Hands-on Exhibitions

Managing Interactive Museums and Science Centres

Tim Caulton

ROUTLEDGE

Hands-on Exhibitions

The development of interactive displays has transformed the traditional museum world in the last decade. Visitors are no longer satisfied by simply gazing at worthy displays in glass cases—they expect to have hands-on experience of the objects and be actively involved with the exhibits, learning informally and being entertained. simultaneously. Hands-on museums and science centres provide the most remarkable example of how museums are redefining their role in society—improving access to real objects and real phenomena, so that they can be enjoyed by more people.

In recent years museums have been thrust into intense competition for the public's time and money with all branches of the leisure industry, from commercial theme parks to retail shopping and home entertainment. This has upset the traditional stability of the museum world and necessitated an evaluation of the economic relationship between museums and their visitors. A hands-on approach encourages a broader visitor base, which in turn helps to bring in additional revenue at a time of declining public subsidy.

Tim Caulton investigates how to create and operate effective exhibitions which achieve their educational objectives through hands-on access. He concludes that the continuing success of hands-on museums and science centres hinges on attaining the very best practice in exhibition design and evaluation, and in all aspects of operations, marketing, financial and human resource management. *Hands-on Exhibitions* provides a practical guide to best practice which will be indispensable to all museum professionals and students of museum studies.

Tim Caulton has been involved in the development and management of museums for over fifteen years. He was a member of the team which developed Eureka! The Museum for Children in Halifax. He has subsequently helped develop a number of new museums, and lectures at the University of Sheffield.

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Tim Caulton

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Contents

Figures and tables

Figures

Tables

Preface

The growth of hands-on museums and science centres has been one of the most remarkable features of the leisure industry in the last decade, with almost every new exhibition proposal today incorporating an interactive element for visitors. As education officer at a working industrial museum throughout the 1980s, I continually wrestled with the problem of how to turn the highly popular, but labour-intensive, metal-shaping activities undertaken by thousands of school-children in the museum school-room into an interactive experience available for all visitors, every day and in a safe environment. There had to be a way of enabling visitors to participate in, and not just watch, all the activity in the museum. A trip to Test Bed at the Science Museum in 1984 provided further motivation, and the activities in the museum classroom became more prominent as formal talks were virtually abandoned in favour of hands-on learning. At that time I knew little of exhibit evaluation, and the possibility of turning museum attendants into explainers seemed as remote as the chance of getting funding for the scheme. In 1988, I was involved in bringing the Discovery Domes to Sheffield for their national launch, and in the following year gained funding from the Committee on the Public Understanding of Science (COPUS) to stage a temporary hands-on exhibition at the museum after the British Association annual meeting in Sheffield. Despite cutbacks in local government funding, the museum trustees were supportive, and a permanent hands-on exhibition at Kelham Island seemed a realistic proposition.

In 1990,1 was fortunate to be appointed Head of Education and Interpretation at Eureka! The Museum for Children in Halifax, and was thrust for the first time to the forefront of the hands-on movement. For three years, Eureka! provided a challenging training ground, during which time I was responsible for developing the content of all the exhibits, and for the recruitment, training and management of the front of house enabling staff. By summer 1993, with half a million visitors through the turnstiles, it was time to move on, and the Eureka! experience opened numerous doors, enabling me to assist in the development of new hands-on museums throughout the UK and abroad. In short, I feel very privileged to have been involved with the hands-on movement for a decade, at a very wide variety of museums in the public and independent sectors, and at local and national levels.

As a university lecturer, I am now able to study the hands-on movement whilst continuing to work on selected new museums. This book is a critical analysis of the development of hands-on museums and science centres in the UK, within the context of parallel trends in the USA and Europe. It is aimed at a dual market of practitioners at museums and other visitor attractions contemplating the development of an interactive exhibition, and also at those studying the management of museum, heritage, leisure and tourist attractions. The book is not designed to teach basic management theory so much as to provide case study information on the specific management of hands-on exhibitions.

There is a broad range of hands-on museums and science centres in the UK, but inevitably the book draws heavily on personal knowledge and experience, on original

research and primary evidence in the public domain, together with material from a range of secondary sources in the UK and USA.

One of the key findings of this study is that the hands-on movement contains a vast array of visitor attractions with differing objectives, and that there is no one ‘right’ way to develop and operate a hands-on museum. Nevertheless, it is clear that all hands-on museums and science centres face similar challenges. In particular, it may be difficult for hands-on museums and science centres to maintain their individual identity in the future as boundaries blur between different types of leisure attraction. If they are to survive cutbacks in revenue funding from public sources, maintain their visitor levels at a time of massive increase in the number of leisure attractions and withstand competition from attractions embracing new technologies, the hands-on museums will have to employ the very best of management techniques to finance, market, staff and operate the centres successfully. Furthermore, if the hands-on museums and science centres are to meet the educational objectives of hands-on learning, they will have to draw upon and contribute to the growing body of knowledge on how visitors behave and learn in an interactive environment.

In short, the aim of this book is to address management issues in the development and operation of hands-on museums as an increasing number of organisations strive to improve physical and intellectual access to real objects and real phenomena through hands-on learning.

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Tim Caulton
Leisure Management Unit
University of Sheffield

Abbreviations

ARC	Archaeological Resource Centre (York)
ASTC	Association of Science and Technology Centers (UK)
BIG	British Interactive Group
COPUS	Committee on the Public Understanding of Science
DNH	Department of National Heritage (UK)
DTI	Department of Trade and Industry
EC	European Community
ECSITE	European Collaborative for Science, Industry and Technology Exhibitions
INSET	In-service education for teachers
ISTP	Interactive Science and Technology Project
OPCS	Office of Population, Census and Surveys

1
Hands-on exhibitions

This chapter provides an overview of the development of hands-on exhibitions in the UK, USA and Europe within the context of changing provision in the museum, heritage and leisure industries.

Introduction

Visitors to museums are no longer satisfied simply gazing at worthy displays of exhibits in glass cases. They expect to be actively involved with the exhibits, to learn informally and to be entertained simultaneously. In the face of declining budgets from government sources, museums have been forced to identify and meet the needs of a discerning public, and they have been thrust into competition for the public's time and money with all other branches of the leisure industry, from commercial theme parks to retail shopping or home entertainment. In short, museums have become increasingly aware of the need to redefine their role in society, reaching a broad visitor market, not only to earn additional revenue, but also to justify any remaining public subsidy.

Museums throughout the world are looking at ways to improve access to their exhibitions so they can be enjoyed by more people. There are many ways of doing this: for example, the use of new technologies, visible storage or live interpretation are all perfectly valid ways of trying to demystify museums and help visitors make more sense of the collections. However, as the twentieth century draws to a close, many new exhibitions are designed exclusively with hands-on exhibits, whilst many more incorporate hands-on exhibits within traditional exhibitions or in galleries utilising a mixed range of interpretative media. In the UK, the hands-on approach has spread from the first science centres to museums, and subsequently to heritage and countryside interpretation centres. The design, management and operation of hands-on exhibitions is very different from that of traditional galleries, and requires different professional skills. This book aims to assist those contemplating the development of an interactive exhibition, drawing on experience in the UK, USA and Europe.

What is a hands-on exhibit?

Traditional forms of museum displays are either passive (glass showcases) or active (working models and machines), but both methods can be described as 'hands-off'. Visitors are encouraged to look, think, hear and sometimes smell, but they are discouraged from touching. Hands-on and interactive exhibits, on the other hand, encourage visitors to explore exhibits more directly. The terms 'hands-on' and

'interactive' have similar meanings and have become largely interchangeable. 'Hands-on' implies that visitors physically interact with an exhibit, whether this is simply pushing buttons, using a computer keyboard, or engaging in a more complex activity with a multiplicity of outcomes. However, a hands-on exhibit that simply involves pushing a button is not truly interactive, rather it is reactive, in that the exhibit simply follows a predetermined outcome.[1]

When the term 'hands-on' is normally used there is an assumption that hands-on activities will also involve interaction and provide added educational value, that hands-on will lead to 'minds-on', although the term itself does not suggest this. On the other hand, an 'interactive' exhibit implies that visitors will engage in mental interaction, but this can clearly happen without any physical interaction taking place.[2] Definition is further complicated in that the term 'interactive' is often associated with computer games, where the only physical activity taking place is via a keyboard, joystick or virtual reality headset, and where entertainment and education are not necessarily joint objectives.

In short, whilst the terms 'hands-on' or 'interactive' have become largely interchangeable in both public and professional use, neither term in itself adequately defines an exhibit which involves physical interaction, which has clear learning objectives, and which has a multiplicity of outcomes dependent on the visitor's individual explorations. Without an adequate alternative term, this book does interchange the use of 'hands-on' and 'interactive', but in both cases there is an assumption that the terms do involve this broader definition:

> A hands-on or interactive museum exhibit has clear educational objectives which encourage individuals or groups of people working together to understand real objects or real phenomena through physical exploration which involves choice and initiative.

A good interactive exhibit will work at a multiplicity of levels for visitors of different ages and abilities. Hands-on exhibits do not have to be high-tech to be interactive, and whilst they may not directly involve handling museum artefacts, exhibits are designed to help visitors explore real objects or real phenomena. As such, hands-on exhibits can involve the direct manipulation of museum objects or replicas, or they can help visitors understand an original object on display alongside the exhibit, or they can take place in galleries without any artefacts at all (for example, in a science centre where the emphasis is on encouraging the public to understand scientific phenomena).

The origins

The origins of modern hands-on museums and science centres lie within two parallel developments: the first children's museums in late nineteenth-century USA, and major traditional science museums in early twentieth-century Europe and North America.

Early science museums

The science centre strand is usually attributed to pioneering developments such as the operation of industrial engines at the Deutsches Museum in Munich from 1925 and the staging of chemical demonstrations at the Palais de la Découverte in Paris from 1937.[3] There were parallel developments in the USA too: Chicago Museum of Science and Industry had a simulated coal mine into which visitors descended in 1933, whilst the Franklin Institute in Philadelphia has had a two-storey walk-through beating heart since 1935.[4] These early science museums have a long and distinguished history of interpretation and explanation alongside their exhibitions, and the more recent trend towards hands-on exhibits is an obvious extension of this tradition. Indeed, the distinction between the old museums of science and modern science centres may be more related to their age than to any differences in mission.

The Children's Gallery at the Science Museum in London, which opened in 1931, also has a claim to be one of the first science centres. Resembling more of a'technological amusement arcade'[5] than a traditional museum with its buttons to push and handles to wind, it became a source of inspiration to generations of children who could later attribute a lifetime interest in science and technology to a childhood visit there. The Children's Gallery was originally designed for all visitors as an introduction to the museum, but with its working models and dioramas it was so popular with younger people that it became known as the Children's Gallery.[6] It was the forerunner of today's hands-on science centres. Indeed, even contemporary criticism in the *Museums Journal* sounds familiar: 'We could not help fearing that all this may be going too far and not quite in the right direction.'[7] Furthermore, exhibit development problems similar to those found in today's hands-on galleries were experienced:

> Working models…would be found after a short time on exhibition unable to stand up to the strain of constant operation by visitors…a new class of exhibit, required to work under special conditions…had to be devised and effected before a satisfactory form of each model could be arrived at.[8]

The Children's Gallery and the Deutsches Museum inspired Frank Oppenheimer, but the Exploratorium that he founded in San Francisco in 1969 was the first of a completely new kind of institution with a truly hands-on approach, and this was followed by a wave of successful science centres throughout North America.[9] The Exploratorium provided a catalyst to other organisations, and by making over 200 'recipes' for interactive exhibits available through its 'Cookbooks', ensured that other science centres were able to start with reliable and proven exhibits—and also to ensure that clones of Exploratorium exhibits can be found in science centres throughout the world![10]

In the same year that Oppenheimer founded the Exploratorium, the Ontario Science Centre opened in Toronto after receiving an investment of $23 million from the Province of Ontario. In summer 1981, the Ontario Science Circus (an extension to the science centre) visited Birmingham and the Science Museum in London. Supported by the Science and Engineering Research Council, the eleven-day visit to the Science Museum was considered extremely successful and encouraging:

> Visitors thoroughly enjoyed the experience, and there is no doubt that the participatory nature of the majority of the exhibits contributed greatly to that enjoyment… The results of the evaluation study vigorously support the development of the Science Centre concept in Britain. The next stage, building on the Science Circus experience, might be to set up some pilot exhibits in similar style.[11]

The Science Museum experimented with its own modest Discovery Rooms in the summers of 1981 and 1982,[12] and in 1984 over 20,000 people visited its Test Bed. It was described at the time by the head of education at the Science Museum as 'a quantum leap forward in the idea of museum participation.'[13] Valuable research and development lessons were learned, and the experiment directly led to the opening of Launch Pad in 1986. Costing over £1 million, Launch Pad was an overwhelming success, with over 20,000 people visiting on its first day alone![14]

If Launch Pad was the first hands-on centre within a UK museum (albeit in a gallery devoid of objects), the first stand-alone science centres were at Techniquest in Cardiff (1986) and the Exploratory at Bristol (1987). By this time the interactive movement was firmly taking shape in the UK, supported by the Sainsbury Foundation, the Leverhulme Trust, the Nuffield Foundation and the Department of Trade and Industry.[15] The movement was moving equally rapidly throughout Europe, with new centres like the Inventorium at La Villette in Paris, which had been the subject of heavy investment by the French government when it opened in 1986.[16] In the UK, by early 1989 there were twelve dedicated hands-on centres, including the nomadic Discovery Domes. Steve Pizzey, the Director of Science Projects (the operators of the Discovery Domes), widely advocated his dream of a science centre in every city in the UK.[17]

Children's museums

In 1987, the Association of Science and Technology Centers in the USA undertook a survey of its members and published the findings in a number of reports. Although the science centres were characterised by their diversity, a number of significant trends did emerge. One of these was that, whereas most new centres founded in the 1960s concentrated on life and natural science, by the 1970s physical sciences predominated, and by the 1980s children and youth museums had emerged as the most popular.[18] Indeed, children's museums are one of the fastest-growing sectors of the museums industry in the world.[19] However, the concept is not new, and many children's museum have a much longer history than science centres. Brooklyn Children's Museum dates back to 1899, and Boston Children's Museum opened soon after. Initially, these long-established children's museums developed traditional museum collections which were considered to be of interest to children. A hands-on approach was adopted after experiments at Boston Children's Museum by the Director, Michael Spock (son of the well-known paediatrician), proved successful in 1964. Spock threw out the glass cases, and reorganised the exhibition programme to create environments in which children could learn. Thus, Boston Children's Museum pioneered the philosophy that the museum exists primarily for people rather than things, and this has governed children's museums throughout the world ever since.[20]

Brooklyn Children's Museum followed suit, and whilst it had always followed a policy of enabling visitors to handle its collections, in 1977 the museum reopened in a dramatic new building.[21] Indianapolis Children's Museum has a similar history—it is not only the fourth-oldest and largest children's museum in the world, but it maintains over 140,000 artefacts in excellent storage conditions. At Indianapolis, it is claimed that a children's museum differs from a traditional museum in essentially four ways:

1 Education justifies every object, activity and event. There is a purpose behind each display, a story to tell with each exhibit, an idea to unfold in each gallery.
2 Bright, vivid colours and dramatic lighting effects are used to capture attention. Labels are written in easily understood, contemporary language.
3 Exhibits are placed carefully to afford even the youngest a good look, and materials are presented in identifiable sequence. Whenever possible, exhibits are 'hands-on' or participatory in nature.
4 No matter how sophisticated the exhibit, human contact remains the most important source of learning.[22]

Around eight children's museums existed in the 1970s, but the movement mushroomed rapidly, such that there were over 400 children's museums known to the Association of Youth Museums in the USA by the end of the 1980s, with over 350 in the USA alone. The phenomenal growth of children's museums in the USA in the 1970s and 1980s has been accounted for by the urge to try new forms of education after alternative experiments within traditional education had failed in the late 1960s. Many of the new museums were small-scale, naive in their goals and amateurish in their operation. However, the burgeoning of children's museums across the world reflects enthusiasm for an institution that seems to make sense to all cultures.

Whilst some children's museums (such as Brooklyn, Boston and Indianapolis) are firmly based on traditional museum collections and successfully integrate interactives and museum objects, other new children's museums (such as Denver) defy convention in the museum world and have no artefacts at all. Although this does lead to criticism and debate that a children's museum without a collection is not a museum at all, the American Association of Museums fully accepts children's museums, defining them for the purposes of accreditation as:

> An institution committed to serving the needs and interests of children by providing exhibits and programs that stimulate curiosity and motivate learning. Children's museums are organised and permanent non-profit institutions, essentially educational in purpose, with professional staff, which utilise objects, and are open to the public on some regular schedule.[23]

It is significant that in this definition the needs and interests of children are placed before those of the collections. The accepted definition of a museum in the UK, on the other hand, places the emphasis on objects rather than people: 'An institution which collects, documents, preserves, exhibits and interprets material evidence and associated information for the public benefit'. Children's museums are challenging and redefining the boundaries of the traditional museum world. They are client-centred, emphasising the

educational role of museums with contextual interactive exhibit strategies over the more traditional museum focus on preservation, research and glass-case presentations. Objects serve primarily as tools to motivate learning and address the developmental needs of children, and are therefore not necessarily collected for their intrinsic value.

Techniquest: a case study

Techniquest began with ambitious dreams but modest premises in 1986, but within a decade it had moved to its third site and grown organically to become the largest interactive science centre in the UK. Under the guidance of John Beetlestone, Professor of Science Education at the University of Wales in Cardiff, Techniquest was established as a company limited by guarantee with charitable status in July 1986. With an initial start-up grant of £83,000 from the Gatsby Foundation (a Sainsbury family trust), Techniquest opened in November 1986 in rent-free premises in the former British Gas Wales showrooms in central Cardiff, and received 45,000 visitors in six months.[24] These temporary premises provided a showroom not only to visitors, but also to potential sponsors and patrons. In 1987, the Gatsby Foundation approved a grant of £600,000 for Phase II of the development, and the new Cardiff Bay Development Corporation provided funds for a new basic industrial building on the waterfront at Cardiff Bay for five years. The first temporary exhibition had closed in August 1987, and the new Phase II Techniquest opened in September 1988. The total cost was around £1 million, providing eighty exhibits in 1000 square metres.[25]

As is shown in Figure 1.1, Phase II of Techniquest attracted around 100,000 visitors in its first year, compared to only 39,000 people in 1990 at the Welsh Industrial and Maritime Museum on the adjacent site. These statistics illustrate the public appeal of hands-on centres compared with even recent traditional object-based exhibitions.[26] Techniquest's success in an isolated and run-down part of Cardiff owes much to the philosophy of John Beetlestone and his management team. Beetlestone considers himself to be an impresario—a 'retailer of science'—who creates experiences that beguile visitors. His interest is in encouraging a broader consumption of science amongst a wider audience, following the tradition of the theatrical science presentations of the Royal Institution's Christmas lectures (it is interesting to note that the Science Theatre in Phase III is in fact based on the auditorium of the Royal Institution).[27] Techniquest strives to reach adults through children, encouraging them to behave 'like they do at the Christmas party after three whiskies'. This probably helps to explain the appeal of Techniquest—as Professor Beetlestone has observed, at theme parks all the noise comes from the exhibits rather than the visitors, whilst in discovery centres (the term he prefers to science centres) the noise is from the visitors rather than the exhibits.[28]

Techniquest adopts the Disney philosophy that its exhibition should look as though it had opened yesterday, and pays particular attention to overall ambience and visitor comfort. One of the reasons for Techniquest's success is that its exhibits are well-designed and sturdy, characterised by bright primary colours. Most of its exhibits are built in-house, with artists employed to design innovative exhibits, and product designers to turn these designs into reliable working exhibits. Establishing an effective discovery centre is capital-intensive, but keeping it looking good and fully operational demands significant revenue income. Beetlestone recognises that Techniquest is in both the

education and the entertainment industries, and whilst it earns more of its income from its trading activities than most traditional education establishments, if there was any money to be made from interactive science, Disney or the other commercial leisure operators would have done it many years ago.[29]

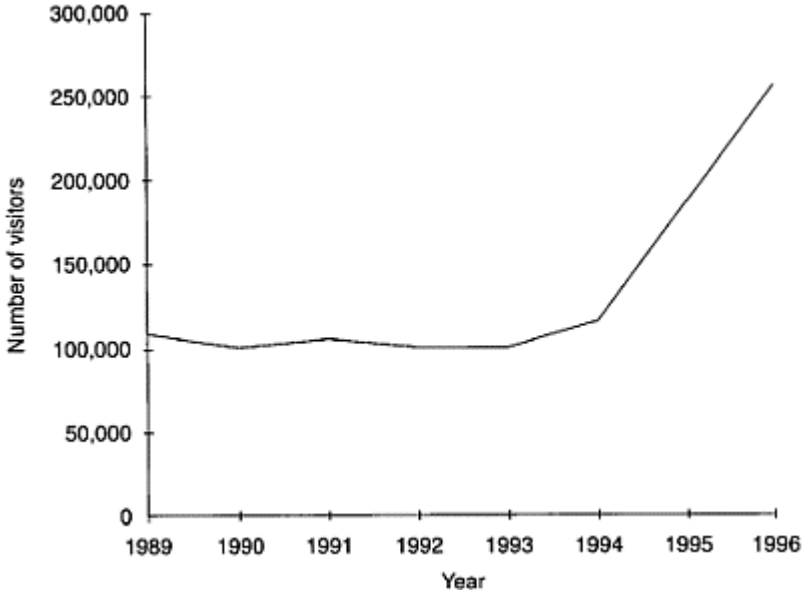

Figure 1.1 Visitors to Techniquest

Source: Techniquest
Notes: i) Phase III opened May 1995
ii) 1996 figure is estimate based on twelve months at end of September 1996

Phase II of Techniquest attracted over 700,000 visitors in seven years. In November 1991 the Cardiff Bay Development Corporation chose Techniquest as its lead project and work began on Phase III, which opened in May 1995. Funded by the Development Corporation, with contributions from the Welsh Office, European Regional Development Fund, the Welsh Development Agency and Wales Tourist Board, the most recent development cost £7 million and Techniquest now occupies a new building designed around the iron framework of a nineteenth-century engineering workshop. This has enabled Techniquest to double the number of exhibits to 160, and in addition there is a science theatre, a planetarium, a discovery room and a laboratory. Techniquest has chosen not to theme its exhibits, preferring visitors to create their own agenda for the visit, and has 'carefully thought-out randomness'. Continuing the well-established Techniquest philosophy, Phase III has a high level of visitor facilities, and its outreach and educational programmes are highly developed.[30] The new Techniquest received

236,000 visitors in its first year in the new premises, of whom around one-third visited in school groups.

