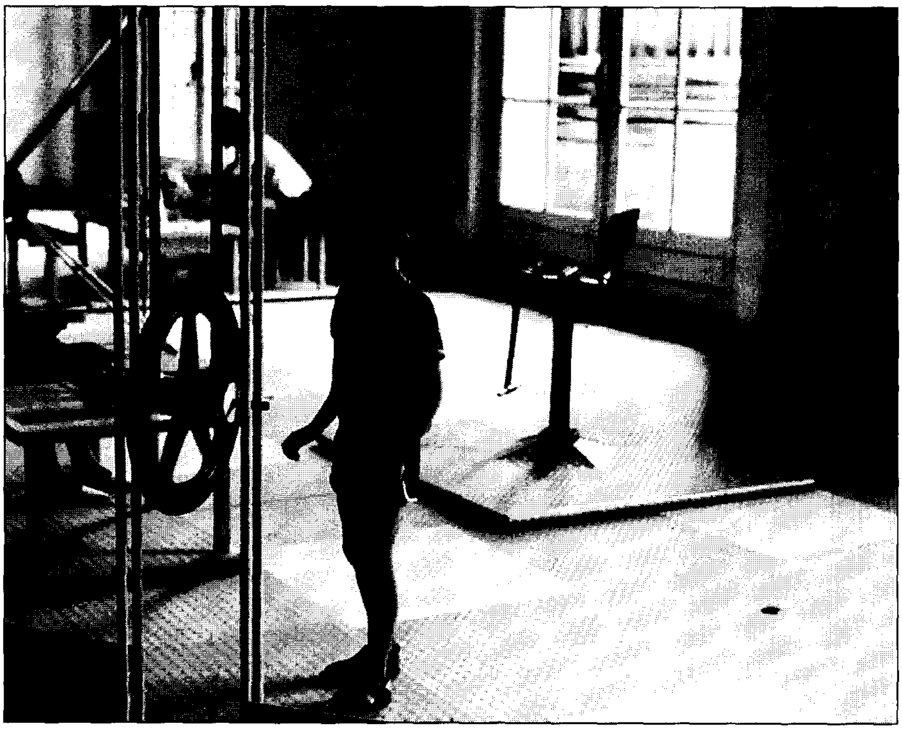
> What we see: the image of a ghost when the stick inside the window is moved. What happens: a hidden projector projects the image of the ghost. The normal way to show that image would be to put up a screen. The stick acts as a screen by collecting separate fragments of the image as it changes positions. Because the stick moves rapidly, our eyes register the image of the last fragment before the image of the first has dissipated. The superposition of all the fragments is then perceived as a whole figure. What we know: the image remains in the photo receptors of the retina for a quarter of a second. In addition, the images are integrated in our short-term memory ensuring that we perceive the world in a continuous way and not in discrete steps.

Observing the visitors

Similar to the experiment conducted by McManus, we used direct non-participatory observation of the visitors, that is, we registered visually the entire range of behaviour patterns without audio or video recordings. In this test we were not concerned with the content of the conversations between visitors, but only in the duration. The data were always collected at the same time of day, between 7 and 9 p.m., which were the busiest hours. An average of eighty people – forty per hour – passed by during this time period, though the numbers varied according to the day of the week and the week itself. Each activity relating to the exhibit was observed without distinction and the following information was gathered: the type of visit according to nine categories (male and female couple, male dyad, female dyad, men and women, fathers with children, mothers with children, fathers and mothers with children, male singleton, female singleton), the duration of the visit (in seconds), and the duration of the visitors' conversations (in seconds). The three categories of reading behaviour defined by McManus with regard to the explanatory panels were also examined, that is to say, non-observed reading (visitors who did not read the panels at all), brief reading (visitors who glanced once or more at the text) and comprehensive reading (visitors who read the panels attentively, their eyes fixed on the text). Owing to the great diversity between the demographic categories and to increase the statistical significance of the study, it was decided to reduce the demographic categories to just three combinations: groups (any size) of men and women (96), groups containing children (40) and singletons (40).