In short, Techniquest represents an organisation that began with a strong vision which, combined with sound business planning (and with the backing of a small, but experienced and committed Council), has enabled it to grow progressively to become the largest purpose-built science discovery centre in Britain.

Supporting organisations

The development of children's museums and science centres in the USA, UK and Europe owes much to the work of many organisations which have worked to campaign for hands-on learning or which have provided charitable assistance to organisations in their infancy. In the USA, the Association of Youth Museums has acted as a professional organisation on behalf of children's and youth museums, whilst the Association of Science and Technology Centers (ASTC) was founded in 1973 as a non-profit organisation of museums dedicated to furthering public understanding of science and technology. ASTC provided an invaluable source of information and contacts for European interactive exhibitions, and in 1988 the decision was taken to establish an equivalent collaborative organisation in Europe. Thus, ECSITE—the European Collaborative for Science, Industry and Technology Exhibitions—was formed, with founding members representing seven European countries. The purposes of ECSITE are:

> The advancement of public understanding of science, industry and technology, and in particular…the advancement of the collaborative effectiveness of not-for-profit organisations…concerning interactive centres, museums and exhibitions.[31]

ECSITE has provided a unique network for sharing information and experience on the production, exchange and maintenance of exhibitions, and as such its role has been invaluable in helping to promote the growth of hands-on museums and science centres. Partly funded by the European Community, ECSITE was launched by and based initially at the Nuffield Foundation, a major British charitable trust with a long tradition of supporting science education in schools. Looking to support innovative experiments which could act as a role model to others, the Nuffield Foundation had largely funded the development of the first phase of the Bristol Exploratory in 1986, supported the travelling Discovery Domes in 1988 and other similar projects like LightWorks (small-scale interactives that visit schools) and Techniquest's kits for schools. Meanwhile, the Fund for the Development of Interactive Technology Centres was established by a Sainsbury family trust to initiate centres in the UK and was managed by Steve Pizzey prior to the development of the Discovery Domes.[32]

In 1987, the Nuffield Foundation—in collaboration with the UK government's Department of Trade and Industry—established the Interactive Science and Technology Project to encourage the development of science centres and to provide a focus for the sharing of ideas and expertise. Chaired by Professor Richard Gregory of the Bristol Exploratory, the Project provided a useful forum for the development of the first science centres in the UK, until it was wound up in 1990.[33] Indeed, its first newsletters were sent

to fewer than fifty people, but by December 1989 the circulation had grown to over 400.[34]

The work of the Nuffield Foundation, the Interactive Science and Technology Project and ECSITE was complemented by COPUS, which is the joint Committee on the Public Understanding of Science of the Royal Society, the Royal Institution and the British Association for the Advancement of Science. Founded in 1986, it provides a focus in the UK to improve public awareness of science and technology. COPUS supports a wide-ranging programme, including awarding small grants to science centres, and in conjunction with the Nuffield Foundation it published an important collection of reports and articles about the first phase of the development of hands-on education in the UK.[35]

The influence of these enabling organisations should not be underestimated. Indeed, at the end of the 1980s as the Interactive Science and Technology Project (ISTP) was being wound up, its Director (and ECSITE Executive Secretary) Melanie Quin wrote with remarkable insight:

> I share Steve Pizzey's dream that, just as today most cities have a library, art gallery, theatre and sports centre, one day—maybe—every city will have an interactive science-technology centre. I do, however, predict that 'hands-on':- will spread beyond science and technology: as a medium of communication it has vast potential—participation would add a new dimension to visitors' appreciation of historic objects, art pieces, etc.—and that it will confidently span the spectrum from value-added leisure activities to enriched classroom teaching.[36]

The current market for hands-on exhibitions

The number of hands-on museums and science centres in the UK has shown a steady increase since 1986, as can be seen in Figure 1.2, at a rate of 3.5 new centres opening every year between 1986 and 1995. Some have achieved remarkable success: for example, Eureka! The Museum for Children received one million visitors in little more than two years from opening in 1992. The inevitable outcome of the success of the early dedicated hands-on centres is that traditional museums are increasingly incorporating interactive techniques into existing displays. Indeed, twenty-five out of eighty-five museums in Yorkshire and Humberside with collections relating to science, design and technology claimed to have interactive exhibits in 1994.[38]

It is no longer a straightforward task to list all the hands-on galleries in the UK, mainly because there are so many new exhibitions which have opened since 1995 which incorporate an element of interactivity in a mixed media gallery. The National Lottery in the UK has served to fuel the number of new developments, particularly with new interactive exhibitions planned to celebrate the Millennium, It can be stated with confidence that the rate of new hands-on exhibitions opening has increased dramatically since 1995, and that the hands-on concept has spread far beyond museums of science and technology to embrace history, archaeology, sport, art and popular music. Furthermore, non-museum sites, such as heritage or countryside interpretation centres, are also introducing hands-on exhibits into their displays.

On the demand side, interactive centres are popular with visitors: a recent report analysing the market potential for museums in the UK identified the ability

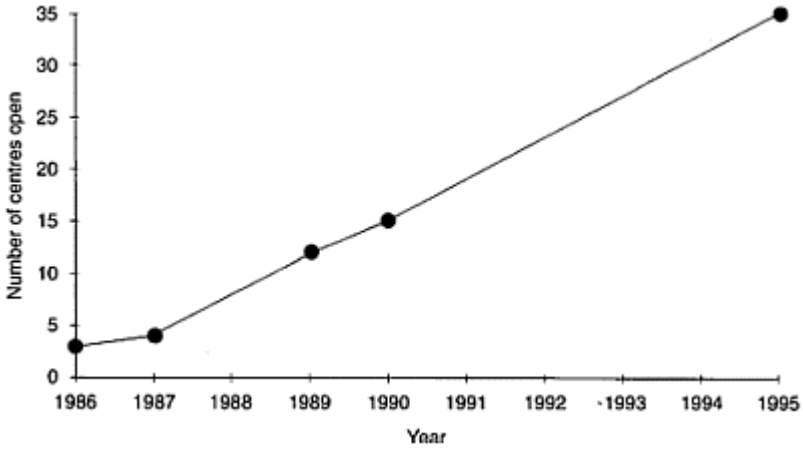

Figure 1.2 The growth of hands-on museums and science centres in the UK

Sources: BIG[37] and author's extrapolations

to interact with exhibits and associated activities for children as two of the key factors encouraging people to visit museums.[39] One-third of museum visits are made by children, and children in family (not school) groups represent the most significant market segment.[40] With the post-war 'baby-boom' population now producing a 'baby-boom echo' of its own, family attractions catering for these growing segments of population can continue to look forward to a growing target audience until the end of the century.[41]

In recent years, hands-on museums and science centres have enjoyed remarkable success as major visitor attractions throughout the world. In 1986, 130 museums responding to the ASTC survey reported attendance exceeding 50 million, and the overwhelming majority of these operated with a surplus of revenue over expenditure.[42] One estimate claims that science centres now attract an annual worldwide audience of 100 million.[43]

In the UK, visitors to all museums have increased by 24 per cent over the last twenty years, and by 9 per cent between 1989 and 1995.[44] The latest estimate, based on a range of sources, suggests that around 100 million people visit UK museums each year (coincidentally, the same number that visit science centres worldwide).[45] However, there are an estimated 2,500 museums in the UK, and the rate of growth in supply has outstripped the increase in demand.[46] Indeed, since the advent of the National Lottery, the rate of increase in the growth of attractions has accelerated, whilst there is evidence that the demand has fallen marginally since 1992.[47] There are too many museums chasing too few visitors in the UK, with museums competing in a very overcrowded leisure market

alongside commercial attractions such as theme parks, family entertainment centres and out of town retailing (particularly on Sundays, traditionally a popular day for visiting museums). In 1997, several UK museums are experiencing financial difficulties, and there have been some well-publicised museum closures or disappointing results, by both traditional museums and some newer attractions. Hands-on museums appealing to families ought to be in a strong position to compete in this overcrowded marketplace, but how are the hands-on museums performing?

It is very difficult to estimate the overall size of the UK market for hands-on museums and science centres for many reasons, not least of which is the problem of defining what is or is not a hands-on exhibition. However, if the thirtyfive interactive centres identified by the British Interactive Group in 1995 are analysed, it is possible to estimate market demand.[48] Visitor figures for tourist attractions in the UK are published by the English Tourist Board annually in *Sightseeing in the UK*.[49] This is not quite as useful as it might at first appear. First, only those organisations with over 30,000 visitors per annum appear in the data, and second, the visitor figures for interactive centres within larger organisations (for example, Launch Pad within the Science Museum, or Xperiment within the Greater Manchester Museum of Science and Industry) are not detailed separately. Third, visitor figures at non-paying attractions are, at best, 'guesstimates'.

Using this data source, thirteen stand-alone interactive discovery centres (on the BIG list of thirty-five) attracted an annual attendance of approximately 1.65 million in 1995.[50] A further five museums containing interactive centres received a combined visitor attendance of 4.15 million.[51] Clearly, not all visitors to these museums use the hands-on exhibitions, although the Science Museum claims that 500,000 (or 28 per cent of 1.44m) visit Launch Pad.[52] If one estimates the attendance at the other four interactive centres within larger museums to be a modest 10 per cent of the total, then these centres attract a further 270,000 visitors. Thus, one can estimate that in 1995 a minimum of 2.42 million people visited eighteen of the thirty-five interactive centres identified by the British Interactive Group. As this figure includes all the major hands-on museums and science centres (eleven of which attracted over 100,000 visitors in 1995), the overall market for the thirty-five interactive centres is likely to be between 3 million and 4 million per annum (this figure is 3–4 per cent of the world market for interactive centres, and 3–4 per cent of the UK museum visiting market—although visitors to many UK science centres would not be included in the UK museum visiting market, since they are not museums).

Although the figure of 3 million to 4 million visitors per annum to hands-on museums and science centres is an estimate based on available data, it seems likely that the size of the market is increasing as new hands-on attractions open and traditional museums adopt a hands-on approach (unless the success of new hands-on centres is at the expense of the existing hands-on centres, rather than creating new demand or taking visitors away from traditional museums). There is some evidence that some recently opened science centres in the USA have not 'fulfilled their visitor targets, and figures are plateauing in existing centres (indeed, a 10 per cent overall decline was reported in 1993/4).[53] Thus, there is a need to investigate the success of individual hands-on museums and science centres over a period of time, and to plot their product life-cycles.

The product life-cycle of a hands-on exhibition

The concept of the product life-cycle is useful in helping to determine the relative success of hands-on museums. The concept suggests that all products have a finite life, going through periods of growth and maturity before reaching peak sales as the market is saturated, after which sales decline. Clearly, different types of products have different life-cycles: for example, the life-cycle of skateboard parks was very short, whilst the life-cycle of a traditional museum with the responsibility of care for collections or buildings for future generations will have an expectancy of a very long life-cycle. New museums are operating in a highly competitive leisure market where product lifespans are typically short.

There are two possible scenarios when a new visitor attraction opens: either it opens in phases building up to a stable operation (as in the case of Techniquest), or it opens as a fully fledged attraction. In the latter scenario, convention within the leisure industry suggests that visitor numbers to large urban visitor attractions tend to reach their peak in the early years after opening, with visitor numbers stabilising in the fourth year after peaking in the second or third year. Thereafter, if there is no renewal or reinvestment in the attraction, numbers can decline sharply.

Using the *Sightseeing in the UK* series, it is possible to plot the product life-cycle of those hands-on museums and science centres which have existed for a period of five years or more. When these are added together, one can produce a typical life-cycle curve for a hands-on centre over a period of time. In fact, hands-on centres appear to follow the leisure industry convention, as can be seen in Figure 1.3.

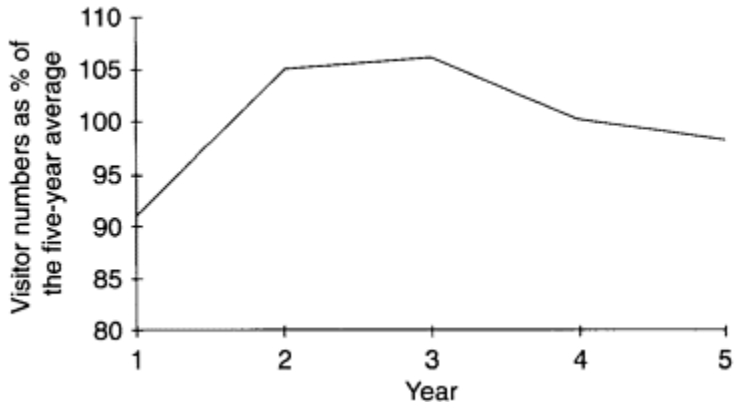

Figure 1.3 Typical product life-cycle of a new hands-on attraction

Source: derived from *Sightseeing in the UK* series[54]

Note: this graph is based on a sample of seven hands-on centres[55]

Based on the evidence of this sample of seven hands-on centres which had opened as fully fledged attractions and which had no major new investment within five years of opening, one can deduce that the product life-cycle of a new hands-on attraction does indeed follow the convention of the leisure industry: that is, that the cycle is short, with peak visitor numbers being achieved in the second or third year after opening (when their profile is often very high in the media), and with the average over five years being reached in the fourth year, when the attraction can be considered as having reached stability. Without substantial reinvestment, visitor numbers may enter a steady decline thereafter. Thus, many hands-on museums and science centres aim to replace their exhibits within a three- or five-year cycle, thereby continually reinvesting in a new product. For example, within four years of opening in 1992, Eureka! The Museum for Children replaced its Recycling exhibition with a duplicate of the Science Museum's exhibition Things.

The product life-cycles of individual hands-on centres

Green's Mill

As one of the first hands-on science centres in the UK, Green's Mill and Science Centre in Nottingham provides an interesting long-term case-study, as shown in Figure 1.4.

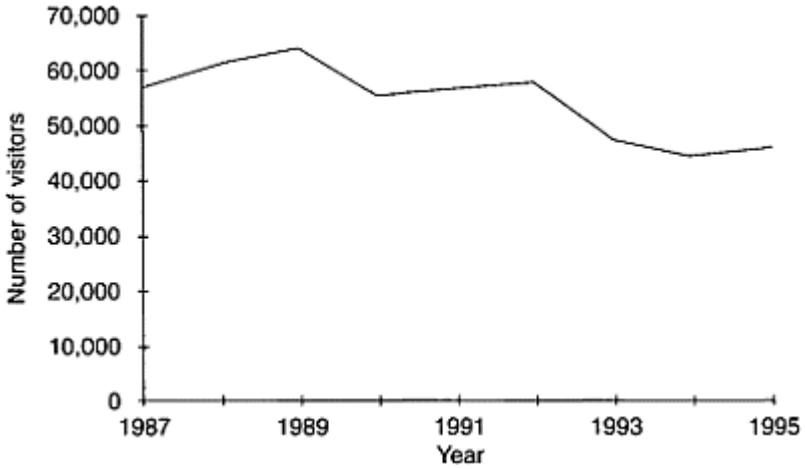

Figure 1.4 Visitors to Green's Mill, Nottingham

Source: derived from *Sightseeing in the UK* series

Notes: i) Visitor numbers are estimates since the site is free

ii) The science centre is attached to a separate heritage attraction, a windmill

Green's Mill reached its peak in its third year after opening, when it was a still a highly innovative attraction as one of the first science centres in the UK. Like the typical centre illustrated in Figure 1.3, Green's Mill stabilised its visitor numbers in its fourth year after opening, when the number of visitors (54,973) approximately equalled the average number 53,928 over the nine-year series. In the face of increasing competition from other museums and family visitor attractions, Green's Mill and Science Centre is no longer such an innovative attraction and has entered the decline stage of its product life-cycle (although it has had minor increases in 1991–2 and 1995, the long-term trend is downwards). Buxton Micrarium exhibited a similar pattern. With 35,000 visitors per annum from 1987–9, numbers declined to 32,675 in 1990 and 33,612 in 1991. Thereafter, data is not published in *Sightseeing in the UK*, as the Micrarium entered a decline phase of its life-cycle and visitor figures dropped below 30,000. Significantly, the Micrarium has closed down in Buxton, and in winter 1995 it was announced that it was considering integration within Eureka! The Museum for Children.[56]

The Archaeological Resource Centre, York

In Figure 1.5 the Archaeological Resource Centre (ARC) portrays a classic product life-cycle curve. If figures for the first year of operation are excluded (the ARC was not open for a full year in 1990), the ARC has received an average of 58,112 visitors per annum—as in Figures 1.3 and 1.4, almost the same as the number in the fourth full year of opening (58,420 in 1994).

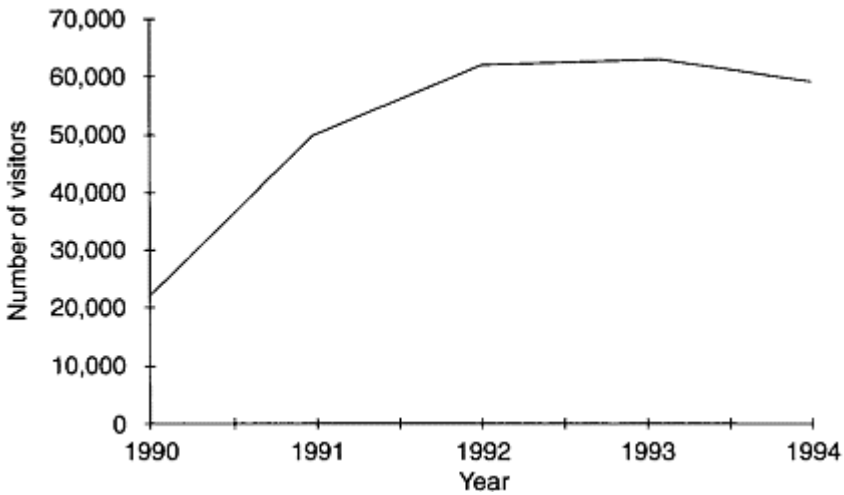

Figure 1.5 Visitors to the Archaeological Resource Centre, York

Source: derived from *Sightseeing in the UK* series

The Exploratory, Bristol

Two centres provide examples of attractions that have developed in phases: the Exploratory at Bristol and Techniquest in Cardiff (see Figure 1.1). Having opened in 1987, the Exploratory moved premises in 1990, which helped it to double its visitor figures. Like Techniquest before it, the Exploratory is planning its second move. As the recipient of a £41 million Millennium Commission award, Bristol 2000 is planning to relocate the Exploratory within Science World, a new £25 million hands-on science centre, by 2000.