In looking at the percentage of visits lasting sixty seconds or less and those lasting more than sixty seconds for each group, it was found that singletons spent the least amount of time with the exhibit in comparison with groups of adults and groups with children. It is noteworthy that the contributions of female dyads and male dyads was a decisive factor in the relatively high percentage of visits over sixty seconds observed in the adult groups.

The duration of conversations was measured according to two variables: those lasting up to twenty seconds and those lasting longer. (Naturally, the category of singletons was dropped in this case.) The results indicate somewhat longer conversations in groups with children, where those lasting more than twenty seconds were recorded in 5 per cent more cases than in adult groups.



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'The trend in museology towards more participatory activities has been paralleled by the development of a new branch of research which looks closely at the relationship between the visitor and the interactive exhibits.' An outstanding example is the giant yo-yo at the Palais de la Découverte in Paris.

Concerning reading behaviour, a striking characteristic of groups with children is the high percentage of visits with no reading at all. Specifically, the number of visits during which no reading took place is twice as high for groups with children as for groups of adults without children. Results for singletons are very similar to those for groups of adults. Groups of adults show the highest percentage of brief reading behaviour; groups with children and singletons show slightly lower percentages. Singletons are particularly likely to engage in comprehensive reading of the panels, followed by individual adults. Groups with children are the least likely to read attentively, a result which corresponds to the previously noted high percentage of non-observed reading in this group. It is possible to observe the evolution of reading behaviour within a single category of visitor. The most widespread behaviour across all categories is brief reading. Nevertheless, this behaviour is particularly striking in groups of adults, while non-reading behaviour is typical of groups with children and comprehensive reading is typical of singletons.

Drawing conclusions

The duration of the visit is directly related to the number of people involved in it. Groups with children or groups of adults spend more time at the exhibit because, basically, all or most of their members want to try out or see the results of the experiment. At times this behaviour is transformed from a group visit into a succession of individual visits, especially in the case of children, since the visit usually turns out to be an all-out competition to see which one can produce the best vision of the ghost. Bearing this factor in mind, we may deduce that, in fact, taking the case of a lone individual, the number of long visits made by singletons is not all that low, as they spend more time at the exhibit than any individual member of a group.

Despite the fact that in groups with children each member of the group (or at least each child) usually interacts with the exhibit individually, the longest visits are made by groups of adults. The reason is that during visits with children the dominant mood is impatience and excitement, despite the efforts of parents or guides to draw the youngsters' attention to the exhibit. In contrast, in adult groups, although not every member will necessarily interact with the exhibit, the mood is much calmer.

With regard to the conversations elicited, we were unable to find any dramatic differences. In general, the comments about the exhibit were brief and the speakers did not go into excessive detail, judging from the length of the conversations. Groups with children produced somewhat higher conversation figures which correspond to children's typical speaking habits and the greater patience on the part of the adults accompanying them in explaining how to use the exhibit.

Reading category is a good indicator of visitor attitudes. As already mentioned, the category 'brief' defines all types of visitors. Usually, visitors glance at the texts without paying strict attention to them. In the majority of cases, they are seeking instructions or details on how to interact with the exhibit, rather than scientific information. This type of behaviour was typical of the groups of adults, although there was a good proportion (25 per cent) of cases of comprehensive reading and the lowest percentage of non-observed reading. The reason is that in this type of group there tend always to be one or more members who, in the background, are reading the information panel attentively while the rest of the group is interacting with the exhibit and only giving a quick glance at the text. Groups with children scarcely notice the information panels and it is usually the accompanying adults who scan the panels rapidly for information on how to use the exhibit. Only in 12.5 per cent of the cases was a scientific answer or explanation sought from the text.

Despite the overall predominance of the 'brief reading' category, individual visits are the ones in which a genuinely detailed reading of the panels features most prominently, and in some cases there are even visitors who read the panels but do not interact with the exhibit. Nevertheless, a quarter of the singletons stroll through the entire exhibition without reading at all. This parameter depends entirely on the attitude of the individual towards this type of exhibition and not so much on the social circumstances of the visit.

We may thus draw a sort of 'profile' of each visitor on the basis of these and other observations made of the exhibit:

- *Singletons*: single individuals visit the exhibit calmly, glancing at the texts. They interact with the exhibit enough to see the effect produced and go back to read the panel for information, though judging from the length of time they spend on it, they do not always find what they are looking for.

- *Groups of adults*: the mood of the visit is light-hearted. One of the members usually dominates the interaction with the exhibit, though others (seldom all) may also interact with it. Normally, the first one to interact with the exhibit barely reads the panel, while one or more of the other members read it attentively while observing the practical skills of their fellow group members. Conversations are brief and, in general, tend to be relaxed and good-humoured.

- *Groups with children*: the sight of the exhibits and the atmosphere of the exhibition suggest fun and games to the children. They seem excited by the idea of enjoying themselves and are interested only in the 'hands-on' possibilities. They do not usually show any interest in the scientific basis of the display, which in any case would be beyond the grasp of many of them. The parents or guides understand this and try to help by showing the children how to manipulate the exhibit rather than explaining how it works. They therefore skim very lightly over the text just to understand the instructions and see what effect should be produced. Once the exhibit has been demonstrated by the adults and tried out by the children, they leave the exhibit without going back to read the panels. Conversations are brief and are confined to expressions of surprise at what they see.

It is evident, then, that studies such as this can be of great value in developing strategies for interpretation based on a clear understanding of visitors and that seek to cater to their needs and wishes.[3] ■

Notes

1. C. Prats and J. Flos, 'Ecology at an Exhibition: Impact and Informal Learning. Homage to Ramon Margalef, or Why There is Such Pleasure in Studying Nature', *Oecología acuática*, Vol. 10, 1991 (Publicaciones de la Universidad de Barcelona), pp. 393–409; M. Benlloch and V. N. Williams, 'Influencia educativa de los padres en una visita al Museo de la Ciencia: actividad compartida entre padres e hijos frente a un módulo. [Educational influence of parents during a visit to the Science Museum: activity shared by parents and children in relation to an exhibit]', 1998.

2. Paulette McManus, 'It's the Company You Keep . . . The Social Determination of Learning-related Behaviour in a Science Museum', *International Journal of Museum Management and Curatorship*, No. 53, pp. 43–50, 1987.

3. A brief bibliography of relevant works has been prepared by the authors and is available on request from *Museum International*. – Ed.

The 'expert visitor' concept

Jean Davallon, Hanna Gottesdiener and Marie-Sylvie Poli

Visitor studies have moved far beyond the simple gathering of statistics to develop increasingly refined data and behavioural profiles. The Centre for Study and Research on Exhibitions and Museums (Centre d'Études et de Recherche sur les Expositions et les Musées, CEREM) at Jean Monnet University, Saint-Étienne, France, is a leader in the field and developed an innovative approach to shed new light on an old question: How do visitors perceive an exhibition?

Jean Davallon[1] *is professor of sociology at the University and director of CEREM. Hanna Gottesdiener is professor of psychology at the University of Paris-X, a member of CEREM and Editor-in-Chief of* Publics et Musées. *Marie-Sylvie Poli is lecturer in language sciences, Pierre Mendès France University, Grenoble, and a member of CEREM.*