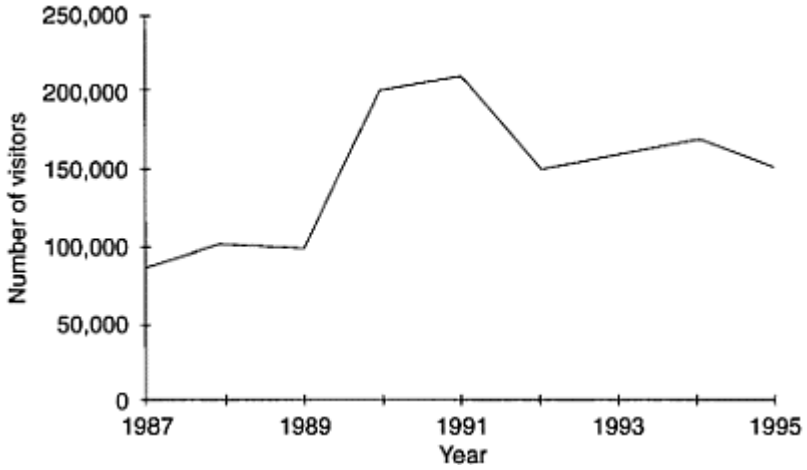

Figure 1.6 Visitors to the Exploratory, Bristol

Source: derived from *Sightseeing in the UK* series

The curve in Figure 1.6 clearly indicates the second phase of development from 1990, when visitor figures doubled, declining in the third year after moving in 1992. The average number of visitors in the six years from 1990 is 173,089 (168,000 were received in the 1994, the fourth year after the move), but it is clear that visitor figures at the Exploratory have not yet stabilised, and may not do so for many years, as Science World is one of the Millennium Commission's Landmark projects.

Conclusions

The growth in the number of hands-on museums and science centres in the UK, USA and Europe has been quite spectacular in recent years, based on a long tradition of innovative communication in science and children's museums, notably in the USA. The demand for high-quality visitor attractions which combine education and entertainment has been

manifest throughout the Western world, and Figure 1.2 suggests that in the UK the supply of hands-on attractions is still in its growth phase.

However, the overall museum visitor market in the UK is saturated, with hands-on museums and science centres competing for visitors with 2,500 other museums and a whole range of commercial leisure attractions. The success of the not-for-profit children's museum sector in the USA and elsewhere has not been missed by commercial operators, with children's adventure play attractions like Discovery Zone and Planet Fun developing rapidly throughout both the USA and UK.[57]

Product life-cycle analysis suggests that new hands-on museums and science centres find it difficult to maintain high visitor levels after the fourth year of opening, particularly if they do not reinvest in the core product. To date, it is the smaller centres which are having the most difficulty in maintaining visitor numbers, in comparison to larger centres such as Techniquest or the Exploratory which are on long-term growth paths. Overall, the number of visitors lost to those centres which have declining visitor numbers is far outweighed by the increase in numbers to all the new attractions. A comparison of the performance of five hands-on centres for which data is available between 1989 and 1995, suggests that they had a 49 per cent increase in visitors over this period. A comparison of the performance of nine centres for which data is available between 1992 and 1995, suggests that they had a 28 per cent increase in visitors over this period.[58]

Thus, the overall trend for hands-on museums and science centres is favourable, with the total number of people visiting hands-on museums in the UK increasing as new attractions open. However, older centres can expect to lose visitors to competitors if they do not reinvest in new exhibitions. Individual hands-on museums and science centres need to define their objectives and target audience carefully, adopting high standards of management practice, to ensure that the centre matures, develops and survives in this highly competitive market.

2
The educational context

This chapter investigates the learning theory underpinning interactive exhibitions, and questions whether it really is possible for visitors to learn and be entertained simultaneously.

Introduction

The underpinning philosophy of interactive exhibitions is that visitors find hands-on exhibits more absorbing and enjoyable than static exhibits in traditional museums, and this is demonstrated both by the number of people visiting hands-on centres and by their responses when they are there. If the success of interactive museums and science centres was measured by the entertainment and enjoyment of their visiting public, then few would doubt that they are meeting their objectives. However, it is not quite as simple as that, since museums and science centres also have educational goals. Few would disagree with Richard Gregory's view that 'the recent popularity of science centres shows clearly that a significant proportion of the British public, of all ages, finds direct exploration of science entertaining and interesting'. However, Gregory is concerned that 'although hands-on experience is effective, indeed essential, for learning to see objects, hands-on experience can hardly be adequate for aiming at scientific understanding'.[1]

The popularisation of science in science centres has been welcomed by those attempting to counter the public's alienation from science, but the issue of whether visitors learn only superficial scientific principles and practices, or indeed if the science centres actually promote scientific misconceptions, has caused debate for many years.[2] The question has frequently been posed: 'Are they really learning or are they merely playing?' Gregory and others are concerned that science centres may trivialise science and give the impression that scientific enquiry leads to instant solutions, when the reality is that it is often slow, tedious and unspectacular. Supporters of the interactive movement argue that if visitors are enjoying themselves, it is more likely that they will be learning at the same time. At the very least, it is argued, visitors will take away an enthusiasm for scientific enquiry.[3] Thus, the question has frequently been reversed: 'Are they really playing, or are they merely learning?'

This chapter investigates both the learning theory behind the assumption that people learn more if they are enjoying themselves, and the evidence from published research of how much visitors actually learn in practice in hands-on exhibitions. Do visitors leave having gained any changes in understanding or knowledge (cognitive learning), or is the role of these exhibitions primarily to change attitudes (affective learning)? Is an interactive exhibit just as likely to communicate an incorrect message effectively as well as the intended message? Is there any difference between learning in an interactive

science centre and an interactive museum? What factors are most likely to encourage a positive learning experience within the centre—or, to use Richard Gregory's words, to turn hands-on into minds-on? To answer these questions, it is helpful to investigate separately how individuals behave or learn in museums (the personal context), how groups behave and learn (the social context) and how design affects the learning environment (the physical context).[4]

The personal context to museum learning

The theory

Much of the educational philosophy upon which interactive exhibitions are based originates from the work of Jean Piaget and other developmental psychologists such as Froebel and Vygotsky. Piaget argued that learning occurs as a result of direct interaction with the environment, and he traced children's development into continuous and consecutive phases from birth to maturity. His research suggested that, in the early years, children predominantly explore their own motor and sensory skills; from age 2 to 4 they begin to explore their place in the world around them, and from 4 to 7 they become less egocentric as they begin to have more contact with others. From 7 children begin to understand the workings of the world, and by adolescence they are beginning to understand logical and abstract principles.[5]

Piaget's approach has had considerable implications for education. By recognising that a child thinks differently from an adult and views the world from a different perspective, it follows that what is appropriate for adult learning is not necessarily applicable to children. According to Piaget, children learn from actions rather than passive observations, and so construct knowledge and understanding for themselves. The role of the teacher is to create environments where learning might take place most effectively, rather than to impart their own knowledge. The objective is to encourage children to ask questions rather than to accept information unthinkingly. Children set the pace at which they learn, and the teacher is the guide in the process of discovery.[6]

Piaget began his research in the 1920s when scientific psychology was in its infancy, but it was not until the 1950s and 1960s when his ideas became popularised. In primary school classrooms, teachers abandoned formal rows of desks and class teaching in favour of experimentation and learning in small groups, with the teacher taking on the role of mediator, supporting and consolidating children's learning. Museums, meanwhile, began reassessing their educational provision. In both the UK and USA, museums had long recognised the value of allowing objects from their collections to be handled in their education or school loans services, and the early children's museums in the United States at Boston, Brooklyn and Indianapolis were founded on collections which were considered suitable for children to explore and handle. However, it was not until Michael Spock was appointed Director of Boston Children's Museum in 1964, that the process began of taking museum objects out of glass cases and providing environments for children to explore. As Chapter 1 illustrated, Boston's experiments were taken up at Brooklyn Children's Museum and in the first truly interactive science centre, Frank Oppenheimer's Exploratorium in San Francisco.

The disadvantage of classroom learning is that it is constrained by the rigidity of the curriculum, by time and by a lack of resources—all of which prevent children from fully exploring their environment. The interactive exhibition, on the other hand, is rich in artefacts and exhibits with which to explore and experiment, whilst visitors can follow their own interests, unconfined by the clock or the bell, for as long as their concentration lasts. Thus, the informal learning environments provided by the hands-on museums provide spatial- rather than time-frames. Learning in interactive exhibitions—especially children's museums—is often placed within a context which is familiar to visitors, enabling them to investigate the commonplacc in a new way. Alternatively, exhibitions often provide dramatic environments designed to stimulate emotions or to challenge visitors' existing conceptions and misconceptions.[7]

By the 1970s Piaget's ideas were becoming discredited in many circles, mainly because of methodological problems exposed in his research and because the ages at which children could perform tasks were shown to be inconsistent with Piaget's predictions. In particular, different abilities emerge at different ages in different children, and the transitions are usually subtle rather than abrupt. Despite these criticisms, Piaget is important because he recognised that children have different needs at different ages, and that we learn by continuous problem-solving interaction with the environment. The essential notion that children develop in stages and as a direct result of interaction with their environment remains valid.

Piaget's developmental theory of learning has contributed to the spread of the hands-on movement, with interactive exhibitions providing a framework that meets the three areas of learning identified in Bloom's 'taxonomy of learning': that is, they encourage cognitive learning (knowledge and understanding), affective learning (attitudes, interests and motivation) and psycho-motor development (physical skills of manipulation and co-ordination).[8]

Other learning theory also suggests individuals have different learning styles, such as, for example, McCarthy's 4MAT system, which describes four different types of learner. These are: the imaginative learner, who learns by listening and sharing ideas; the analytic learner, who learns by thinking through ideas sequentially; the common sense learner, who learns by testing theories; and the experimental/dynamic learner, who learns by trial and error.[9] Kolb[10] and Gregorc[11] have produced similar frameworks to describe different learning styles. The fundamental point is that not all learning styles are catered for in a formal learning environment. It follows, therefore, that the informal learning environment of interactive exhibitions may provide the opportunity for individuals with different learning styles to learn effectively.

One eminent psychologist who recognises the importance of interactive exhibitions is Howard Gardner. Gardner likens children's museums to 'play-grounds for the mind'—places where children can find things that interest them, explore them on their own and at their own pace, and create their own understanding.[12] Gardner proposes that that the brain supports at least seven different abilities or intelligences, and that these develop at different rates and to different extents in different individuals.

Gardner's seven areas of intelligence are:

1 Linguistic intelligence: the ability to use language to excite, please, convince, stimulate or convey information.

2 Logical-mathematical intelligence: the ability to explore patterns, categories and relationships, and to experiment in a controlled, orderly way.
3 Musical intelligence: the ability to enjoy, perform or compose a musical piece.
4 Spatial intelligence: the ability to perceive and mentally manipulate a form or object, to create composition and balance in a visual or spatial display.
5 Bodily-kinaesthetic intelligence: the ability to use motor skills in sport, the arts or craft.
6 Interpersonal intelligence: the ability to understand, communicate and socialise with others.
7 Intrapersonal intelligence: the ability to understand one's own ideas and feelings, to work independently and show initiative.[13]

Gardner's view is that different intelligences dominate in different individuals, and that these may not develop to their full potential in a formal school environment constrained by time, resources and the curriculum. Thus, it is argued, interactive museums are important learning environments because the rich variety of interpretative techniques can stimulate a multiplicity of intelligences.[14]

In total, the research of the developmental psychologists has encouraged the growth of the hands-on movement. Piaget and others demonstrated that we learn by role-play with our environment, and that children learn differently from adults, and indeed, from children of different ages. Gardner, McCarthy and others have demonstrated that we learn in a variety of different styles, and Gardner argues that the formal school environment may not stimulate all areas of learning to their full potential. Interactive exhibitions can provide a rich resource and multiplicity of environments for visitors of different ages and abilities to explore. That is the theory—but what actually happens in practice?

The reality

Several authors have commented that whilst many evaluation studies designed to improve interpretation within particular interactive exhibitions have been published, there has been very little systematic research about visitor learning in controlled environments.[15] The former tend to be pragmatic studies primarily concerned with improving individual museum environments, whilst the latter are concerned with more general issues of how and why people learn.[16] Evaluation studies can be classified as applied research: they typically identify who visits museums and their reasons for visiting, investigate the effectiveness of design features (such as the location of exhibits or the readability of graphics), observe visitor behaviour and interactions, or assess the factors that influence the outcome of a visit (such as the prior knowledge of the visitor). This applied research has immediate practical benefits to the commissioning museum, but basic pure research into human cognition and learning behaviour within science centres and children's museums is less common.[17]

The Science Museum in London provides a good example of an institution that has carried out extensive evaluative research into the development and operation of its two stand-alone interactive galleries, Launch Pad and Flight Lab, and more recently its extensive new education galleries aimed at a range of age groups from pre-school to adolescent. The Science Museum is also embarking on a programme of pure research into learning in science museums, building on work previously carried out on visitors to Launch Pad by Stephenson. Stephenson employed a range of research techniques: he

tracked individual members of family groups in Launch Pad and observed their behaviour, questioned all group members immediately after the visit, sent each member of the group a written questionnaire several weeks later, and interviewed each member of the group six months later.[18] He concluded that children do not spend their time rushing around aimlessly, and that 81 per cent of time is spent interacting with other family group members or with other visitors. After the visit everyone was able to talk freely about the exhibits, and several months after the visit people were able to recall not only what they did with the exhibits, but also their feelings about them. However, most of this thinking was concerned with effects rather than understanding or explanations. Significantly, visitors with little or no scientific training stated that they did not find Launch Pad threatening and nor were they embarrassed by their lack of scientific knowledge. Children in particular were inspired and motivated by the exhibits and viewed the visit as an enjoyable educational experience, not just a giant fun-fair. In total, Stephenson's research shows that people's memories of interactive exhibits and their feelings towards them are long-term. However, it tells us little about changes in attitude or understanding brought about by the visit, although many visitors claimed that they subsequently had more positive attitudes to science. Stephenson was able to demonstrate, therefore, that Launch Pad influenced visitors' learning in the affective domain over a long period, but cognitive changes were unproven.

Stephenson has argued that only systematic and informed debate will help museums understand the effects of interactives and the public understanding of science. For example, are hands-on exhibits more effective if placed next to traditional displays and artefacts, or are they more effective in isolation within an interactive gallery with trained interpretative staff? Stephenson was formerly Head of Education at the Science Museum. His successor, Roland Jackson, argues that research is urgently needed to build upon his predecessor's findings: as well as having great fun and remembering the experience, are people actually learning anything? In particular, what are they learning and how are they learning it? It is relatively simple to measure visitors' behaviour, but at present there is little evidence to link behavioural changes to long-term changes in thinking and attitudes.[19]

Other pure research has also raised more questions than it answers. Feher's research on interactive museum exhibits as tools for learning in the USA suggested that the science learning process via the exhibit is an experiential, exploratory and explanatory process. At first, the process is participatory, then visitors give meaning to the experience through their own interpretations and explanations, and these are validated or confronted as visitors use related exhibits. Museum environments have great potential for challenging visitors' misconceptions, to produce the breakthrough in understanding that opens people to new understanding.[20] However, Feher's research identifies many areas of uncertainty which require further systematic investigation: for example, why do people hold on to a previously-held misconception, even when the evidence in front of them contradicts it?[21]

In total, the evidence suggests that visitors to interactive exhibitions thoroughly enjoy the experience, that the visit may change their attitudes to science or other subject areas, and that they can remember the experience for a long period after the visit. However, the evidence that they have actually learned anything, or indeed have not actually had previously held misconceptions reinforced, remains unproven. The educational

arguments in favour of interactive exhibitions may be compelling, but the evidence to date is patchy and largely anecdotal. Interactive exhibitions remain a largely untapped laboratory for systematic research to investigate how people learn in an informal environment.

The social context to museum learning

Although Stephenson's research looked at individuals within a family visit, much of the preceding theory and practice relates to the personal context of learning within an interactive museum environment. The reality, of course, is that most visitors to museums do not visit alone, and even when they do they will enter into a dialogue with members of staff either directly, or indirectly through the language of the exhibit labels. Vygotsky added a social dimension to learning theory with the recognition that much learning is culturally mediated, by a shared language and by contact with parents, family, friends and the media.[22] Children develop intellectually through direct and mediated experiences, and Vygotsky demonstrated that the development of more sophisticated thinking depends on children grasping more and more concepts—the more concepts they understand, the more likely they are to use their full intelligence.[23]

Adults play an important role as mediators. The role of enabling and interpretation staff in the learning process is considered in more detail in Chapter 7, but this section considers learning in the social context of a family visit. Families looking for experiences that are both educational and entertaining clearly make up the largest single market segment within hands-on exhibitions. In the United States, census statistics in 1984 and 1991 suggest that museum visiting was rapidly becoming the single most popular out of home activity.[24] If success is measured in terms of numbers, then interactive discovery centres are meeting the needs of families. However, numbers alone do not tell the whole picture of the quality and nature of family visits, of how family members interact with each other or how they learn. Systematic widespread research using consistent techniques across a broad range of museums and interactive centres has not been undertaken, although attempts have been made to build up a holistic picture of family learning and behaviour in museums from an increasing range of small-scale evaluative studies.[25] More recently, Minda Borun of the Franklin Institute has been researching family behaviour at four science centres and is developing ways to define family learning at exhibits through a series of performance indicators.[26] This section provides a summary of the evidence from museums in Europe and North America, most of which have a significant interactive element.

Wood stresses the importance of the family visit to the long-term future of museums by emphasising that future leisure choices are more closely linked to leisure experiences begun as a child in a family visit than in an educational visit. A study in the USA showed that 60 per cent of regular museum visitors said their interest in museums had been shaped by childhood family visits, compared to only 3 per cent in school visits.[27] Family visits are different from other types of museum visit, and although each family arrives at the museum with its own agenda, the evidence from visitor research in Europe and North America suggests that the family unit functions in a remarkably consistent way in the museum environment.[28] Families arrive with a dual educational and entertainment

agenda, but it is also increasingly apparent that one of the main sources of pleasure is to be found not in the exhibits themselves, but in the opportunity to function as an intimate social unit in a public place. Competition for leisure time and disposable income has resulted in family groups valuing the time spent together, and with outings increasingly serving to strengthen family ties. Family museum visits are rarely planned more than a day in advance, and are popular because museums provide a safe and non-threatening environment for family explorations. Several authors have commented on the ritualistic and cementing nature of museum visits.[29]

> One can see how a parent's perceptions of a museum as a mediated area for first-hand experience, offering real objects and repeatable phenomena from which to gain that experience, could prompt a museum visit for the whole family. If, in addition, personal interests can be harnessed…then a museum visit can start to look like a successful outing even before it has begun.[30]

Research has focused on family behaviour (for example, group interactions, time allocation and family agenda issues) and the nature of family learning. It shows that families behave in consistent ways in different museums, and that they behave differently from other groups of museum visitors.[31] Many of the early studies concentrated on descriptions of activities at particular exhibits, whilst later studies more systematically investigated the behaviour of family groups during the entire visit to an exhibition. For example, Diamond studied the teaching behaviour of families in science centres, and found that the average visit lasted just over two hours, interacting with sixty-two exhibits. Families did not read labels before interacting with the exhibits, only reading the instructions if they were unsuccessful and if their attention was held. Children were more likely than adults to manipulate exhibits, whilst parents were more likely to read labels and study graphics than children. Between 80 and 90 per cent of the visit was spent at exhibits, with the remainder spent at the café, shop, toilets or waiting for other members of the group.[32]

A recent study at the small interactive Discovery Centre at Cleethorpes, England (interpreting the river estuary which it overlooks), found that the average time spent at each exhibit was just forty-four seconds, and the average time spent in the centre was twenty-one minutes (ranging from five to fifty minutes). In a gallery of only twenty-nine interactive exhibits, this raises serious questions about the quality of learning that can take place with exhibits which have such short holding power, although the visitors' comments were overwhelmingly positive about the exhibition in terms of its enjoyment and educational value. The research identified that visitors became more selective as they progressed through the exhibition, stopping for longer periods at fewer exhibits.[33]

Clearly, the length of time spent within a museum or science centre will depend largely on the size of the exhibitions, and one would not expect visitors to spend two hours in a very small discovery centre. Falk's studies of family time allocation at two natural history museums suggests that visits to those museums can be divided into four phases:

1 An orientation or familiarisation phase, lasting three to ten minutes.

2 An intense viewing phase, lasting twenty-five to thirty minutes, during which visitors interact with exhibits in a concentrated manner.
3 An exhibit cruising phase, lasting thirty to forty minutes, when visitors scan exhibits.
4 A preparation for departure phase, lasting five to ten minutes, when visitors go to the shop, cloakrooms and toilets.[34]

McManus likens the behaviour of a family during a museum visit to that of a 'co-ordinated hunter-gatherer team actively foraging in the museum to satisfy their curiosity about topics and objects that interest them, and to satisfy their curiosity about topics and objects which museum professionals collect and study'. McManus suggests that whilst parents are likely to select the exhibition to be explored, subsequent exploration and information-gathering is shared out between the family members. The family purposefully moves in a loose formation to explore the selected area, with children typically leading in this exploratory behaviour. As individual members encounter interesting items they report back to the family group, with parents commenting on and interpreting the information introduced by children. Children, on the other hand, are much less likely to comment on information introduced by their parents. If the family is relaxed and works harmoniously as a unit, the exploration is most likely to be successful.[35]

McManus's anthropological analysis of family behaviour is based on a broad pattern of research conducted by herself and others, and most commentators agree there is remarkable consistency in different types of museum in Europe and North America. One area where there is inconsistency, however, is in the interpretation of gender-specific behaviour. Falk and Dierking conclude that there is evidence to suggest mothers are less likely than other group members to choose the exhibits to view, and that their interactions with sons are on a higher level than with daughters.[36] McManus, however, finds the evidence inconclusive, pointing out that there is a lack of research where mothers, fathers, sons and daughters are all present at the same time, and where variations in the age of children are taken into account.[37]

In total, one can draw a number of conclusions from the evidence:

1 Family visits to museums are informal, unstructured occasions, rarely planned more than a day in advance, which provide a pleasant opportunity for members to strengthen family ties.
2 Families come with their own agendas, but these are likely to include learning in an informal environment (i.e., combining entertainment and education).
3 Families behave remarkably consistently in different types of museum, in both North America and Europe.
4 Families behave like window-shoppers, browsing until they see something that attracts them.
5 Parents are most likely to choose the area to explore, but children are more likely to select individual exhibits.
6 Most families do not read labels before interacting with hands-on exhibits.
7 Children are more likely to interact than adults, and adults are more likely to read labels.
8 Family behaviour and learning is influenced by the type of exhibit and by the stage in the visit at which an exhibit is encountered.[38]

This pattern which has been described above is an assimilation of small-scale evaluative research conducted in Europe and North America, much of which relates specifically to science museums, zoos and aquaria in the USA, most of which have a significant interactive element. The evidence suggests that there is consistency in family behaviour, but where discrepancies do occur (for example in gender-specific behaviour) this may reflect cultural differences between countries—or indeed, over time—or simply the need for systematic, large-scale research across a broad range of institutions. At present, we do not know with any certainty how families behave in interactive history or art museums, or in other parts of the world.