Difference: Three Museums, Three Perspectives is unlike any other ethnographical exhibition, in terms of its form (three exhibitions in one), its successive venues (first at the Museum of Ethnography in Neuchâtel, Switzerland, then the Musée Dauphinois in Grenoble, France, with a detour to the Museum of Folk Arts and Traditions in Paris, and ending up at the Canadian Museum of Civilization in Quebec) and also its rationale, which has more to do with a challenge taken up by three reputed institutions than with the staging of an ordinary exhibition. In order to have some chance of describing in formal terms the innovative museographical character of this achievement, the attentive observer therefore had to devise methodological tools other than the usual semiotic analytical frames and draw on theoretical frameworks other than those normally used by museologists. As our objective was to bring to light the full extent of the proficiency[2] of visitors to the exhibition when it was held at the Musée Dauphinois in Grenoble in April 1996, we devised a protocol for analysing the discourse of first-time visitors that was focused on the frames of reference (or frames of meaning) detected in respondents' comments. We thus developed an inductive method based on a study of the visitors' perception of what might (in their view) have been the ideological motivations and the production strategy options of each of the three museums, and also of the museographical project as a whole. This article contains a synopsis of the findings of the research conducted by CEREM on visitors' interpretation strategies, our purpose being to show that on many points, often unsuspected by curators and consultants, certain visitors' comments can raise questions that go beyond the specific exhibition they have just visited and are more akin to exhibition criticism in general.

At the outset, this study lent itself readily to a strictly linguistic approach because the first step was to process the visitors' comments by means of speech analysis software, which, once the initial lexical processing had been completed, enabled quantitative lexical data to be processed in turn by placing them back in the context of the survey and the exhibition. The analysis yielded the respondents' frames of reference, that is to say, the mental frames to which they referred when they spoke about the three parts of the exhibition and about the exhibition as a whole. The museological approach came in at the second stage. When all the respondents' frames of reference were available, they were considered to be language markers (or indices) of the visitors' skill at taking an active part in the exhibition designer's project,[3] meaning the extent to which the visitor's experience might be not just that of a visitor-as-reader, but also that of a visitor-as-author.

Three ways of treating difference

Difference: Three Museums, Three Perspectives can be seen first of all as a collective exhibition in which three teams propose three ways of treating difference, a key concept in ethnography. Saying, telling, explaining and persuading are well-known rhetorical strategies of persuasion used in essays, dissertations or scientific papers. In our view, therefore, *Difference: Three Museums, Three Perspectives* stands as a mode of museographical discourse with a three-voice rhetoric. Each voice corresponds to a statement implying that there is an author (designer) and a reader (visitor) and that the three designers intend to influence the visitor.[4] The complexity of this semiotic situation means that the visitor-spectator

ISSN 1350-0775, *Museum International* (UNESCO, Paris), No. 208 (Vol. 52, No. 4, 2000)

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA)

must have the receptive and interpretative capacities that are usually found more among experts than amateurs. This exhibition therefore has the merit of enabling us to see the visitor in a new light, that is, as an interlocutor who can perceive/describe/explain the rhetorical relationship that characterizes *Difference: Three Museums, Three Perspectives* and is due to the dialectic juxtaposition of three distinct types of discourse.

Aware as we were that this rhetorical relationship required a highly complex exhibition format, which is something of a novelty for visitors, we developed a survey protocol enabling visitors to express their personal views in detail both about the exhibition as a whole and about the performance of the three museums individually. We therefore asked visitors to the Musée Dauphinois who were willing to take part in the study to take photographs of anything that made a particular impression on them in the exhibition. The exact instructions that the thirty-nine volunteers were given were as follows:

> As you go through the exhibition, take a picture of whatever strikes you most, either because you like it very much or because you do not like it at all or just because you feel like it. You have ten Polaroid pictures in hand, which you can take anywhere in the exhibition, in whatever order you like. We shall meet in a little room at the end of your visit to discuss your views about this exhibition and the pictures you have taken.

Polaroid pictures seemed to us to be ideal for this kind of research because they can be taken and developed instantly in the museum as a tangible item for discussion and, placed in the middle of the table equidistant from the two people taking part in the conversation, prompt comments about the exhibition and encourage the respondent to think carefully about the reasons behind the choices made. In so doing, the person concentrates on the museographical interpretation to be given to the exhibition items captured 'in the box'.

The analysis of the respondents' interpretation shows that *Difference: Three Museums, Three Perspectives* was perceived more as three exhibitions placed side by side than as a single museographical system. In fact, in their remarks the respondents spontaneously compared one with the other, some being critical of Neuchâtel but full of praise for Grenoble, others making little of Grenoble but extolling the virtues of Quebec, or going into raptures about Neuchâtel compared with Quebec, and so on.

© Musée Dauphinois, Grenoble

The exhibition Difference: Three Museums, Three Perspectives *as interpreted by the Museum of Ethnography in Neuchâtel; visitors laid emphasis on the ideological and intellectual character of the approach.*

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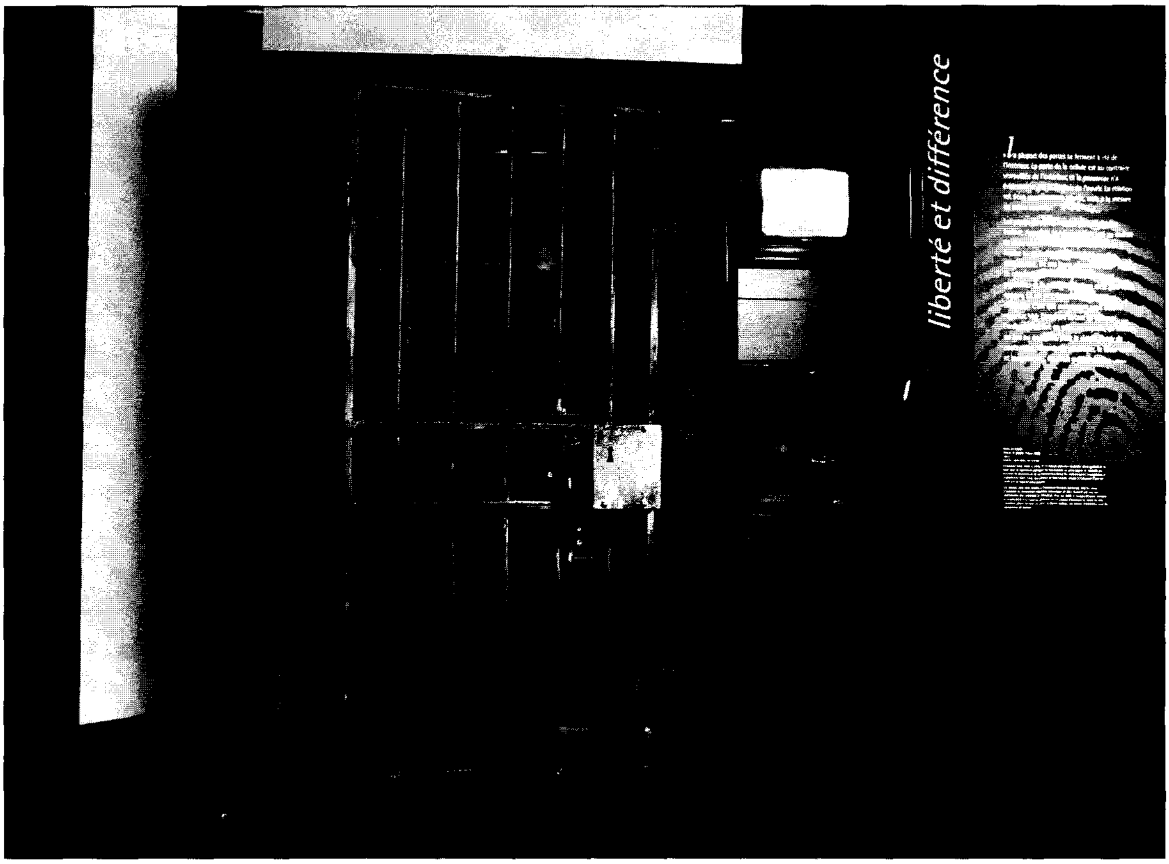


Difference *with a difference: visitors responded to the emotion-arousing strategy of the Canadian Museum of Civilization, Quebec.*

The photographs about which the visitors spoke most were those of the texts. Regardless of the exhibition, the written commentaries obviously caught the eye. In their comments the visitors were able to construct their analyses since they were on familiar ground, namely, the critical explanation of a text. Speaking about the written commentaries on the exhibition, the visitors voiced keen, constructive criticism. They thought that the exhibition was interesting but very difficult. They considered the experiment to be an intelligent, effective means of portraying ways of thinking in French-speaking countries that have neither the same history nor the same contemporary socio-cultural situation. Another museographical component that was very thoughtfully analysed were the showcases. The visitors had a very acute perception of the 'instructions' on the showcases and exhibition areas because of the interactive relationship between the arrangement of the exhibits and the tone chosen by each museum (emotional or cerebral, cultural or educational, serious or humorous, as the case may be). The reactions are summarized below.