One small-scale comparative study of family behaviour at the (non-interactive) National Palace Museum in Taiwan concluded that Chinese families do behave in similar ways to those found in the UK and USA studies. However, the research found that Chinese families do read labels, and that 'not only do parents take on the role of teachers, but children also perform the teacher role for their companions'.[39] The author of this study accounted for this difference in behaviour to the high value placed on education within Chinese culture and to high parental expectations.

The physical context to museum learning

The developers of interactive exhibitions typically set out to provide a welcoming, attractive, informal, comfortable and easily understood environment conducive to gallery learning.[40] Given that families arrive at a museum with an agenda for both entertainment and education, the museum environment should enhance the social context of the visit, with an ambience that is likely to be friendly, engaging, lively, exciting, dynamic, warm, inspirational, thought-provoking, full of movement and fun. In addition, the success of the visit is likely to be enhanced if attention is given to fundamental human comforts. The agenda for providing an appropriate physical context for museum learning is very broad:

- On arrival, are the aims of the museum clearly presented?
- Are daily events and activities clearly displayed?
- Is there an easily understood map available?
- Are cloakrooms and lockers available for bags and coats?
- Is there somewhere to leave a buggy?
- Can backpacks for babies be borrowed or hired?
- Are toilet facilities designed for children?
- Are there separate spaces for baby changing and feeding?
- Is there a water fountain for children?
- Does the café sell food and drink at prices families can afford?
- Is there somewhere to eat packed lunches?
- Are there plenty of seats for resting?
- Can the exhibits be used by children and adults of different ages?
- Are exhibits designed to encourage social interaction between family members?
- Are the exhibits accessible to people in wheelchairs, or with other disabilities?
- Are all the exhibits visible from child height?
- Are labels designed to be read by children?
- Is there additional information for the able child or the interested parent?

This checklist is by no means exhaustive, but it is indicative of the issues that need to be addressed to create a favourable physical context for the visit. Every hands-on exhibit chosen, every artefact, every structure, every label or graphic image communicates a message to the visitor. An effective exhibition requires an effective communications strategy, which includes every aspect of museum design, to help visitors make sense of their surroundings, to encourage them to interact with the exhibits, and to enhance the effectiveness of that interaction.

Visitor orientation is a vital component of the communication process. This has four elements: geographical orientation to guide the visitor, psychological orientation to stimulate the right frame of mind, intellectual orientation to encourage understanding of content, and conceptual orientation to help develop associated ideas. It follows that if the visitor is oriented geographically and psychologically, the intellectual and conceptual learning process will be facilitated.[41] Language—whether in its written form as text or in its spoken form as the verbal interaction of the explainer/enabler—has a clear role to play alongside objects, graphic images, models, audio-visual material and computer aids.

Integrating adults and children

Typically, half the visitors to interactive museums are adults. Adults play a key role in the educational success of exhibits, by assisting with the difficult task of interpreting, explaining and teaching. Thus, the primary role of the adult is one of mediator, and every effort should be made to ensure their physical comfort (by, for example, providing ample seating, clean toilets, cafeteria, parent-and-baby facilities).[42] If they are uncomfortable, they will tend to draw children on to other activities. Furthermore, as the key decision-makers in the family, if they have not enjoyed the visit, they may resist pressure to revisit at a later date.

Adults in family groups are more likely to have a positive frame of mind if the exhibition is perceived to be designed for children. Improving the tangibility of the experience on offer begins with the image portrayed by the exhibition in its promotional material, extends to visitor orientation, and subsequently to the whole design and layout of the galleries. The size and structure of the exhibition, the choice of materials and colour, the quality of the finish, the floor covering and the type of lighting, all identify the exhibition as being for a specific visitor segment, and determine a specific type of learning.

The importance of appropriate psychological orientation cannot be overemphasised. The concept of the hands-on exhibition is still quite unusual for many visitors, who were indoctrinated with a ‘do not touch’ philosophy, such that some family groups do not maximise the opportunities of their visit because the adults lack the prior knowledge of what is expected of them. This is manifest in the way that many adults stand back watching their children interact with exhibits, without contributing to or sharing in the learning experience. For example, when Eureka! first opened to the public in 1992, the concept of a children’s museum was still very new in the UK and adults were often observed holding children’s coats whilst the children themselves interacted with the exhibits. Orientation must be designed to encourage adults and children to share the interactive experience together.

Another difficult issue is the provision of facilities for small children. The physical and learning needs of small children are very different from those of older children, and it is difficult to design exhibits that work at a multitude of levels and are simultaneously appropriate for small children. Therefore, the problem arises of whether or not to provide separate learning spaces for children under 5. Providing a dedicated space for young children, one which caters for their learning needs and excludes larger children is an attractive proposition, but this can cause problems for families with children in different age categories. A more practical solution might be to include activities throughout the centre which are clearly identified as being appropriate to the needs of very young children. For example, if these exhibits provide a safe environment for parents to place a small child, thereby enabling them to continue to explore, this would also provide an opportunity for parents to interact with an older child at an exhibit in the same gallery.

Parents with children are naturally concerned for the security and safety of their children. Whilst it can be cost-effective to provide a dedicated member of staff to an under-5's discovery area, this will rarely be possible in a mixed gallery. Parents will not wish to leave their children unsupervised, so exhibits for the under-5s have to be highly visible to parents and to staff working in the gallery.

The design of interactive exhibits

Drawing on appropriate learning theory discussed earlier in this chapter, it is highly desirable that exhibits are designed which:

1 Have direct and obvious actions and reactions.
2 Have clear goals, expressed in terms of encouraging visitors to develop physical skills, to improve their knowledge or understanding, or to refine their feelings and opinions (i.e., psycho-motor, cognitive and affective outcomes).
3 Are intuitive to use and require minimal label-reading.
4 Work at multiple intellectual levels, for visitors of different ages and abilities.
5 Encourage social interaction between friends and family members.
6 Have open-ended, variable outcomes.
7 Are founded upon research into the existing knowledge and understanding of targeted visitors, and which do not include confusing information.
8 Are multi-sensory and employ a range of interpretative techniques, appealing to visitors with a wide range of interests and learning styles.
9 Are challenging but not threatening to visitors, and which help to build confidence.
10 Provide enjoyment for visitors, and leave them feeling they have understood something more than they did previously.
11 Are well-designed, safe, robust and easily maintained.

Designing hands-on exhibits is a formidable challenge: indeed, it has been suggested by an experienced designer of hands-on exhibits that it is not success that we should be aiming for, but to fail less miserably.[43] This comment may have been made tongue-in-cheek, but it is a painful reminder to all those who strive to create the perfect hands-on exhibit. A successful exhibit will shake the visitor 'out of the glazed and passive role of the ambulant couch-potato into that of the agile mental gymnast'.[44] On the other hand, an unsuccessful hands-on exhibit will elicit a response of 'So what?' from visitors, and this

is just as likely—perhaps even more likely—to occur with an expensive, high-tech exhibit as a simple low-tech interactive. Indeed, the simple ideas are often the best! It is also a mistake to incorporate interactive exhibits in every exhibition scenario: the hands-on approach is a seductive medium because of its popularity with visitors, but there are many areas where it is simply not appropriate for the story being told.

The problems in creating an effective hands-on exhibit are diverse. Eureka! The Museum for Children enjoyed the benefits of an experienced exhibit developer on secondment from Denver Children's Museum. He had two main messages for the Eureka! team: design your exhibits to nothing less than military standards, and anticipate the most unimaginable behaviour from visitors! If an action is possible, sooner or later one visitor will try it. The developers must try and anticipate this, protecting the visitor and the exhibit from any possible danger. Exhibits must be constructed to the highest possible safety standards, with guards to protect visitors from moving parts, and no sharp corners which might injure visitors.

If the first rule of exhibit development is to accept that visitors will sooner or later do the unimaginable; the second rule is that if an exhibit breaks down, it is the fault of the museum rather than that of the visitor. Physical safety is one issue, but if failure to interact with the exhibit leads to frustration, confusion or misunderstanding, the fault lies not with the visitor but with the exhibit developer. It is highly unlikely that the design will be perfect at the first attempt, and it is common for exhibits to go through a number of amendments before reaching the final version (ideally evaluated at the cheaper prototype stage before going on to the exhibition floor). There are many lessons to be learned: visitors do not go around exhibitions in a linear fashion, so each exhibit must stand alone and work independently from other exhibits, even if a group of exhibits are linked conceptually. Indeed, adjacent exhibits compete with each other for attracting and holding visitors' attention—there is every likelihood that visitors will not interact with exhibits in the shadow of a popular exhibit.

The physical design of the exhibit is vitally important, since visitors come in all shapes and sizes, some with disabilities, from different cultural backgrounds and with different levels of interest and understanding. The appearance of the exhibit, its structure, graphics and colour all affect visitors' response. Issues such as selecting the right control for the job, accessibility for people with different disabilities, ergonomics, visibility, noise interference with adjoining exhibits, all need careful thought and evaluation. Choosing the right control alone can be a difficult decision. There are choices to be made between mechanical devices such as pulley wheels, levers and handles; between different types of electronic switches; and between computer trackballs, mice and touch-screens. There is no ideal solution for all applications: for example, a pulley wheel with a handle attached at the perimeter may enable the user to exert more force to operate a difficult exhibit, but this may be too powerful for another exhibit on which a dimple for a finger may be more appropriate to prevent abuse (although this would be more difficult for someone with motor disabilities). Many factors will affect the decision, but ideally the choice of control should reinforce the exhibit concepts: for example, if the exhibit demonstrates leverage, then the ideal control will itself be a lever.[45]

Every exhibit needs to be designed to be as rugged and maintenance-free as possible, using durable components that are available locally to the museum, and ideally using components that are standardised throughout the centre. For example, it makes sense to

standardise on basic components, such as computers, switches or water-pumps, that are likely to be utilised in a number of exhibits. If the exhibit can be removed easily to a workshop for repair, then the visitor will not be confronted by a broken exhibit. If it cannot be removed, access to internal components needs to be easy so it can be repaired in situ, which in itself can present a good teaching opportunity with a well-trained and friendly technician.

Role of text

The best hands-on exhibits are intuitive to use, and do not rely on the visitor reading complex instructions or large amounts of explanatory text. However, text and associated graphic images can play a key role in helping visitors use the exhibits. It is quite common for children to interact with an exhibit without reading any instructions, whilst their adult helpers stand back and read the labels. If the exhibit is not intuitive, exhibition graphics must make it clear what physical activity should take place, otherwise the exhibit is confusing and 'doesn't work'. Ideally, the text should clearly outline the educational value of the activity and how the adult can enhance learning, otherwise the exhibit is fun, but of limited educational value.[46] Thus, text has a complex role in that it must not only be understandable and appealing to children, but also interesting to adults in its own right, enabling them to discuss exhibits with their children.

The assertion is often made at interactive exhibitions that visitors do not read text. Research suggests that this is too simplistic an explanation, and that whilst most families (especially children) interact with exhibits before reading any labels, they do go on to read the text—especially if their initial interaction is unsuccessful.[47] People are also much more likely to read text in the early part of the visit, after the initial orientation phase, but before museum fatigue sets in.[48]

Families visit exhibitions as a social event, and people select small segments of text and introduce them into their conversations. This piecemeal selection of text underpins the need for a clear framework for the presentation of text, and a simple conversational style of writing so that these interactions are facilitated.[49] The interpretation framework is likely to consist of a main message for the whole exhibition, which is the single most important idea that we would like the visitor to leave with. Everything else within the exhibition should be consistent with or reinforce this message, although it may challenge visitors' previously held misconceptions (this will be facilitated if a questioning approach is adopted). Thereafter, the interpretation framework consists of a hierarchy of messages in decreasing importance: ones that we feel we must communicate, ones that we feel we should communicate and ones that we would like to communicate (recognising that we expect a diminishing number of visitors to receive each level of messages).[50] In an interactive learning space it may be decided for clarity that only the first two tiers in the hierarchy of messages will be communicated.

Effective labels for children should be short, use non-technical language, make a limited number of points, use a large simple typeface, adhere to a traditional upper-case/lower-case convention, and be black on white to aid reading by people with disabilities.[51] Four simple stages will help ensure that labels are effective:

1 The target audience should be clearly defined.
2 The proposed text should be analysed for grammatical content and reading level.

3 The proposed text should be evaluated by teachers specialising in language development of the target age group.
4 Lastly, and most importantly, the text should be evaluated with children (preferably alongside the prototype exhibit and associated graphic images).[52]

The interpretation framework must provide text to fulfil several goals. Clear directional signage and introductory texts at the entrance to each exhibition will assist geographical orientation and aid psychological orientation. A large clear title for each exhibit will orientate the visitor conceptually, and clear instructions for manipulating the exhibit provide an essential prerequisite for intellectual orientation. If the language used in labels is inappropriate for the visitor or if they cannot quickly work out what the exhibit is about, then the exhibit is likely to be rated as dull or boring, or even out of order.[53] Intellectual orientation can be further assisted by background information, which can be presented in a hierarchical manner—perhaps in a smaller font to differentiate it from manipulative information or perhaps at adult eye-level, given that it is most likely to be read by adults. This strategy might also be used to provide additional complementary information for teachers or parents, perhaps suggesting activities that children might want to do within the exhibition, or follow-up activities back at home or school, to reinforce the learning process. Specific information informing adults what children might be learning can change a bored parent into an interested observer.

Role of graphics

Graphics images, like text, play an integral part in the communication strategy, assisting in the interpretation and orientation process. Accessible to non-readers and to speakers of other languages, they have their own unspoken code which gives a message to all visitors. Graphics can be used in a variety of ways:

1 To identify areas or themes.
2 To create an environment.
3 To reinforce a message on a specific exhibit.
4 To give instructions, either on exhibits or for services.

The corporate identity can be used to give an overall framework within which a graphics policy can be developed. This gives both a visual coherence and helps reinforce the main exhibition message, which is of particular importance in visitor orientation. It does not mean that graphics have to be of a single style or approach throughout, but rather that an overall framework for development of graphics is created; and that any change from this framework should be the result of an informed decision to fulfil a specific purpose, as opposed to *ad hoc* development of individual graphic styles, which may confuse the visitor.

Both in the general geographical orientation and in exhibition interpretation, illustrations designed specifically for children are perceived positively by parents, thereby enhancing psychological orientation. Graphics designed to create an environment for learning can aid conceptual orientation, whilst a pictogram can simplify manipulative instructions, thereby aiding intellectual orientation. The adage ‘a picture is worth a 1000 words’ is particularly appropriate in this context, but only if the image is clear and

simple, relevant, attractive to children and easily understandable. A complex image or pictogram may confuse the visitor and can add a further barrier to be disentangled.

Graphics can also signal unintended messages, for example, on equal opportunities. While text can be monitored relatively easily to ensure that no racial or gender group is either privileged or excluded, graphics present a more difficult problem. This is particularly the case where characters are involved in the storyline of an exhibition. The choice of a single character is rendered very difficult and recourse is often made to an animal or space alien, which may be gender and race free. Even this is not an ideal situation, as characters may be perceived by the public as having a different connotation (for example, the asexual Scoot the Robot at Eureka! is frequently assumed to be masculine). Research on proposed characters at Eureka! showed that relatively small changes in drawing style can affect substantial changes in understanding.

In short, graphics can play a positive role in reassuring the visitor and in aiding comprehension. As with text, formative evaluation of images alongside the exhibit prototype is desirable if the exhibit and its surrounding graphics, objects, models, audio-visual material and computer aids are to be interpreted as part of a coherent communication strategy.

Communication strategies at Eureka!: a case study

Eureka! opened in 1992 for children up to 12 and accompanying adults. Using bold primary colours and a strong corporate logo throughout the exhibitions and associated educational and promotional material, the development team attempted to integrate graphics, text and exhibits into a coherent communication strategy. Large ‘child-friendly’ images of children, drawn by children’s book illustrator Satoshi Kitamura, appear outside the museum and act as an integral part of overall signage. This strategy, derived from Museum De Los Niños in Caracas, Venezuela, is intended to provide a welcoming environment for children and adults as an aid to psychological orientation. Geographic orientation is provided by a comprehensive signage system of hanging panels detailing main exhibition areas and facilities, also illustrated by a Satoshi cartoon. Some—particularly for the boys’ and girls’ toilets—are particularly humorous, appealing to children and adults alike.

Whilst there is an overall strategy for directional signage, each exhibition within Eureka! required slight adaptation from the model presented above. The largest single exhibition, ‘Me and My Body’, presents the most coherent communication strategy. The exhibition is the only one with an orientation area, and exhibits, images and text are given a uniform treatment throughout, despite the wide variety of exhibit types. A central character, Scoot the Robot, appears in various two- and three-dimensional guises asking children questions about themselves: in effect, putting children in the role of experts on themselves and their bodies. The gallery incorporates a series of short, specific activities which are clear to children and whose learning possibilities are clear to adults.[54]

Each exhibit has a large title, usually expressed in the form of a question, followed by simple graphics and instructions (with the word ‘Do’ clearly signified in orange). Illustrations incorporating children of both sexes (in equal numbers), of mixed race and of varying size and physical appearance are provided in an attractive cartoon style. The gallery is successful because the context for learning is clear, and whilst each exhibit

works on its own, learning from each individual exhibit has a cumulative effect throughout the exhibition. The Eureka! team was able to draw heavily on existing research into children's understanding of themselves and adopted a conceptual approach that is successful in health education. The questions that appear on the exhibits are typically questions that children ask themselves. Supporting information for each exhibit is available for adults at eye-level, whilst background information is provided at key quiet locations throughout the exhibition in a file for interested children and adults. A passport collected at the entrance and with sections to fill in as the visitor walks around the exhibition, helps to maintain interest.

The overall coherency of approach evident in Me and My Body is less obvious in Living and Working Together, and Inventing and Creating (subsequently renamed Invent, Create, Communicate). Living and Working Together presents a number of environments around a town square (a house, shop, bank, garage, post office, factory and recycling centre) for children to role-play and investigate simple technology. Each environment—developed by smaller teams than Me and My Body—has adopted a slightly different approach to its use of graphics and text, although the broad model is similar. The context for learning is much more difficult to comprehend, although each space does have a short orientation panel (with Satoshi cartoon) outlining the possibilities for exploration within.

Text and graphics have three main roles in this exhibition: operational instructions, supporting information and suggestions for role-play. Typically, role-play is not facilitated by written text but by the verbal interactions of museum enablers, who are often preoccupied with explaining the function of exhibits. For example, in the shop the enabler present is frequently overseeing the operation of the (real) till rather than stimulating role-play.[55]

The diversity of content within Living and Working Together is both a strength and a weakness. The expectation that something special is around the corner, and the small intimate environments, provide great opportunities for learning. However, the difficulty of presenting the weird and wacky alongside the commonplace within a familiar environment, and within a coherent communication strategy, is only partially met successfully.

Invent, Create, Communicate is a more traditional interactive science gallery which lacks the intimate learning spaces of Living and Working Together, or the simple and coherent interpretation strategy of Me and My Body. The exhibition presents a series of opportunities for children to use communication technology, with a strategy of providing an appropriate context for the use of that technology (for example, a desert island for primitive communication or a yacht for distress messages). In addition, simple communication games are suggested which were devised to illustrate the strengths and weaknesses of each communication device. A character, Squawk the Parrot, is used to aid interpretation, but its role is less clear or compelling than that of Scoot the Robot in Me and My Body.

The exhibition is less successful for a number of reasons, one of which is that the use of real technology, such as the fax or videophone, often requires quite detailed operational instructions (even though the equipment has been simplified for museum use). Another difficulty is that the communication devices often require the interaction of two people at a distance apart. Although the devices are linked physically by coloured overhead cables and pipes, it is not always immediately obvious to visitors that two

people are required to make the exhibit work. Like in the shop in Living and Working Together, enablers are typically preoccupied with explaining the technology rather than stimulating role-play.

In total, Eureka! is successful because it provides an environment for learning that is clearly aimed at a target of children aged 5–12 and their adult helpers. Its overall strategy communicates a message to adults and children that this is a special place for children to learn by discovery. However, within this framework, some elements are more successful than others. The exhibitions were developed in less than two years, allowing little opportunity for formal evaluation of more than basic exhibition concepts. Me and My Body is successful because the Eureka! team were able to build upon existing research into children's knowledge of themselves, but Living and Working Together and Invent, Create, Communicate are more experimental. Early evaluative studies revealed that although most adults understood the context for learning at the museum, many felt that they needed more information about their potential role, on the content of individual exhibits, and more guidance on which exhibits were suitable for children of different ages. This research suggested that visitor orientation in general, and geographical orientation in particular, could be significantly improved.[56]

The mixed use of museum objects and hands-on exhibits

Increasingly, as Chapter 1 has illustrated, traditional museums are incorporating hands-on exhibits within their galleries. Museum education officers have a wealth of experience in encouraging visitors to touch and learn from objects, but this is usually in a controlled environment. In recent years, many more museums have experimented with discovery galleries, where every object is selected so that it can be handled. One of the first experimental discovery rooms was opened in 1977 at the Royal Ontario Museum, and this was considered a great success by both the public and evaluators. In 1983, the museum reopened this hands-on facility as the Discovery Gallery in a space of 260 square metres. This new gallery was designed to provide direct access to specimens and exhibits for both adults and children, using a range of techniques from objects on open shelves and in discovery boxes and drawers, a discovery trail, a touch wall, and utilising scientific equipment to examine objects more closely. The original gallery was designed in a linear fashion, with the visitor encouraged to learn on a sequential journey of discovery. Evaluation revealed that visitors did not interact with the displays in this fashion, selecting activities and objects more randomly according to their personal skills and interests, and learning more through shared problem-solving than guided discovery. Based on the experience of the early evaluation, the gallery was revised in 1986, and three years later the museum published a reference manual to share its experiences with other museums planning or operating object-based discovery learning environments for people of all ages.[57]

The problem for the traditional museum is to define what is the specific place of both objects and interactives and to decide how they can both be put to best use. The inclusion of hands-on exhibits within museum galleries (or in stand-alone galleries within a museum) is not necessarily incompatible with the other core museum functions. There are, however, many areas of potential conflict: for example, if the interactive gallery diverts scarce resources away from conservation or documentation; if the safety of

original artefacts is threatened by the hands-on approach; or if the presence of interactives encourages inappropriate behaviour in adjoining galleries.

Hands-on exhibits are not appropriate for all exhibition themes. There is a danger that, if interpretation is reduced to participatory activities alone, very selective and superficial storylines may be presented which distort historical or scientific reality. For example, whereas physics is ideally suited to interpretation with interactive exhibits, other scientific phenomena that are not reversible or repeatable, or that happen too slowly or too fast, or on too small or too large a scale, are simply not appropriate to be interpreted by interactive exhibits.[58] There is a danger too that the message 'science is fun' may be misleading, when much of scientific research is slow, tedious and boring. Similarly, whilst exploring history through hands-on exhibits can be fun, it would be unfortunate to suggest that 'history was fun' for all groups in different periods of history. 'Experiencing the ultimate in human degradation by trying on a slave collar surrounded by jolly designer graphics while the rest of the family calls you Fido is not promising.'[59] Thus, although the hands-on exhibit is an extremely attractive medium, it cannot, alone, tell the whole story.

The real issue is not so much whether museum objects and interactives can coexist in harmony, but whether interactive exhibits can be designed which play to the strengths of the museum by improving understanding of museum objects. Brooklyn Children's Museum has an exhibition called The Mystery of Things which is specifically designed to demystify museum objects. One of the new galleries at the Science Museum (also called Things) similarly aims to use hands-on techniques to interest primary age children in museum objects, and forms a new introduction to the museum for visitors of this age. The All Hands Gallery at the National Maritime Museum integrates objects and interactives as a key element of its interpretation programme, and has a comprehensive evaluation programme. It is only through the use of such evaluative research that a museum can determine the juxtaposition of objects and interactives, and indeed other media such as live interpreters, that will enhance visitors' understanding of museum artefacts and will enable visitors interacting with a limited range of hands-on exhibits to take away a 'minds-on' understanding of the museum gallery as a whole and the objects it contains.

There is clearly a distinction between a purpose-built museum gallery incorporating a whole range of interpretation tools and the traditional gallery adding a few hands-on exhibits as an afterthought. However, the mixed use of artefacts and hands-on exhibits raises a number of issues for all museums:

1 Why do museums want to introduce hands-on exhibits? Is it for sound educational reasons as part of a co-ordinated interpretation plan, or is it merely that they want to jump on the interactive bandwagon in response to declining visitor figures?
2 Will the addition of hands-on exhibits lead to increased visitor figures for the museum, or has the medium passed the peak of its life-cycle?
3 Can a traditional museum hope to compete with new purpose-built hands-on attractions?
4 Should museums not play to their existing strengths, and place more emphasis on artefacts?
5 Do museums that introduce hands-on exhibits consider all the implications: they take up valuable display space, require regular maintenance, have a life of five years at

best, divert scarce resources away from conservation and documentation, and require specialist interpretation staff ?
6 Should the museum risk the use of museum objects in a hands-on display?
7 Will the addition of hands-on exhibits change the nature of the gallery, perhaps encouraging inappropriate behaviour elsewhere in the museum?
8 Not all subjects are appropriate for hands-on activities. Is there a danger that the selection of media may cause a selective and superficial approach to science or history to be presented?
9 What is the evidence that hands-on leads to 'minds-on' understanding of museum objects? How can we design hands-on exhibits that improve the understanding of museum objects in a mixed gallery?

Museum learning in the constructivist museum

This chapter has presented a simplified view of the theory and practice behind how individuals and family groups learn in an interactive museum environment, and it has been shown that the museum experience depends on the personal, social and physical context of the visit. Learning in a traditional museum equates to traditional methods of lecturing, with curators imparting their expert knowledge through storylines usually presented in an incremental, linear manner. In a hands-on exhibition, there may also be closely defined messages which the developer wants to communicate, but the exhibits are designed so that the visitor discovers the educational objectives of the exhibit by interaction rather than by being told. In a children's museum, the exhibits may be linked in an environment which is familiar to children; in a science centre, they may be grouped together by physical process. Either way, the exhibits are not usually arranged in a linear fashion, but so that they can be experienced individually and independently of each other. Of course, as Feher's research showed, visitors can also go away with misconceptions, and this is what so troubles many scientists when they observe the interactions within a hands-on science centre and why so much evaluation concentrates on the messages visitors receive from interactive exhibits.[60] However, the theory is that visitors will learn by experience, and gradually—by interacting with a range of exhibits which build on their existing knowledge whilst challenging their preconceived ideas—misconceptions will be replaced by correct conceptions.

Both traditional leaning and discovery learning assume that there is a correct body of knowledge, and these are merely different techniques to enable the visitor to arrive at this expert view of the world, either by being told or by trial and error. There is, however, another model which concentrates less on the importance of the body of knowledge to be learned and more on the learning process, and especially the interests and needs of the visitor. Constructivism suggests that learners do not simply add facts to what is already known, but that they constantly reorganise information and their view of the world as they interact with it. In other words, they construct knowledge for themselves as they interact with the world.

The constructivist museum accepts that visitors construct their own knowledge based on their personal, social and physical context for the visit. Material is presented so that it meets the educational needs of the visitor rather than the subject of the storyline, the

social, political, cultural or historical context, or the properties of the object. In other words, there is no single way to interpret the material presented. Visitors can enter and leave the exhibition at any point, as each exhibit stands alone on its own merit. A range of interpretative devices are introduced to stimulate all Gardner's multiple intelligences. Opportunities are provided for visitors to make connections with familiar concepts and objects, for it is only by making connections with the familiar that we reinforce or challenge our existing knowledge, to make meaning of our experiences.[61]

In short, in the constructivist museum, visitors are encouraged to construct knowledge from the exhibit through personal and social interaction, and they are enabled to draw their own conclusions about the meaning of the exhibition. Based on the learning theories of Piaget and others, many children's museums have successfully adopted constructivist principles. However, by providing physical experiences which can respond to the varying needs of different interest groups and all ages of learning, the constructivist museum with its mixed range of hands-on exhibits, artefacts and other media perhaps offers the best opportunity of providing a meaningful museum experience for a truly broad museum public. As the recent report into museum education in the UK noted, 'Adults as much as children need a gallery environment that allows open and exploratory learning and encourages them to question and challenge.'[62]

3
Exhibit development

This chapter investigates a range of different approaches to the development of hands-on exhibits, and identifies the importance of front-end, formative and summative evaluation.

Introduction

Exhibit developers conceptualise exhibitions, write the storylines and exhibit labels, design and build interactive exhibits, draft instructions, prepare the graphics, select and arrange any accompanying artefacts, choose the lighting, colours and constructional materials to be used in the display, and generally attend to the physical context of the exhibition. As Chapter 2 has illustrated, the experience each visitor has within any museum—hands-on or traditional—is influenced by their physical surroundings, but it is also influenced by their prior knowledge and expectations, and by the people attending with them: in other words, the visitor experience is dependent upon this interplay of the personal, social and physical contexts of the visit.[1] The primary aim of the exhibit development process is to provide an exhibition environment which will enhance the visitor experience, by providing a physical context which will help visitors to construct their own interpretation from the exhibits.

The most critical factor for the successful design and development of hands-on exhibits is the setting of appropriate goals for targeted visitors. The development process begins with a broad conceptualisation of the exhibition and potential exhibits within it, and of the type of activities that will take place. As each exhibit idea is refined and developed, it is essential that measurable objectives are set for targeted visitors in terms of physical activities, enjoyment, behaviour, feelings, attitudes and understanding. Without specified goals, it is impossible to measure the effectiveness of exhibits by evaluating visitors' affective, cognitive and psycho-motor responses (that is, visitors' emotional, learning and physical responses) against expected outcomes.

A focus on the intended activities of the visitor is essential in the exhibition development process. In traditional museums, exhibition development was typically product-led: new exhibitions were the responsibility of the museum curator, working sometimes—but not always—in consultation with a museum designer. Museum educators were frequently excluded from this process. Exhibition goals—if they were stated at all—were likely to concern the safety and museological significance of artefacts rather than the activities or experiences of visitors. This process produced the scholarly, product-led exhibitions closely associated with traditional museums. A recent survey has shown that even in 1996, only 33 per cent of museums in the UK had a structured education input at the planning stage of exhibitions and events.[2]

In the modern museum, and especially in interactive discovery centres, the exhibition is much more likely to be orientated towards the needs of visitors. The exhibit development process draws upon the skills and knowledge of several key players, but the main exponent is likely to have educational objectives, conceptualising the broad thrust of visitor activities and messages to be communicated. Consultation will take place with academic and other experts, including curators if museum objects are to be included, to ensure that the facts presented are accurate. The exhibit developer will also consult with target visitors at the conceptualisation stage, to ensure that visitors both enjoy the exhibits and understand the underpinning concepts behind them, and thereafter at every subsequent stage of development, construction and installation. The developer will also consult with funding partners, sponsors and other stakeholders who may have an interest in the content and design of the exhibit.

The development process can be likened to communicating messages. The exhibit developer is the sender of the messages to be communicated. Consultation with experts helps to ensure that the messages to be communicated are technically accurate and appropriate to match the needs of all stakeholders. However, there is always the possibility that interference will confuse the message during transmission, such that visitors are unable to decode the message as originally intended. The designer's role in the development process is to encode the message in such a way that the recipient is able to decode it with as little interference as possible—to maximise the opportunities for visitors to construct the meaning (or range of meanings) from the exhibition that the exhibit developer intended. Since the visitors' experience of the exhibition will always depend on the social and personal context of the visit, which are largely beyond the influence of the development team, this can never be an exact science. However, it is the role of the designer to provide the environment in which individuals and groups feel confident to explore further whatever the social and personal context of the visit.

In the early science centres, the majority of hands-on exhibits were produced by academic scientists, enthusiastic to share their enjoyment of scientific exploration with others and thereby to promote the public understanding of science. Professor Francis Evans—a major influence in many UK centres—coined the term 'wondersmith' to describe himself and fellow Professors John Beetlestone (Techniquest) and Richard Gregory (Exploratory). Influenced enormously by the success of Frank Oppenheimer's Exploratorium, and the subsequent distribution of exhibit ideas through the widespread distribution of its exhibit 'Cookbooks', these early science centres were concerned primarily with the product—the exploration of scientific phenomena. Oppenheimer disagreed that it is necessary to define target audiences for exhibits, arguing that each exhibit at the Exploratorium can be appreciated on a variety of levels, and that, with over 400 exhibits in the museum, there would always be sufficient exhibits to absorb visitors for a two- or three-hour visit.[3]

At the Exploratorium, exhibits are designed in-house by trial and error, involving 'a great deal of play, learning, discussion, experimentation, and tinkering'.[4] Approximately 80 per cent of the cost of an exhibit is spent in research and development, and only 20 per cent in construction. Exhibits are developed collaboratively by a range of people who make suggestions and contribute ideas, although it is common for one person to conceive and build the exhibit after this collaborative discussion. Artists are an integral part of the exhibit development process, 'not just to make things pretty, although it often does, but

primarily because artists make different kinds of discoveries about nature than do physicists or biologists'.[5] Thus, exhibits evolve from a concept to a working prototype often made from junk and evaluated on a table top in the museum. No attempt is made to standardise size, colour or shape, with the design of each exhibit determined by its function and the developer's preferences. After 'thorough testing and subsequent modification, the exhibit gradually evolves. Very few exhibits emerge complete straight from the Exploratorium's machine shop.

The early science centres like the Exploratorium were able to develop because the product which evolved proved to be enormously popular with visitors. This process is the very antithesis of that adopted by many new UK hands-on museums, anxious to acquire interactive exhibits that work reliably, look good, and which require very little human input to interpret or maintain them. The early experiments with hands-on exhibits quickly evolved into a more formal process of studying how visitors learned and behaved in these new interactive environments, and a new body of knowledge arose in the UK, learning much from their predecessors in the USA. Thus, over the ten-year period in which hands-on exhibitions have developed in the UK, a new range of skilled experts—the exhibit developers, designers, constructors and evaluators—has developed.

Exhibit development in the UK

There are three alternative forms of exhibit development in the UK:

1 All exhibits are conceived, designed and constructed in-house.
2 All exhibits are conceived in-house, but are designed and constructed by contractors.
3 All exhibits are conceived, designed and constructed by contractors.

Some hands-on centres, such as Techniquest in Cardiff, encompass all the design, development, construction and evaluation skills in-house, and as a result they develop their own exhibits. The process has some similarities with that of the Exploratorium, although Techniquest values good product design, and—unlike at the Exploratorium—all its exhibits have a similar physical appearance to each other. Techniquest's exhibit development skills have evolved over a number of years, and the centre now sells their products to other organisations wishing to gain from their expertise (thereby earning income which helps to maintain specialist exhibit development skills in-house). Science Projects has a similar duplicity of roles, operating a number of science centres around the UK (including the travelling Discovery Domes), and the company is also a major commercial producer of exhibits for other centres.

Very few UK hands-on museums are able to develop their own comprehensive skilled teams like Techniquest and Science Projects. It is more common in the UK for museums to develop small internal exhibition development teams which draw upon external expertise as and when required. For example, the Science Museum originally produced all its exhibits in-house, but now contracts development and construction of many of its exhibits to one or more of the specialist firms of exhibit builders. The Science Museum stresses the importance of identifying and clarifying objectives and methodologies when commissioning interactive exhibits, and maintains an open dialogue with contractors, to ensure effective exhibits are delivered on time and within budget.[6]

Finally, many smaller museums and science centres, lacking the expertise and resources to develop their own exhibition team, but wishing to share in the public enthusiasm for hands-on learning, buy in their exhibitions from one of the suppliers. For example, the PowerHouse at Elsecar is the product of three main subcontractors: story-writers, exhibition designers and exhibit builders. In short, a complex array of skilled professionals has developed, operating independently or within commercial companies, or from within science centres, museums and universities.

Since few organisations planning new hands-on centres have the skills, experience or resources in-house to enable them to set up internal exhibition development teams, staff are increasingly involved in developing hands-on exhibits without appropriate experience, with the result that mistakes are often repeated and the wheel is frequently re-invented. The challenges facing many aspiring hands-on museums are how to minimise the risks involved and how to ensure that the original concept is turned into an effective interactive exhibit. There is a difficult choice to be made between exhibition designers (who will take an overview of the whole exhibition, but who will probably subcontract exhibit construction), or specialist exhibit builders (who will generate ideas, produce designs and construct the effective exhibits, but may have less of an overview than exhibition designers). It is a common complaint from exhibit builders that they have received an unworkable idea from a designer, and that they have to start from scratch to turn it into an effective exhibit!

Many museums turn their attention to exhibition design companies, not simply to design the exhibition, but also to write the storylines, procure the exhibits and manage the installation. These companies often incorporate a broad range of experienced people alongside more traditional designers, and they, in turn, recruit any other necessary expertise as and when required (taking on the role of project managers subcontracting construction work). In short, these large design groups will convert the design and interpretation brief into a completed interactive exhibition. For the client, this process has the advantage of placing all responsibility with the design and development contractors. In that sense, there is less risk involved to the client, and there are clearly efficiencies to be gained if the whole creative process is placed in the hands of one company whose role is to subcontract as and when necessary to procure the finished exhibition.

However, the process is fraught with many potential difficulties. First, whilst it does not involve the recruitment of additional in-house staff, it is costly since design companies will add a significant fee to all stages of design and construction, even on to subcontractors' charges. Second, the original intended message may well become distorted, particularly if the original objectives are weak, or if there is little control over the development process. Third, whilst exhibition designers are skilled professionals, they are not necessarily educationalists or evaluators. Although many design companies possess or recruit expertise in these areas, these are specialist skills in their own right which can get excluded from the development process unless the client is wary. For example, many designers are inclined to rely on their professional judgement rather than to see the need for exhibit evaluation. As a result, it can be more effective for the client to employ these skills in addition to and outside of the design contract, thereby helping to ensure that the objectivity of the designers is not compromised.

In short, the collective experience of many organisations is that whilst it is simpler and more straightforward to write a design brief and award a contract after a tendering

competition to one company to devise the storylines, design the exhibition, procure the exhibits and manage the installation, this is by no means any guarantee for a successful exhibition. It is essential to monitor the design process at every stage to ensure that educational, technical and safety considerations are not compromised. This may necessitate the recruitment of an independent project manager and other external advisers to oversee production and development. This method of procuring exhibits may be less efficient than placing the whole contract in the hands of one company, but it does ensure that the client maintains control of both the process and the finished product. As such, this is a sensible strategy which is being employed by many large new developments in the UK to maintain control over the development process.

Exhibit development at Eureka!: a case study

Eureka! The Museum for Children, which opened in July 1992, employed a number of strategies to procure its exhibits. The core exhibition development team consisted of the Director, a Head of Design, and the author as Head of Education and Interpretation. In the first instance, these three key players spent three months at the end of 1990 evaluating the exhibition concepts inherited from the previous Director (which had been developed after visiting science centres and children's museums around the world) and adding their own creative ideas and concepts. A detailed exhibit database was produced for every exhibit, outlining aims and objectives, the intended audience, and what the key activities would be. This database became a working document identifying how long each exhibit would occupy visitors, whether they would explore alone or with others, and outlining technical specifications.