The Neuchâtel Museum of Ethnography section

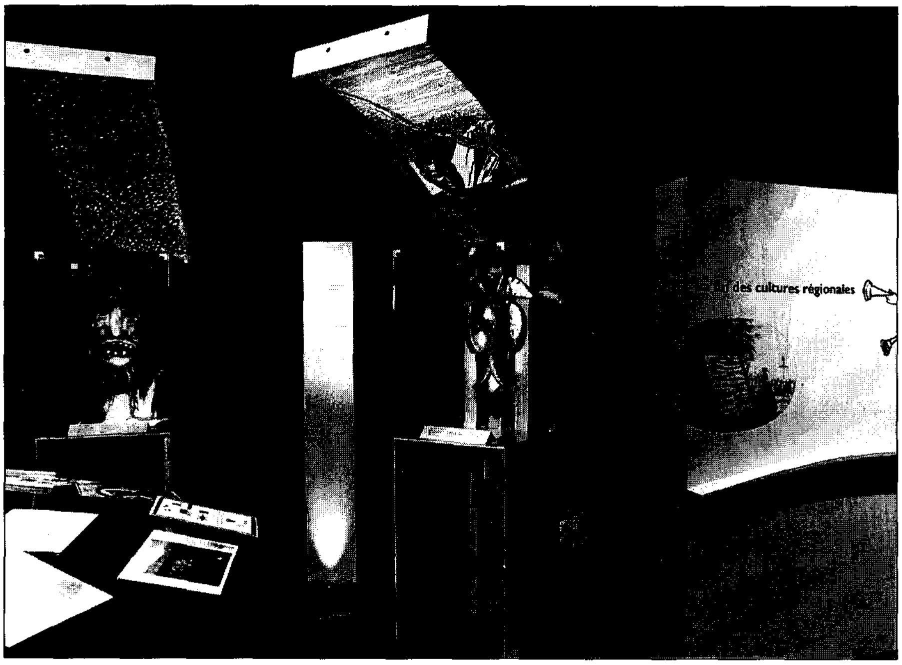
The visitors saw very well why it was difficult to understand. How was the performance[5] of the Neuchâtel team perceived? This part of the exhibition was understood as the portrayal of a committed vision of the world. In their interpretations, visitors laid emphasis on the ideological and intellectual character of the approach. The strong points of the exhibition, recognized as such, were the intelligence of the complex showcase arrangement, the scientific quality of the texts, images and heritage items and its deliberately provocative style and freedom of tone. On the other hand, it was criticized by those who found it incomprehensible, for intellectuals only, impossible to take children to, cold, too aesthetic and even soulless.

The Canadian Museum of Civilization, Quebec, section

The emotion-arousing strategy was clearly perceived. Four key words characterized the visitors' analyses: doors, written commentaries, habitat and North American. These words were very much to the point since they reflected the exhibition's style, ideological register, architecture and use of modern tools.

The Musée Dauphinois, Grenoble, section

The comments revealed a clear grasp of a distinctive 'Musée Dauphinois style'. The key words to describe the exhibition? The visitors used practically the same linguistic formulations as those of the designers, namely: regional diversity in France, differences (cultural and physical) worldwide, and philosophical reflection on the notion of difference. It soon became obvious to us that the visitors had grasped perfectly well the three-part plan devised by the Musée Dauphinois team, each part dealing with a possible ethnological acceptation of the concept of difference.



© Musée Dauphinois, Grenoble

The exhibition presented by the Musée Dauphinois, Grenoble, was perceived by visitors as a philosophical reflection on the notion of difference.