A graphic designer and two education officers were subsequently employed to further the development process, whilst the Assistant Director of Denver Children's Museum was seconded to the project for three months in 1991. Whilst the education team evaluated its exhibition proposals with children, and consulted teachers and other academic experts, the design team began an assessment of exhibition designers and constructors. When the whole exhibition development team felt assured that they had developed comprehensive working briefs, the process began of appointing designers and, later, exhibit builders. None of the exhibits installed at Eureka! in July 1992 was actually constructed on site. Technicians were not employed until shortly before opening, and their preliminary role was maintenance rather than construction.

It has been noted by observers that there are significant differences between visitor experiences within Eureka!, and that the educational objectives of some of the exhibitions are clearer than others.[7] As one of the development team has subsequently noted, internally this was informally attributed to the way the different galleries were developed.[8] The health education gallery, Me and My Body, was developed by one design company, Imagination. These designers had been given a very clear educational brief, based on a considerable body of knowledge on children's attitudes and perceptions about themselves. Anxious to promote best practice in health education, the Eureka! education team consulted widely with experts in the field, and very close monitoring of Imagination's proposals ensured that the final gallery appears much as the team had envisaged. The close working relationship between client and contractor paid dividends.

Living and Working Together was developed rather differently. This exhibition consisted originally of a house, shop, bank, garage, factory, recycling centre and post office set around a town square. On the client side, responsibility for each space was divided between members of the Eureka! education team to specify learning goals. On the contractor side, each space was allocated to a different young designer. It was intended that this process would give the space richness and diversity, compared with Me and My Body where Imagination imposed a consistency of design throughout. Indeed, this objective was achieved. However, whilst each of the spaces was overseen for content and design by the Eureka! team, inevitably the pressure to complete the exhibitions in a relatively short space of time resulted—as the commentators have noted—in some spaces working more successfully than others.

Eureka!'s own small design team took an overview of the whole design process, ensuring the schemes of the various contracted designers would gel together, and looking after the public service and orientation spaces. They also designed the Inventing and Creating exhibition directly, working with an adviser from the Science Museum on technical content of the communications exhibits. Thus, the Eureka! designers were direct creators of this exhibition, rather than overseers of contracted designers as in the other spaces. Of all the different strategies employed at Eureka!, the exhibition development team arguably worked most effectively primarily as a creative force producing the design and educational briefs for others to realise and secondarily as client supervisor of contracted designers and exhibit builders.

Exhibit evaluation

If the role of exhibition designers is to encode the museum message in such a way that visitors can decode it with as little confusion as possible, then evaluation is the way in which feedback is received from visitors. Communication is a two-way process, and without 'listening' to visitors through evaluative research, it is impossible to measure the success of the exhibition. Whilst museum visitor research investigates the broad nature of the museum experience and its impact on visitors in a wide variety of situations, evaluative research is more localised, investigating whether a specific exhibition meets its specified objectives. In an increasingly competitive market for visitors, evaluation studies help to ensure exhibitions are meeting visitors' needs and expectations. Furthermore, with increasing pressure for accountability in museums, evaluation helps to demonstrate to funding bodies and other stakeholders that a museum is meeting its stated objectives.[9]

The increase in evaluation studies in recent years in both the USA and UK is a reflection of the increasing professionalisation of the exhibition world, helping museums to plan and utilise resources efficiently and to target exhibitions effectively.[10] By concentrating on the visitor experience, evaluation helps to orientate all staff towards the expectations and needs of visitors and away from internal concerns and a product-led approach.[11] Undertaking audience research because everyone else is doing it, to confirm what is already known or to justify a decision that has already been made, are poor reasons to devote resources towards an evaluation programme. The key to success is to gather quality information that can be depended upon, and then to act upon it—even if the findings are unexpected and difficult to accept. If the research findings are valid

(accurate) and reliable (consistent over repeated studies), the information provided can assist in the planning process. If the data collected is invalid or unreliable, it can lead to a false sense of security and steer the planning team towards erroneous decision-making.[12] In short, the key to successful evaluation is to employ the right research methods at the right time in the right place, and then to have the confidence to act upon the findings in the knowledge that the results are a representative reflection of the views or behaviour of visitors.[13]

Visitor surveys

A successful evaluation strategy is likely to be an integral part of the exhibition programme, rather than being based on occasional one-off studies. The first stage in devising the evaluation plan is to prioritise aims and objectives within the constraints of human and financial resources, and the time available. The most important study an existing organisation can undertake is a large-scale survey investigating socio-economic and demographic characteristics of existing visitors, together with their likes and dislikes. If a museum can define its actual visiting audience, this will enable it to undertake smaller-scale evaluation studies subsequently of defined target groups.[14] The usual methodology is to undertake a random-sample quantitative questionnaire survey. In general, the more detailed information required concerning small subsamples, the greater the survey population will have to be to ensure the validity of the results. The validity of random samples is dependent on the finite size of the sample, rather than on any given percentage of the parent population. However, whilst the accuracy of the sample will increase as the sample size increases, validity does not increase at the same rate as increases in sample size.[15] Thus, a compromise has to be reached, based on the accuracy required and the resources available. Eighty-five per cent of museum visitor surveys in the UK are conducted on sample sizes of less than 350 (average 279),[16] although a random sample size of 500 is advocated if any meaningful cross-tabulations are to be carried out.[17]

Conducting research on the characteristics, attitudes and behaviour of existing visitors is simpler than trying to identify why people choose not to visit an attraction. One researcher in the USA conducted a large-scale telephone survey of over 500 people to identify visiting patterns and attitudes of frequent, occasional and non-visitors to a museum of art. More frequently, research to investigate the views of identified non-visitors uses qualitative focus group techniques, particularly if a new exhibition aims to attract those groups.[18]

Having identified the characteristics of existing visitors or non-visitors, detailed evaluation of exhibits with target visitor groups can take place. The timing of evaluative research is critical.[19] Clearly, the earlier in the exhibition development process that the evaluation is carried out, the earlier any potential problems can be identified and rectified.

Front-end analysis

Front-end analysis is research to identify the attitudes, understanding and misconceptions of identified groups of target visitors to potential exhibitions. This is usually carried out

with focus groups (as in the non-visitor surveys identified above), using storyboards and illustrations to prompt responses, and will provide detailed information gained from a limited number of respondents. This was the main evaluative technique employed at Eureka! The Museum for Children. It is also possible to undertake a large-scale quantitative survey using more traditional market research techniques, provided the nature of the proposed exhibitions is clear: for example, the author conducted a quantitative survey of 430 respondents for the National Centre for Popular Music in Sheffield investigating the likely levels of interest in proposed exhibition themes.

Formative evaluation

Formative evaluation is an investigation of how visitors react to proposed exhibits at a mock-up stage, which may be within an existing gallery or in isolation behind the scenes. Carrying out this research at an early stage of development will help to identify whether visitors understand the aims and objectives of the exhibit, whether the instructions and labels are clear enough, whether the lighting and ergonomics are appropriate, whether the controls are suitable for the intended audience and, indeed, whether they actually like the exhibit. Once again, it is cheaper to rectify mistakes identified at the research and development stage than it is after the exhibit is built to exhibition standards. Having identified the target group(s) for the exhibit, a sample of twenty-five to thirty visitors randomly selected from each group will provide an informative sample for this kind of investigation. Of course, the formative process may have to be repeated several times after each modification of the exhibit under trial.

Summative evaluation

Summative evaluation of exhibits is research to investigate how visitors actually use an exhibition after it has been installed, which should lead to remedial action if problems are identified. It is the easiest research to conduct, but leads to the most costly alterations. There are numerous techniques available, including questionnaires, in-depth open-ended interviews, structured interviews, observation or tracking. Observation and tracking can be particularly useful to inform the exhibition development team on visitor circulation and orientation, or on the attracting power and holding power of exhibits.[20] Several professional evaluators advocate the use of multiple methodologies to give greater rigour, reliability and depth to the research.[21] For example, Paulette McManus employs a battery of research techniques to triangulate the findings from each study. At Birmingham Museum's ethnography gallery, she employed no less than nine techniques to provide a demographic description of visitors, to describe the volume and pattern of visitor use, to assess the emotional and intellectual impact of the exhibition, and to provide an in-depth study of interactive video exhibits. These techniques included an exit survey, observation, tracking, analysis of written comments and research into visitors' long-term memories of the exhibition.[22] A study of visitor behaviour at the Discovery Centre, Cleethorpes, similarly employed a battery of techniques, including observation and tracking, interviews and recording visitors' spoken comments.[23]

In short, there are numerous evaluation techniques available to inform exhibit development. Once the demographic and socio-economic characteristics of existing or

target visitor groups have been identified, it is possible to undertake evaluative research on small subsamples representing those groups. In most circumstances, the earlier the research is carried out in the exhibit development process, the least costly will be the outcome in terms of changes to proposed exhibits, although evaluation should be considered an integral part of the exhibit development programme rather than a one-off activity. Clearly, the validity of the findings will increase as more research is carried out, and the use of a range of evaluative techniques can be a useful way to triangulate results.

Exhibit evaluation at Eureka!: a case study

The evaluation process at Eureka! The Museum for Children was largely informal, an inevitable consequence of the piecemeal nature of the development process, the small development team and the very short period of time between the creation of that team and opening to the general public (twenty-two months). Eureka! had the great advantage of the support of a local primary school which seconded a member of staff to the project for one day a week for the whole duration of the development process. This enabled ideas to be 'bounced off' the teacher as they were formulated, with the immediate opportunity to evaluate them with local children. The LEA also assisted in this process, by identifying a range of schools within the Calderdale area with whom access was arranged for evaluative studies; these included a range of urban and rural schools, from both prosperous and deprived areas, including some schools with high proportions of ethnic minorities and some special needs schools.

The evaluation process at Eureka! inevitably owes much to Gillian Thomas's experience at the Inventorium in Paris, where a range of techniques were employed over a four-year period, resulting in the Inventorium becoming one of the most successful spaces within the City of Science and Industry.[24] At Eureka!, like the Inventorium before it, the evaluation programme was restricted by the available time and budget, with the inevitable outcome that the results were fragmentary. Developing techniques used at the Inventorium, Eureka! placed considerable emphasis on front-end evaluation, ascertaining children's ideas for all the proposed themes. The first stage of this process was to survey existing research: for Me and My Body, research into children's concepts of themselves and their bodies at different ages was available in the form of Health for Life, the Health Education Authority's Primary School Project, directed by Noreen Wetton at Southampton University.[25] For Living and Working Together, an exhibition devoted to the roles and exchanges within contemporary society, research supported by the Department of Trade and Industry into children's ideas on the world of work proved useful, although less comprehensive and directly relevant than Health for Life.[26] Both these pieces of research informed the development team on children's conceptions and misconceptions in areas relating to the proposed exhibitions. For example, the world of work research investigated children's understanding of the exchanges that take place within a shop. When asked at what price a greengrocer buying a piece of fruit should resell the product, not all children accepted that the fruit should be resold at extra cost to cover the greengrocer's overheads and profit: indeed, small children believe it should be sold for less than it first cost, as it has become second-hand or because it is rotting. The crucial point to learn is that children do not necessarily think in the same way as adults, and it is very easy to assume that concepts that appear obvious to adults will appear

equally clear to children—they do not! By utilising existing research into children's interests and understanding, Eureka! was able to employ the limited resources available for evaluation more effectively in other areas.

The Health for Life research demonstrates similar characteristics about the development of children's thinking. One problem in researching children's concepts is that research methodologies appropriate for adults are not necessarily applicable to children, who are likely to have weaker reading and writing skills. Health for Life uses drawing and writing techniques, in which children are invited to draw their response to a particular question or situation with which they can relate, and then they are asked to label the main elements of the drawing. At each stage, children are encouraged to draw and write about their views by the teacher, who offers help if they have difficulty writing words, thereby ensuring children who cannot write are not excluded from the research. Clearly, the teacher plays an important mediation role, helping children to draw and write their own personalised views, but also knowing when not to ask inappropriate questions.

Health for Life presents a detailed picture of the way children understand themselves at different ages, and Eureka! was able to build upon this research in its displays. The questions that children frequently ask about themselves and their bodies, identified in the research, are questions which can be found at the top of the exhibits in Eureka! As an example of this research, Health for Life identifies how children understand their skeleton. Typically, children in their early years of primary education will draw unconnected 'doggy' bones under their skin. Whilst evaluation of children's concepts is not necessarily transferable across cultures, research into children's understanding of their skeleton undertaken at the Inventorium produced very similar results to Health for Life, and the development team there utilised the findings of their research in a similar way to the Eureka! team: designing exhibits to question misconceptions, and utilising the questions and language children use.[27]

The Health for Life research did not cover the sensitive area of children's knowledge and feelings about growing and changing at puberty. The Eureka! team wanted to cover this topic, and so Noreen Wetton was employed as an advisor to the project to develop an appropriate draw-and-write technique to undertake further research. Considerable care was taken to ensure the research had the full backing of the school. Children were invited to draw a teenager going out alone for the first time, and then to annotate their drawings indicating how they are growing up, how they feel about growing up, and what they take with them on their outing. Children were then invited to draw the teenager coming out of a bath or shower, and to annotate their drawing showing how the teenager is growing up, how the teenager feels about growing up, how they (the respondent) feel about growing up. Thus, peer pressure and any potential embarrassment created by asking the children directly was avoided by creating the draw-and-write scenario. By carrying out the research in a range of schools, cultural sensitivities could be ascertained, and the exhibition content developed accordingly.

In the Living and Working Together area, front-end evaluation involved a range of research techniques, including draw-and-write, discussions with children, and site visits behind the scenes at a supermarket and other places. For example, draw-and-write research asked children to draw what happened in a garage, shop, bank or factory and to annotate the drawing with labels describing what people were doing and what they would

like to do in that area. Subsequently, in group discussions children were also asked ‘What is work?’ and ‘Why do we go to work?’. These 10-year-olds provided typical responses:

Question: What is work?
Asma: Things you do that aren’t fun.
Robert: What your mum and dad do when they are not at home. It’s like when some boys have a paper round and they don’t want to do it.
James: Things that you have to put effort into. Sometimes you get paid and sometimes you don’t. It usually makes you tired.
John: Things that you find difficult.
Helen: How you make a living, that means a job. Work can be what you do at home as well, like cleaning.
Question: Why do we go to work?
Julia: To get money so we can live. To have company. To help other people.
Robert: To get richer. To have someone to talk to.
Helen: To be with other people so that you won’t be bored. To get some money to give to your children. To be able to pay the mortgage.
John: To do the things that you enjoy and get paid for doing it.

These responses indicate a variety of sophisticated and naive conceptions about the nature of work. Within each proposed exhibition space, responses were similarly diverse, although certain patterns emerged. For example, children typically drew adults in roles in accordance with sexual stereotypes: the garage was invariably a male-orientated space. This has implications for the design of graphic images in the exhibition itself, where children’s conceptions are challenged with the portrayal of girls in active roles in traditionally male environments. The draw-and-write research revealed differences in interests according to age: whilst young children wanted to go under a car, wash a car or change a wheel, older children wanted to drive a car or find out how it worked. The activities within Eureka! are directly related to this research: the car-wash in particular was developed because so many young children specified this as an interesting and appealing activity.

Similarly, the bank provided an unexpected source of fascination to children, who expressed a clear desire to be surrounded by large amounts of money. As this could not be real money, the Eureka! team had to devise a way of providing money which children would acccpt as the real money of the Eureka! world. A significant number of children expressed a desire to obtain money from the ‘hole in the wall’—a cash dispenser is provided, alongside role-play activities which encourage children to appreciate that it is necessary to deposit money into a bank before it can be withdrawn. The research tried to identify children’s perceptions of roles within a bank, and one group of 10-year-olds all sat back with their feet on the table when asked what the bank manager did! It quickly became apparent in the research that a large percentage of children also expressed a desire to rob a bank, which might have created problems with potential sponsors! A bank vault with appropriate security devices was introduced, with the activity devised so that it was difficult to reach the treasures in the vault without setting off the alarms. Inevitably, using children’s ideas can create potential conflict with sponsors, but, on the other hand, the research can play a useful role in persuading sponsors of the relevance and use of the

exhibition since it helped identify areas of interest, levels of knowledge and misconceptions to be challenged. The activities eventually developed within the bank arose directly out of the front-end evaluation, which is one reason why it is one of the most successful exhibition spaces at Eureka!

The research also revealed incredible diversity of knowledge. On the supermarket visit, one young boy quizzed the manager about the ratio of white to Asian staff, and whether the manager had ever been sued by a member of staff or a customer. Conversely, some 8-year-olds had no knowledge of what takes place within a factory, whilst many more associated factories with chocolate, since a local chocolate factory is a major employer. This range of knowledge amongst children of similar ages, let alone children of different ages, has implications for the development of exhibitions: exhibitions have to be introduced simply and clearly ('What happens in a factory?') and also include activities for children with more detailed knowledge.

Similar evaluation also took place for the Inventing and Creating exhibition, for which it became apparent that children have a particular interest in the communication of today's adult world. Yesterday's technology, or indeed the technology of the future (such as the videophone), met typically with indifferent responses from the children, but the chance to get their hands on a fax machine for the first time was very exciting! This finding matches that of the Living and Working Together research, which indicated a fascination for role-play in the bank or with the technology of the cash dispenser—providing access to the familiar, but unavailable adult world is one of the secrets for success in a children's museum. Providing access to the unfamiliar—such as the factory or the videophone—is less appealing and much more problematic conceptually.

Whilst the front-end evaluation can help identify children's interests and misconceptions, and provide guidance for the development of exhibits, only evaluation of the exhibit itself will identify whether or not the developer has successfully met the exhibit objectives. It is clearly much more cost-effective to address problems during the development process, and this is the role of formative evaluation. Assistance from BT enabled some communications equipment to be set up in the classroom, and some simple activities were devised to evaluate children's interests. Fax machines are inherently complex, and formative evaluation helped identify the simplest possible instructions which would enable children to use two back-to-back machines successfully. Unfortunately, the nature of the development process at Eureka! before opening, where every exhibit was provided by external exhibit builders, meant that it was not possible to test many prototypes with target audiences. Hands-on centres where all exhibits are built in-house offer the opportunity to try out prototypes with visitors, and indeed Eureka! was able to test new exhibits at the mock-up stage after it had opened to the public. Thus, new exhibits to enhance visitor orientation were tested at the formative stage in summer 1993.[28]

The alternative to responding to formative evaluation is to take remedial action after the exhibit has been constructed to exhibition standards and after instructional graphics have been designed and printed. Responding to summative evaluation in this way is clearly more expensive than responding to evaluation at a developmental stage. The Eureka! development team had reservations about the final form of five of the exhibits for Me and My Body that had been produced with some considerable adaptation from the original brief. Summative evaluation was carried out by an external consultant after these

exhibits had been installed, but prior to opening to the public. One of these exhibits was intended to help children gain an understanding of the digestive process, but the research revealed that many children misconstructed the intended messages. Although the fantasy design of the exhibit appealed to children, its complexity caused some younger children to speculate about what was going on and some older children to rationalise on little evidence. In general, the design appeared to work against the simplicity of the messages to be conveyed.[29] Thus, although the overall exhibit was intended to show digestion in humans, many children identified the fantasy design with a fish or shark, with a robot or machine. Each individual component of the biting, chewing and swallowing sequence caused similar misconceptions: for example, orange inflating and deflating bags designed to represent lungs were misconstrued by one 9-year-old to be windsocks which fill up when you breathe out.

After Eureka! opened to the public in July 1992, a formal summative evaluation programme was identified by the Eureka! development team in conjunction with the same external consultant to:

1 Discover whether the intended educational objectives of the exhibits were being met.
2 Review unpopular exhibits with the aim of improving them.
3 Identify those factors which help make a successful exhibit.[30]

The first stage of this evaluation programme was to conduct a demographic survey of visitors to identify the visitor profile, so that smaller quota samples could be later used in evaluating individual exhibits, and to gauge visitor opinions to inform marketing and exhibit development in general. Thus, a questionnaire survey of 600 visitors, designed by the consultant in association with the Eureka! team, was administered by students in summer 1993. This identified some surprising findings: for example, it was found that 25 per cent of all visitors were aged under 5, and yet only a very small percentage of the exhibits were designed specifically for this age group.

The subsequent evaluation programme identified research to evaluate individual exhibits, the education programme and, in particular, psychological and geographical visitor orientation. The Eureka! team felt strongly that some children in family groups did not maximise the opportunities at Eureka! because visitors lacked the prior knowledge of what was expected of them. Without prior experience of a children's museum, many parents did not contribute to the learning process, whilst others allowed their children to become over-excited, causing annoyance to other visitors and sometimes causing damage to exhibits. The evaluation programme sought to identify how physical and psychological orientation might be improved to overcome these problems.