Understanding/overstanding

The results of the discourse analyses on the visitors' frames of reference show that visitors are capable of critical discourse – or 'overstanding' – that goes much further than understanding what they have seen in the specific exhibition on which they have been asked to give their views. What do we mean by 'overstanding'? The following distinction has been made between understanding and overstanding literary texts: 'Understanding consists in asking questions and in finding the questions on which the text insists. Overstanding, on the contrary, consists in asking the questions that the text does not ask of a model reader.'[6]

Now, what do we observe about the visitors who, as we have found systematically in this study, prove that they are capable of placing *Difference: Three Museums, Three Perspectives* in the context of the 'literature' of exhibition discourse, comparing content, style, positions and modes of mediation with the public? First of all, they demonstrate possession of a museum-goer's culture, which extends to other places, other times and other contexts than those of this particular exhibition. They also show skill in memorizing the grammar of exhibition production and curators' discourse, and in adapting it subsequently to a process of dialectical understanding. Lastly, the visitors manifest an ability to describe the communication mechanisms that enable exhibitions to function or not, depending on the contexts (or frames) of mediation. By constructing in this way hypotheses that go beyond the 'here and now' of the exhibition visited and thinking more broadly in terms of the exhibition as an object (or a concept), they raise general issues, such as the conception of objects as heritage, spatial arrangements and messages conveyed by the exhibition, certain curators' styles, types of exhibition and the political and educational roles of museums today. This means that when visitors engage in this process of formalizing the kind of museographical questions that all experts must ask themselves, they are, in our view, placing themselves in a situation of overstanding the exhibition, which makes them expert visitors. The terms 'expert visitor' and 'visitor-as-critic' seem to us to be synonymous to the extent that they describe a person capable of analysing – and evaluating – the different ways in which the same procedures for mounting an exhibition are reused in different forms in all exhibitions. There are therefore expert visitors who, without being professional museographers, distinguish 'exhibition as products' from figurative exhibition-mounting procedures, or 'tropes', just as there is a form of literary poetics practised by expert readers who are not writers or literary critics, but simply amateurs who are familiar with questions of tropes and other figurative methods of composing texts. ■

Notes

1. Jean Davallon may be contacted at: Davallon@univ-st-etienne.fr

2. We borrow the notion of skill from language sciences because we consider it to be altogether relevant to museology: 'Proficiency is the system of rules internalized by speakers and constituting their linguistic knowledge, which enables them to utter or understand an infinite number of sentences.' – O. Ducrot and J.-M. Schaeffer, *Nouveau dictionnaire encyclopédique des sciences du langage*, Paris, Seuil, 1995.

3. M.-S. Poli, 'Le parti-pris des mots dans l'étiquette: une approche linguistique', *Publics et Musées*, Vol. 1, pp. 91–107, Lyons, Presses Universities de Lyon, 1992.

4. We use 'designer' and 'visitor' in the singular, but they are of course generic terms that refer to more than one person.

5. 'Performance depends on the proficiency of the psychological subject and the communication situation, for it depends on very different factors such as memory, attention, social context, psychosocial relations between speaker and listener, and the affectivity of those participating in the *communication*' – Ducrot and Schaeffer, op. cit.

6. J. Culler, 'Défense de la surinterprétation', in U. Eco (ed.), *Interpretation et surinterprétation*, Paris, PUF (Formes Sémiotiques), 1992.

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Museum International (English edition) is published four times a year in January, March, June and September by Blackwell Publishers, 108 Cowley Road, Oxford OX4 1JF (UK) and 350 Main Street, Malden, MA 02148 (USA).