The orientation evaluation study showed that of 118 studied groups, at least 70 per cent turned left as they entered the museum, into the Inventing and Creating exhibition, and the area with the least exhibits appropriate for families with young children. A subsequent small-scale semi-structured interview of groups which had not previously visited Eureka! found that whilst virtually no one wanted a planned route around the exhibition, many would have liked better age-ranging and description of the exhibits. Most visitors understood the context of the gallery spaces through their titles, but had less idea of their contents. Most had a clear idea of the benefits to their children that a visit could bring, but were less clear of the benefits to adults. Although the general concept of Eureka! as being a place of fun/activity/light and colour was clear, the concept of a

children's museum was not. Whilst the majority thought that adults and children could learn together, only half felt that their role was to be active with their children throughout all stages of the visit.

The outcome of this summative evaluation was to design visitor orientation that would begin in the museum car park, and introduce and reinforce messages before the visitor reached the admissions desk, particularly in the queuing areas. The objectives were to place emphasis on the underpinning concept of a children's museum, to create a warm and friendly welcome, to offer visitors more awareness of the content of museum spaces, to suggest appropriate roles and behaviour for adults and children, and to emphasise the charitable nature of the organisation (the visitor survey had identified confusion over the financial objectives of the organisation, with visitors unclear whether it was not-for-profit, commercial or run by the local authority). One particular problem was to take into account the need to be non-directive: based on the philosophy of discovery learning, the museum clearly needed to avoid intentional directing, route planning or too many rules on behaviour. A number of statements were suggested by the Eureka! team which were then subjected to a programme of formative evaluation with visitors.[31]

The evaluative research undertaken by the Eureka! team was a pragmatic response to developing an exhibition with limited time and human resources. The research would not meet rigorous academic scrutiny: the findings are indicative rather than comprehensive, for with more staff and time it would have been possible to produce more reliable results. However, the front-end evaluation programme provided valuable data which informed the team on children's interests and understanding, and upon which exhibits could be developed with more confidence. The inability to carry out formative evaluation on exhibits constructed on a tight time schedule and away from Halifax was a major disadvantage, but the summative evaluation programme begun in 1992, drawing on the results of a valid visitor survey to provide the overall context for future research, was a logical and consistent attempt to address some of the problems identified, and to inform the future development of exhibits.

Exhibit evaluation at the Science Museum: a case study

The Science Museum conducted a similar programme of work on the development of its basement galleries, which opened in 1995. Within this space, the Things gallery is designed to encourage children aged 7–11 to look closely at objects and how they are made, and to function as an introduction to exploring artefacts in the museum as a whole. The museum conducted front-end evaluation with children to find out those qualities of objects they found most interesting. This study gave a valuable insight into children's thinking about the museum's role and provided guidance in the choice of objects to form the focus of activities.[32] As the exhibits were developed, small groups of children and adults were recruited from school groups visiting Launch Pad to test the prototype exhibits. These children were observed and interviewed, and the results of the research informed further development of the exhibit.[33] Shortly after the gallery opened to the public, a programme of summative evaluation took place. Between October 1995 and January 1996, a tracking study of sixty family and school visitors took place in the gallery. It was found that the median time spent in Things was fifteen minutes, with a maximum recorded time of fiftynine minutes and a minimum time of one minute.

Observing when visitors physically interacted with exhibits, and how long they interacted for, enabled the museum to identify the relative attracting and holding powers of individual exhibits. It also helped identify 'dead' areas of the gallery, for example where exhibits were hidden from view, in a cul-de-sac, or simply in the 'shadow' of more popular exhibits adjacent to them.[34]

This observational research was subsequently followed by an exit survey of eighty adults and children in both school and family groups. This identified visitors' likes and dislikes in the Things gallery. Children expressed preferences for mechanical interactives where they were physically involved, where they felt in control or where they could perform to their friends and family. Not surprisingly, they disliked exhibits which were physically difficult, static or required too much or difficult reading.[35] This research was supported by detailed observational studies of fourteen groups which were accompanied around the gallery to identify their reactions, behaviour, routes taken, the relative appeal of individual exhibits to different members of the groups, and potential or actual safety problems.[36]

Thus, the Science Museum has carried out a range of small-scale research at every stage of exhibit development to gauge the reactions of the target audience to the Things gallery. In most cases, the sample studied was small, but utilising a range of research techniques helps to triangulate the results. As at Eureka!, a battery of evaluation studies helped to build up a larger picture of visitors' interests and understanding, and helped to inform future development of exhibits. Unlike Eureka!, the Science Museum has a team of research specialists in its Public Understanding of Science Unit, who are employed to undertake this research. Thus, the Science Museum research was able to be more thorough and systematic than that employed at Eureka! during its early development, but the techniques used were similar. Whilst the results of these evaluation studies are indicative of visitors' interests, behaviour and understanding, they are simply too small in scale to constitute academic research with findings that are valid and reliable, or indeed that are transferable between hands-on centres or between different cultures. However, these studies do provide a very useful tool to inform the exhibit development process and, as long as interpretation of the data is rational and objective, they are a significant improvement on the more traditional method of developing exhibits based on experience and gut feelings alone.

Exhibit development and evaluation: some conclusions

There is no one process that will guarantee the successful development of an effective interactive exhibition. For very large museums and science centres, it has been possible to develop a broad range of design, construction and evaluation skills in-house, and over a period of time considerable expertise has been accumulated, largely by a process of trial and error. For most small or new centres, limited resources ensure that it is rarely feasible to develop a comprehensive in-house team, and even if resources are available, mistakes made by other centres as part of the learning process will be made again unless experienced exhibit developers are recruited. The alternative for new centres is to employ contractors whose expertise has developed elsewhere. The difficulty is to know whether to turn to exhibition designers or companies specialising in developing interactive

exhibits. The reality is that both groups have strengths and weaknesses. Either way, the client needs to have specified a very clear brief identifying the exhibition objectives. Thereafter, the problem is to maintain control over the development process to ensure effective exhibits that meet the original objectives are delivered on time and within budget. To achieve this outcome, many hands-on museums and science centres find it advantageous to maintain control of project management in-house (or by employing an independent project manager), even if the design and construction of exhibits is contracted out.

It is an essential prerequisite of an effective interactive exhibition that all exhibits are evaluated with target visitor groups. The museum or science centre commissioning contractors to develop exhibits needs to ensure that evaluation is an integral part of every stage of the development process, as there is always a temptation for contracted designers and developers to rely on their previous experience. Exhibit evaluation is such an integral part of exhibit development that it is desirable for the museum to develop in-house skills to oversee the process, or at the very least to employ an independent specialist evaluator.

Few museums or science centres are able to develop specialist teams of evaluators like those at the Science Museum. For most museums, the evaluation programme implemented will be a pragmatic response to developing an exhibition with limited resources. Much of the success enjoyed by Eureka! The Museum for Children can be attributed to the front-end evaluation carried out with children as the exhibit briefs were being prepared. Since most exhibits were constructed away from Halifax, formative evaluation at the prototype stage was difficult, and many exhibits were delivered without effective trialling by their developers. Thereafter, Eureka!’s decision to employ an independent evaluator to train in-house staff and to develop and oversee a summative evaluation programme carried out by museum staff and student volunteers was a cost-effective compromise.

4
Finance

This chapter considers both capital and revenue funding for interactive centres, and investigates their financial and operational performance through a range of indicators.

Introduction

The rapid development of hands-on exhibitions in recent years (outlined in Chapter 1), together with the plethora of awards that centres such as Eureka! The Museum for Children have won, can lead to the conclusion that hands-on exhibitions are highly successful. Indeed, they are—if success is measured in terms of popularity by visitors. However, it is significant that whilst some private sector operators have successfully developed profitable attractions based on children's play, the commercial leisure industry in general has not tried to emulate hands-on museums. Hands-on museums are expensive to develop and operate, and this chapter investigates their financial viability in detail.

The financial performance of hands-on centres in the USA

The Association of Science and Technology Centers' (ASTC) survey provides detailed aggregate information on the financial health of eighty-one US science centres and museums in 1986. Of those museums, 86 per cent had an excess of income over expenditure in the three preceding years, and 64 per cent had increased this surplus in this period. Almost all museums operated near breakeven point, with 47 per cent with a surplus or deficit within 5 per ccnt of their total gross revenue (and over three-quarters within 10 per cent).[1]

Overall, 35 per cent of income was generated by trading activities from visitors and 65 per cent from donations and grants (although the smallest and largest centres generated a higher proportion from grants than the medium-sized centres).[2] Twenty-nine per cent of earned revenue overall came from admissions, with the larger institutions being less dependent than the small centres for admissions as a source of income. Food sales were insignificant at small centres, but income from shops ranged from 9 per cent to 15 per cent of earned income. On the support side, about half of all support came from governmental sources, with local government being the most important for all sizes of centre, but with federal support being second most important for the small organisations, and state support second most important for the large organisations. Support from individuals ranges from 6 per cent to 22 per cent (being most important for small centres), whilst corporate support ranged from 6 per cent to 9 per cent, and foundation support from 6 per ccnt to 11 per cent.[3]

In total, therefore, around one-third of income came from trading activities, onethird from governmental sources, and one-third from individuals or corporate sources.[4] However, among the centres that opened after 1979, about two-thirds of income was earned, with centres opening after 1986 claiming even higher percentages of earned income. There is an increasing trend for centres to rely more on trading activities than government or philanthropic support, with some of the more recent centres trying to survive on earned income alone, although whether they can be successful is not yet proven.[5]

A comparison of the sources of income for four children's museums in 1990 is interesting:

Indianapolis Children's Museum

42 per cent of income was earned from trading activities (17 per cent from admissions; 25 per cent from shop sales or from the leased restaurant), 19 per cent was donated by individuals or corporations, whilst 40 per cent was earned through museum investments.[6]

Chicago Children's Museum

51 per cent of income was earned, 42 per cent was donated (28 per ccnt came from foundations or corporations; 14 per cent from individuals), 4 per cent came from government and 2 per cent from other sources.[7]

Please Touch Museum, Philadelphia

60 per cent of income was earned (48 per cent from admissions, memberships or special events; 12 per cent from the shop), 37 per cent from grants and contributions and 4 per cent from interest and other sources.[8]

Children's Museum of Manhattan

62 per cent of income was earned (55 per cent from admissions, memberships, special events and programme fees; 7 per cent from the shop), 16 per cent from government sources and 17 per cent from individuals, corporations or foundations, with 5 per cent from other sources.[9]

It is significant that the largest of these children's museums, Indianapolis, was less dependent on earned income than any of the other museums, but received 40 per cent of its income from investments. The Children's Museum of Manhattan, on the other hand, was dependent on trading for almost two-thirds of its income, with the remainder split between governmental and private support. Please Touch Museum received a similar proportion of its income from earned sources, but almost all the remainder (37 per cent) came from grants and contributions. Chicago Children's Museum received the highest proportion of its income (42 per cent) from grants, sponsorship or donations. Overall, these four museums reveal the huge diversity in sources of income between similar types of museum, although only Children's Museum of Manhattan received a significant proportion of its income (16 per cent) from public sector sources.

The financial performance of hands-on centres in the UK

In the UK, the hands-on centres are largely operated by public sector bodies or by independent charitable trusts, rather than by private sector operators. Indeed, a private sector organisation would not meet the UK definition of a museum, and would not be eligible for public sector funding in the UK. Nevertheless, the receipt of, for example, National Lottery funding requires the applicant to demonstrate the financial viability of the project, and several hands-on projects have secured substantial awards from the Millennium Commission. So how successful are the hands-on centres in financial terms, and how can one measure performance?

In the public sector it can be difficult to separate the accounts of one site from those of a broader leisure services department, and this is particularly true if the hands-on centre provides one element of a much larger institution, such as the Science Museum. Whilst the capital costs of Launch Pad, Flight Lab and the new basement galleries in the Science Museum can be accurately quantified, the operating costs of these centres are much more difficult to measure, particularly as they share many central services with other parts of the Science Museum. Furthermore, it is also very difficult to identify the proportion of income that is derived from having hands-on centres within a larger museum, as admission prices cover the whole site and visitors rarely confine themselves to just the hands-on centre itself. Even if these public sector organisations produce their own working budgets for their hands-on centres, these figures are not likely to be available in the public domain.

However, it is possible to investigate the accounts of those independent hands-on centres which are private companies backed by charitable status. Such organisations are obliged to file their annual accounts at Companies House, and these records are available for scrutiny by the public. The published accounts of Eureka! The Museum for Children, Techniquest and the Exploratory provide an insight into the financial health of these hands-on exhibitions.

Table 4.1 presents abbreviated financial accounts for Eureka!, Techniquest and the Exploratory in 1995.

Table 4.1 Comparative financial performance of UK interactive centres, 1995–6

	Eureka!	*Techniquest*	*Exploratory*
Trading income	1,176,099	624,760	441,697
Grants, donations & sponsorship	1,014,686	747,943	85,330
Interest	−7,278	38,297	3,815
Expenditure	−1,433,577	−976,913	−541,925
Depreciation	−795,114	−442,825	−6,034
Net surplus/deficit	−45,184	−8,738	−17,117

Source: derived from statutory accounts; additional information supplied by Techniquest
Notes: i) Eureka!'s financial year ended December 1995
ii) Techniquest's financial year ended July 1996
iii) Techniquest's accounts exclude development costs of Phase III
iv) The Exploratory's accounts for period ended January 1996 were for sixteen months and have been adjusted pro rata to twelve months for comparative purposes

Direct comparison between different accounts must always be an inexact science owing to different individual circumstances and accounting methods. Comparison of these abbreviated accounts for Eureka!, Techniquest and the Exploratory in 1995–6 shows the very different financial performance of the centres, although all three showed a modest overall deficit which was 3 per cent or less of total revenue in each case (Eureka! 2 per cent, Techniquest less than 1 per cent, the Exploratory 3 per cent). This measure of performance is therefore very similar to that described above for the US hands-on centres in the 1986 ASTC survey.

The Exploratory has the smallest turnover of the three centres, and is also the least dependent on grants, sponsorship and donations. Techniquest, on the other hand, earned the smallest percentage of its income from its trading activities and received the largest percentage from grants, sponsorship and donations. Conversely, Eureka! earns a significantly higher sum from its trading activities than Techniquest, although its overall net deficit is higher. This is largely because its depreciation of tangible fixed assets of £5 million is significantly higher than Techniquest's depreciation on £2.4 million and the Exploratory's depreciation on £20,000 (Eureka! and Techniquest depreciate exhibition equipment over a shorter period than the Exploratory: five rather than ten years for non-computer equipment, and five rather than three for computers).

Table 4.1 provides a snapshot of the financial health of the three hands-on centres in 1995. The following pages analyse the financial position of these centres over a longer time-period, and introduce some indicators by which performance of the centres might be measured. These include:

- Average income per visitor from trading activities.
- Trading activities as a percentage of total income.
- Sponsorship and grants as a percentage of total income.
- Operating costs per visitor.
- Average cost per staff.
- Staff as a percentage of total expenditure.
- Publicity spend per visitor.
- Publicity as a percentage of total expenditure.

Eureka! The Museum for Children

Eureka! The Museum for Children opened to the public in July 1992, and its accounts for that year do not reflect a full year's operation. However, the published accounts for 1993–5 do provide an insight into the longer term financial health of the organisation, as can be seen in Figure 4.1.

Between 1993 and 1994, Eureka! gained a 2 per cent increase in visitors, and raised the average income from visitors from £2.89 to £3.03 (from ticket sales and secondary spend in the shop and cafeteria). At the same time, overall expenditure was reduced by 8.6 per cent, reducing average costs per visitor from £3.66 to £3.29. Between 1994 and 1995, Eureka!'s visitor figures fell by 16 per cent, although the average income from visitors increased to £3.28. At the same time, expenditure increased by 5 per cent.

Year	1993	1994	1995
No. of visitors	407,000	414,000	358,000
Income			
Operating income from trading activities (£)	1,178,061	1,255,792	1,176,099
Av. income per visitor (£)	2.89	3.03	3.28
Income from spons./grants (£)	722,189	528,945	1,014,686
Total income (£)	1,908,038	1,790,924	2,199,722
Trading activities as % total income	62	70	53
Spons./grants as % total income	38	30	46
Expenditure			
Operating costs (£)	1,488,211	1,360,631	1,433,577
Operating costs per visitor (£)	3.66	3.29	4.00
Expenditure: staff (£)	706,512	634,631	659,678
No. of staff	58	52	70
Av. cost per staff (£)	12,181	12,204	9,424
Staff as % expenditure	48	47	46
Expenditure: publicity (£)	102,719	124,012	158,656
Av. publicity cost per visitor (£)	0.25	0.30	0.44
Publicity as % expenditure	7	9	11
Surplus/deficit			
Net surplus/deficit before tax (£)	−375,635	−384,110	−45,184

Figure 4.1 Financial performance of Eureka! The Museum for Children, 1993–5

Source: financial data derived from statutory accounts; visitor figures derived from statutory accounts (1995) and *Sightseeing in the* UK[10]

Notes: i) Financial year ends December

ii) Expenditure excludes depreciation

Eureka!'s accounts do not provide a full breakdown of operating expenditure, although they do reveal that the museum is spending increasingly large sums on marketing, increasing the expenditure per head on publicity from £0.25 in 1993 to £0.44 in 1995 (from 7 per cent of expenditure to 11 per cent). Overall, Eureka! is both losing visitor numbers and spending increasing sums on marketing. This is consistent with an organisation three years into its life-cycle, approaching the maturity stage and therefore no longer gaining as much exposure in the media as when it first opened.

Although the average remuneration per employee and the percentage of expenditure on staffing remained much the same between 1993 and 1994, the reduction in staff numbers from fifty-eight to fifty-two ensured an overall reduction in staffing expenditure. By 1995, staff numbers had increased to seventy, although the overall proportion of expenditure allocated to staffing remained constant (in fact, Eureka! was employing more staff at an average cost of 23 per cent less than in 1994).

Eureka! is heavily dependent on sponsorship and grants: indeed, 46 per cent of its income in 1995 was derived from this source (compared to 30 per cent in 1994, and 38

per cent in 1993). This represents a 92 per cent absolute increase on 1994, which helped to offset the loss in income from trading activities caused by the reduction in visitors, and the increase in overall expenditure. Overall, Eureka! substantially reduced its net deficit before tax between 1994 and 1995, but rising costs alongside reduced visitor numbers conceal an organisation that is becoming increasingly dependent on grants and sponsorship rather than earned income.

Techniquest

Figure 4.2 shows an organisation undergoing fundamental change as it expanded and developed (Phase III of Techniquest opened in May 1995). What is significant is that Techniquest has effectively doubled its visitors on the new site, and has increased the relative share of its income gained from trading activities (79 per cent of this earned income in 1996 is from admissions, compared to 67 per cent in 1995, and 68 per cent in 1994. It is not possible to compare this performance with that of Eureka!, as Eureka!'s published accounts do not identify the separate income from admissions). Although Techniquest increased its income from trading activities between 1995 and 1996, it remains more dependent than Eureka! on grants and sponsorship.

On the expenditure side, expenditure on publicity at 6–7 per cent of total expenditure reflects an organisation that is at an early stage of its life-cycle. Whilst Eureka! is having to increase expenditure on publicity in an effort to maintain visitor levels, in 1996 Techniquest was still enjoying the benefits of publicity associated with the launch of Phase III.

Although the average cost per staff member is less at Techniquest than at Eureka!, Techniquest has continued to increase the number of its staff, such that by 1996 they constitute 70 per cent of all expenditure. This is significantly higher than the figure of 46 per cent at Eureka! in 1995, or indeed in the USA where staff costs are typically between 51 and 53 per cent of all expenditure.[11]

Year	1994	1995	1996
No. of visitors	107,277	125,414	250,433
Income			
Operating income from trading activities (£)	204,278	299,465	624,760
Av. income per visitor (£)	1.90	2.39	2.49
Income from spons./grants (£)	379,540	392,564	747,943
Total income (£)	602,621	693,288	1,411,000
Trading activities as % total income	34	43	44
Spons./grants as % total income	63	57	53
Expenditure			
Total costs (£)	529,834	691,342	976,913
Total costs per visitor (£)	4.94	5.51	3.90
Expenditure: staff (£)	304,036	416,271	681,117
No. of staff	48	60	104
Av. cost per staff (£)	6,334	6,938	6,549
Staff as % expenditure	57	60	70
Expenditure: publicity (£)	35,047	48,400	60,977
Av. publicity cost per visitor (£)	0.33	0.39	0.24
Publicity as % of expenditure	7	7	6
Surplus/deficit			
Net surplus/deficit before tax (£)	54,731	−14,450	−8,738

Figure 4.2 Financial performance of Techniquest, 1994–6

Source: derived from statutory accounts and information supplied by Techniquest

Notes: i) Financial year 1994 ends March; financial years 1995 and 1996 end July

ii) Accounts for period ending July 1995 were for sixteen months and have been adjusted pro rata to twelve months for comparison

iii) Expenditure excludes depreciation

iv) Development costs of Phase III are excluded

The Exploratory

As can be seen in Figure 4.3, the Exploratory earns a substantial proportion of its income from its trading activities (83 per cent of total income in 1995). The vast majority of this income is from admissions (85 per cent of trading income in 1994), although these fell by 8 per cent between 1994 and 1995, with a consequent fall in income from trading by 8 per cent. The Exploratory is less dependent on grants and sponsorship than either Techniquest or Eureka!, although income from these sources fell by 6 per cent between 1994 and 1995.