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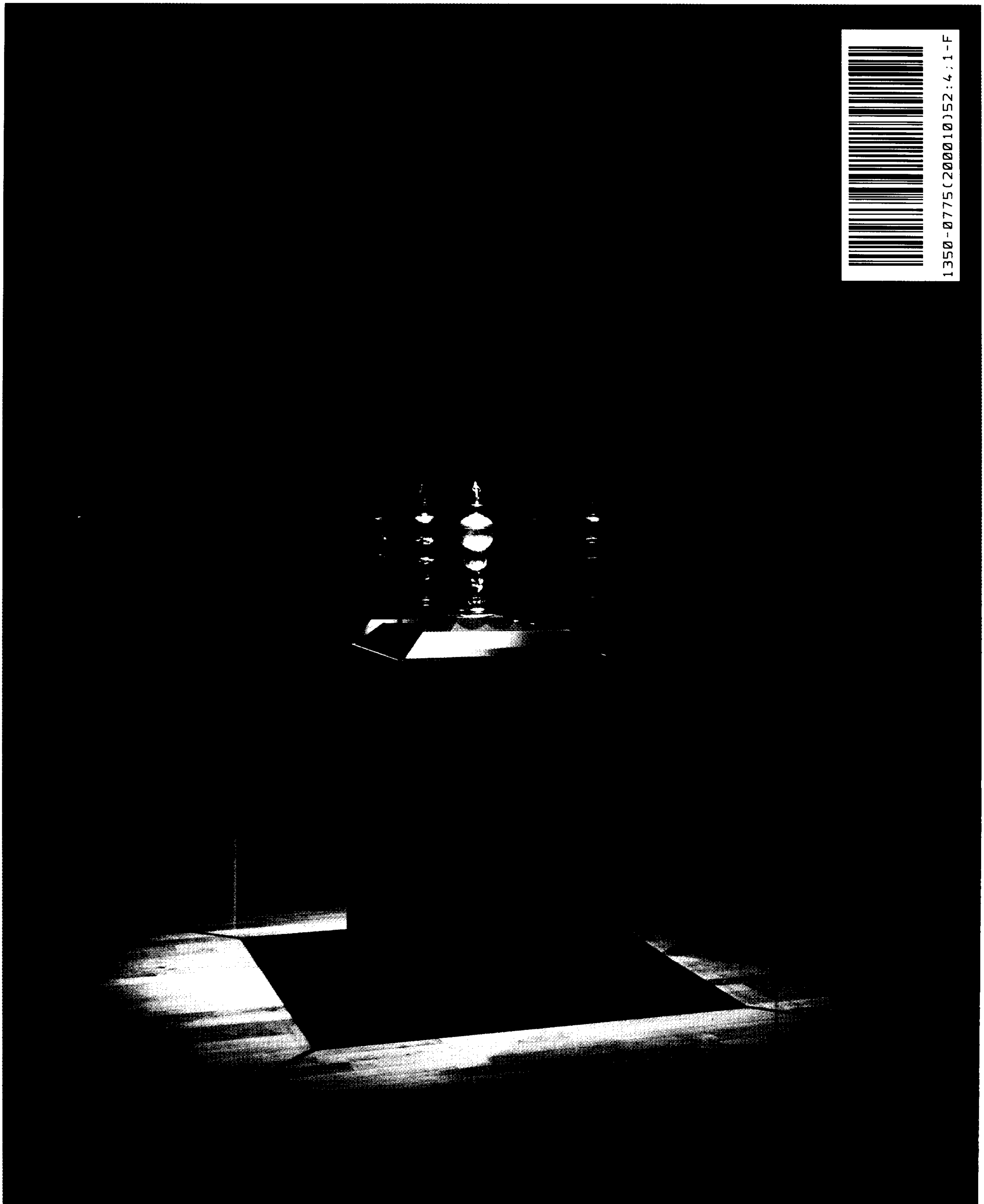
US mailing: Periodicals postage paid at Rahway, New Jersey. Postmaster: send address corrections to *Museum International*, c/o Mercury Airfreight International Ltd Inc., 365 Blair Road, Avenel, NJ 07001 (USA) (US mailing agent).

Printed and bound in the United Kingdom by Headley Brothers Ltd, Kent. Printed on acid-free paper.



The Darell Tucker Dayrell Cup at the Buckinghamshire County Museum, Aylesbury

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