Year	1993	1994	1995
No. of visitors	157,408	165,969	153,194
Income			
Operating income from trading activities (£)	401,523	477,865	441,697
Av. income per visitor (£)	2.55	2.88	2.88
Income from spons./grants (£)	170,633	90,986	85,330
Total income (£)	572,896	571,275	530,841
Trading activities as % total income	70	84	83
Spons./grants as % total income	30	16	16
Expenditure			
Operating costs (£)	510,339	538,593	541,925
Operating costs per visitor (£)	3.24	3.25	3.54
Expenditure: staff (£)	216,773	303,940	310,601
No. of staff	39	43	40
Av. cost per staff (£)	5,558	7,068	7,765
Staff as % expenditure	43	56	57
Expenditure: publicity (£)	32,638	59,690	N/A
Av. publicity cost per visitor (£)	0.21	0.36	N/A
Publicity as % expenditure	6	11	N/A
Surplus/deficit			
Net surplus/deficit before tax (£)	256,970	25,054	−17,117

Figure 4.3 Financial performance of the Exploratory, 1993–5

Source: financial data derived from statutory accounts; visitor figures derived from *Sightseeing in the UK*[12]

Notes: i) Financial years 1993 and 1994 end September; financial year 1995 ends January 1996

ii) Accounts for period ending January 1996 were for sixteen months and have been adjusted pro rata to twelve months for comparison

iii) Expenditure excludes depreciation

On the expenditure side, there was less than a 1 per cent increase between 1994 and 1995, and operating costs per visitor are very similar to those of Eureka! Overall, the Exploratory is an organisation that is fairly stable in terms of expenditure, but is suffering from reduced visitor numbers. Although expenditure on marketing is not available for 1995, it is interesting that the proportion spent on publicity increased from 6 to 11 per cent between 1993 and 1994. This suggests that the Exploratory may have entered a decline in its lifecycle, having to spend more on marketing, but nevertheless gaining less visitors in 1995 and less income from grants and sponsorship. The outcome is that the Exploratory showed a net deficit in 1995, compared to surpluses in 1993 and 1994. Although Eureka! exhibits similar characteristics, that organisation has been able to increase its income from grants and sponsorship in 1995. The Exploratory has responded to the decline in its life-cycle, since it will be relocating within Science World, a new £25 million hands-on centre, by the year 2000 (see Chapter 1).

Financial performance indicators

Average income per visitor from trading activities

All three centres demonstrated a consistent improvement in earned income over the three-year period, from £1.90 to £2.49 per visitor at Techniquest, from £2.89 to £3.28 per visitor at Eureka!, and from £2.55 to £2.88 at the Exploratory. This includes income from admissions, retailing and catering activities. The average for all three centres is £2.70.

79 per cent of earned income at Techniquest came from admissions in 1995, compared to 85 per cent at the Exploratory in 1994 (similar data for Eureka! is not available).

Trading activities as a percentage of total income

There is considerable variation between the centres on this performance indicator, ranging from 34 to 44 per cent of total income at Techniquest, from 53 to 70 per cent at Eureka! and from 70 to 84 per cent at the Exploratory. The average for all three centres is 60 per cent.

Sponsorship and grants as a percentage of total income

There is also considerable variation between the centres on this performance indicator, ranging from 53 to 63 per cent of total income at Techniquest, from 38 to 46 per cent at Eureka! and from 16 to 30 per cent at the Exploratory. The average for all three centres is 39 per cent.

Operating costs per visitor

The average operating costs per visitor over the three years are similar at both Eureka! and the Exploratory (varying from £3.24 to £3.54 per visitor at the Exploratory and from £3.29 to £4.00 at Eureka!).Techniquest's operating costs per visitor have fallen from £5.51 in 1995 at the old site, to £3.90 in 1996 at the new site. The average for all three centres is £3.90 per visitor.

Average cost per staff member

The average cost per staff member ranged from £9,424 to £12,204 at Eureka!, from £6,334 to £6,938 at Techniquest, and from £5,558 to £7,765 at the Exploratory. This indicator needs to be treated with caution: for example, the Exploratory's indicated staffing of 43 in 1994 is made up of 16 salaried and 27 waged staff, according to the statutory accounts. This is at variance with information in the 1993/4 and 1996 British Interactive Group Directory entries, both of which indicate a staffing level of 16 full-time equivalent, made up of 10 full-time and 25 part-time staff. Whilst the financial accounts are clearly accurate for the sums spent on staffing, the numbers of staff are not necessarily for full-time equivalent posts: thus, it may be dangerous to extrapolate an average salary or wage from this information. However, the average for all three centres is £8,225 per annum.

Staff as a percentage of total expenditure

This is a more reliable indicator, ranging from 46 to 48 per cent of total expenditure at Eureka!, from 57 to 70 per cent at Techniquest and from 43 to 57 per cent at the Exploratory. The figure of 38 per cent at Techniquest in 1995 was distorted by the large overall expenditure on its redevelopment. The average for all three centres is 54 per cent, which is only marginally higher than the US science centres in the 1986 ASTC survey.[13]

Publicity expenditure per visitor

Both the Exploratory and Eureka! increased their expenditure per visitor on publicity in the period: from £0.25 to £0.44 at Eureka! for 1993–5, and from £0.21 to £0.36 at the Exploratory for 1993–4. Techniquest spent £0.39 per head in 1995 at the time of its redevelopment, but only £0.24 in the following year, when it enjoyed media exposure. Overall, the increases made by Eureka! and the Exploratory reflect an increasingly competitive leisure market in the UK. The average for all three centres is £0.32 per annum.

Publicity as a percentage of total expenditure

Eureka! increased its expenditure on publicity from 7 per cent of overall budget in 1993 to 11 per cent in 1995, and the Exploratory from 6 per cent in 1993 to 11 per cent in 1994. Techniquest spent 6 per cent of its expenditure on publicity in 1996 (compared to 7 per cent in 1994–5). These figures are consistent with the general ‘rule of thumb’ that promotion and public relations expenditure is typically around 10 per cent of total expenditure in a leisure organisation. The increases made by Eureka! and the Exploratory reflect the need for older attractions to increase promotional activity in the face of increased competition. The average for all three centres is 8 per cent.

Operational performance indicators

The performance indicators in the preceding section are based on financial information in the statutory accounts of the centres, combined with visitor figures derived from the accounts or from the *Sightseeing in the UK* series.[14] If one adds exhibition space and numbers of exhibits to the financial and visitor information, it is possible to derive some additional performance indicators. However, these indicators should be treated with a certain amount of caution: the Eureka! and Techniquest exhibition space is based on estimates supplied by the organisations of two-thirds of total floor space being devoted to exhibitions. The Exploratory exhibition space (52 per cent of total floor area) is based on information in the British Interactive Group Directories. The number of exhibits at each centre is based on the British Interactive Group Handbook,[15] and information supplied by the centres in promotional material. Clearly, each organisation may define an interactive exhibit differently from each other. The operational performance figures can be seen in Tables 4.2, 4.3 and 4.4.

Table 4.2 Operational performance of Eureka!, 1993–5

	1993	*1994*	*1995*
Visitors	407,000	414,000	358,000
Expenditure (£)	1,488,211	1,360,631	1,433,577
Exhibition space (square metres)	3,000	3,000	3,000
Visitors/square metre	136	138	119
Op. costs/square metre (£)	496	454	478
No. of exhibits	350	350	350
Visitors/exhibit	1,163	1,183	1,023
Op. costs/exhibit (£)	4,252	3,888	4,096
Op. costs/visitor (£)	3.66	3.29	4.00

Source: derived from statutory accounts; *Sightseeing in the UK;* promotional material; British Interactive Group, *Handbook*

Table 4.3 Operational performance of Techniquest, 1994 and 1996

	1994	*1996*
Visitors	107,277	250,433
Expenditure (£)	529,834	976,913
Exhibition space (square metres)	800	2,200
Visitors/square metre	131	114
Op. costs/square metre (£)	662	444
No. of exhibits	80	160
Visitors/exhibit	1,341	1,565
Op. costs/exhibit (£)	6,623	6,105
Op. costs/visitor (£)	4.94	3.90

Source: derived from statutory accounts; data supplied by Techniquest; British Interactive Group, *Handbook*
Note: 1995 data is excluded as Techniquest changed sites in this year

Table 4.4 Operational performance of the Exploratory, 1993–5

	1993	*1994*	*1995*
Visitors	157,408	165,969	153,194
Expenditure (£)	510,339	538,593	541,925
Exhibition space (square metres)	1,140	1,140	1,420
Visitors/square metre	138	146	108
Op. costs/square metre (£)	448	472	382
No. of exhibits	150	150	160
Visitors/exhibit	1,049	1,106	957
Op. costs/exhibit (£)	3,402	3,591	3,387
Op. costs/visitor (£)	3.24	3.25	3.54

Source: derived from statutory accounts; *Sightseeing in the UK;* promotional material; British Interactive Group *Directories*[16]

Visitors per square metre

The number of visitors per square metre is consistent across all three centres, ranging from 108 per square metre at the Exploratory in 1995 to 146 at the Exploratory in 1994. Data for both other centres fell within this range for all years. The average for all three centres is 129 visitors per square metre per annum.

The 1986 ASTC survey found that 44 per cent of US science centres had between four and ten visitors per square foot, which is the equivalent of between thirtyseven and ninety-two visitors per square metre, whilst 23 per cent had between 101 and 186.[17] Thus, the three UK centres have a slightly higher number of visitors per square metre than the USA average, but within the second most frequent category in the US survey.

Operating costs per square metre

Operating costs per square metre range from £382 at the Exploratory in 1995, to £662 at Techniquest in 1994. The average for all three centres is £480 per square metre per annum.

Visitors per exhibit

The average number of visitors per exhibit is also consistent between the three centres, ranging from 957 at the Exploratory in 1995 to 1,565 at Techniquest in 1996. The average for all three centres is 1,173 per annum.

Operating costs per exhibit

Operating costs per exhibit ranged from £3,387 at the Exploratory in 1995 to £6,623 at Techniquest in 1994. The average across all three centres is £4,418 per annum.

Operating costs per visitor

Operating costs per visitor ranged from £3.24 at the Exploratory in 1993 to £4.94 at Techniquest in 1994. The average across all three centres is £3.73 per annum. The 1986 ASTC survey found the average cost per visitor at US science centres was $7 (which is £4.40 at 1997 exchange rates).[18] Given that these figures do not take into account inflation or variations in the exchange rate, it is difficult to make any meaningful comparison between operating costs per visitor in the UK and USA, although the levels are clearly similar.

Sources of capital funding

Chapter 1 detailed how the early science centres in the UK received considerable financial support from charitable sources such as the Sainsbury trusts and the Nuffield Foundation. In the late 1980s, the Nuffield Foundation spent £1.25 million a year on education, financed from the endowment bequeathed by the late Viscount Nuffield. The early phases of the Exploratory in Bristol were funded by a Nuffield grant in 1986, and from 1988 the Discovery Dome travelling science centre received substantial support. The Foundation also supported other pioneering initiatives in the field, including the development of mobile science centres that could visit primary schools in a van (LightWorks), and extension activity kits developed by Techniquest.[19]

In 1987, the Foundation collaborated with the UK Government's Department of Trade and Industry (DTI) to establish the Interactive Science and Technology Project, which encouraged the development of science centres and provided a focus for the exchange of information and ideas. Nuffield provided £20,000 per annum over three years, with the DTI providing £10,000 over the period. In 1990, the Foundation provided £33,000 as a launching grant for ECSITE, the European Collaborative for Science, Industry and Technology Exhibitions, which exists as an exchange for information and activities for its members made up of non-profit science centres and museums.[20]

In the UK, the Royal Institution, the Royal Society and the British Association for the Advancement of Science co-founded COPUS, the joint Committee on the Public Understanding of Science. COPUS was formed in 1986 to improve public awareness of science and technology.[21] In 1989, COPUS collaborated with the Nuffield Foundation to produce a collection of reports and discussion articles on the state of hands-on education in the UK.[22] As part of its activities, small grants are awarded for the public understanding of science. In 1990, over £48,000 was made available in grants averaging £2,000 each. Indeed, the author received four such grants between 1989 and 1993 to enable Sheffield Industrial Museum to stage the Great Sheffield Exploratory in 1989 and to provide interactive exhibits for Eureka! The Museum for Children and the PowerHouse at Elsecar. In 1995, COPUS introduced a new level of grants from its Development Fund of up to £20,000 per annum, to complement grants from its existing Seed Fund of up to £3,000.[23]

The Nuffield Foundation, COPUS, ECSITE and the Department of Trade and Industry have played an integral role in providing funding, support and a focus for the exchange of ideas for the early development of science centres in the UK. However, there were other important contributors to the early development of the hands-on movement.

Eureka! The Museum for Children owes its origins to a £50,000 grant from the Department of Trade and Industry to the Children's Discovery Centre, which had been formed as a result of Mrs Rosemary Goldsmith returning from Boston in 1979 with the aim of establishing a children's museum in London. The grant helped pay for preliminary feasibility work, and in the mid-1980s a brochure was produced to try and attract financial support. This was sent to Mrs Vivien Duffield, who had herself recently returned from Boston after a visit with her children. Vivien Duffield is daughter of the late Sir Charles Clore, whose Clore Foundation had provided the capital for the Turner extension on the Tate Gallery. Initially, the Clore and Vivien Duffield Foundations provided £5 million for the development of the Children's Museum project, which eventually found its home in Halifax in 1987.[24] By the time Eureka! opened to the public in 1992, with the influential Vivien Duffield as Chairman of Trustees, the museum had been able to attract an additional £2 million of corporate sponsorship and private patronage, in addition to £7 million from the Clore and Vivien Duffield Foundations. Indeed, as Figure 4.1 indicates, Eureka! continued to receive significant levels of grants, donations and sponsorship in 1995.

Whilst Vivien Duffield remains as Chairman of the Eureka! trustees in 1997, the Clore and Vivien Duffield Foundations have continued to support other hands-on centres. They provided the main source of funding for the Natural History Museum's Travelling Discovery Centre, for Things at the Science Museum, and for the fit-out of All Hands, the interactive gallery at the National Maritime Museum which opened in 1995 (All Hands is part of the £2 million Leopold Muller Education Centre, made possible with £1.3 million from the Leopold Muller Estate).[25] Private family foundations have played an important role in the development of many of the UK hands-on museums and science centres. For example, the Gatsby Foundation—a private trust of the Sainsbury family—provided the initial £83,000 launching grant for Phase I of Techniquest, but had provided £680,000 in total by 1990 for Phase II.[26] Seed funding by private foundations can often help a new museum persuade other organisations to provide financial support. For example, by 1993 over fifty other organisations had made grants or donations to Techniquest, ranging from £1,000 to £250,000, and totalling over £1 million to Phase II of its development.[27] Similarly, the Exploratory received funds from over eighty organisations and companies, with seven organisations having given £1,000 or more by 1992.[28]

The early science centres and hands-on museums were generally more dependent on charitable foundations and commercial sponsors than on grants from local or national government sources. One exception is the £7 million Snibston Discovery Park, which received £4.5 million from Leicestershire County Council for developing its exhibitions, together with grants from other public bodies, and sponsorship and donations from private sources. Even those hands-on centres within traditional local authority or national museums were heavily dependent on sponsorship and patronage to enable new developments to take place. For example, Launch Pad's initial £1 million development costs were funded by the Science Museum, a government grant and support from the Leverhulme Trust.[29]

Whilst commercial sponsors and charitable foundations remain important for the future development of hands-on centres, increasingly large-scale developments are dependent on newer public sources of funding. Elsecar Discovery Centre, which includes the PowerHouse interactive gallery, has largely been funded by European grants and

other sources of finance available to former coal-mining areas. Similarly, as the lead project of the Cardiff Bay Development Corporation, Techniquest's £7 million Phase III development was funded largely by the Welsh Development Agency, Wales Tourist Board and European grants. The sites of both Elsecar Discovery Centre and Techniquest in areas of urban regeneration provided these opportunities for substantial financial support. As one commentator has noted, 'The future of the science centre appeared to be in the lap of politicians and property developers, sidelining the visionaries into the role of a pressure group.'[30]

The future development of hands-on museums and science centres in the UK is very much dependent on National Lottery funding. The Millennium Commission, in particular, is funding several major new developments or redevelopments of existing centres. In May 1996, the Millennium Commission announced that it would support half the costs of the £82 million Bristol 2000 scheme, including two new interactive centres, one of which is Science World—a new home and name for the Exploratory. The Exploratory part of the project will cost £25m, including a planetarium, virtual theatre and a high-tech 'explanatory' (with interactive computer technology to tailor information to visitors' interests and needs). In total, there will be 400 exhibits. Partnership funding of £41 million for the whole scheme will come from Bristol City Council, English Partnerships, the Harbourside Sponsor Group (a levy will be provided from adjacent commercial and residential development), the Smithsonian Institute in Washington and other private sector funding.[31]

Meanwhile, the Birmingham Discovery Centre will provide a new home for Light on Science, with funding of £50 million from the Millennium Commission for the Millennium Point complex at Digbeth.[32] The Discovery Centre will include major new hands-on galleries integrating low- and high-tech exhibits with the museum collections of science and industry, natural history and local social history. Partnership funding for the Discovery Centre will come from the European Regional Development Fund, Birmingham City Council and the private sector.

Science World and the Birmingham Discovery Centre are just two of a whole range of interactive projects supported by the Millennium Commission that will fuel competition for existing centres. At the time of writing, there is uncertainty over which projects will actually raise the necessary partnership funding, but it is clear that apart from the Millennium Commission—which supports large innovative new projects—there is no other obvious source of National Lottery money available to hands-on museums and (especially) science centres. The Heritage Lottery Fund places its emphasis on the management of heritage assets, and will not support interactive exhibitions unless they are part of a much larger scheme which can demonstrate considerable heritage benefits (an award of £23 million from the Heritage Lottery Fund towards the Science Museum's new Wellcome Wing of contemporary science, medicine and technology was the first award from that body to the sciences).[33] Indeed, the British Association and the Royal Society are campaigning for scientific institutions to be able to access National Lottery funding more directly.[34] Meanwhile, the Arts Lottery Fund is funding the National Centre for Popular Music in Sheffield, which will contain a major interactive element throughout its exhibitions, and especially in its Making Music gallery.

Capital costs

The cost of developing a new interactive discovery centre is clearly made up of a combination of site acquisition and development costs, building costs and exhibit development costs.

Site

Site costs are entirely dependent on the location chosen. The original proposers of the Children's Museum that eventually became Eureka! were initially looking at sites in the London area. The Halifax site was chosen for a number of reasons: the Prince of Wales—the patron of Eureka!—is president of Business in the Community, an organisation which chose Calderdale as a pilot area for a regeneration project. Through its influence a 12.5 acre derelict plot of land (a former railway goods yard) valued at £2.8 million was obtained for £350,000 on a 125-year lease from the local authority.[35] As illustrated in the previous section, other centres such as Elsecar Discovery Centre and Techniquest have been able to take advantage of grants available to derelict areas. Thus, the choice of site frequently depends on a range of factors, such as the availability of development grants, in addition to market value.

Buildings

Many of the early centres were developed in low-cost conversions of existing premises. Techniquest began in former gas showrooms in the central shopping area of Cardiff, before moving to a modern industrial unit, and then to its current high-quality premises built around the iron framework of a nineteenth-century engineering workshop. The Exploratory began in temporary accommodation in Bristol's Victoria Rooms, before moving to its present premises in the old Temple Meads Railway Station. The PowerHouse at Elsecar also occupies former railway premises (an old engine repair workshop), whilst Eureka! was originally planned to be located in the Great Northern Shed, a vast railway warehouse on the Eureka! site.

In fact, the decision was made to construct purpose-built new premises at Eureka! adjacent to the Great Northern Shed largely on cost grounds—it was cheaper to build a new building than to convert the old warehouse for public use (the new building also has the advantage of being nearer to the station and town centre, and is much cheaper to operate than a converted Victorian industrial building). Eureka!'s building is deceptively clever. Although many of its services are designed to very high standards, the building is essentially an industrial unit cleverly disguised with a glass front. A stone wall dissecting the glass wall symbolises a 'knife' cutting through the building, within which many of the structures and services have been left exposed and interpreted for visitors. The building won an architectural award from the Royal Institute of British Architects,[36] yet it cost little more than an standard industrial unit. Such a building costs around £500 per square metre to build; Eureka!'s building cost around £2.4 million, or around £533 per square metre in 1992.[37]

The designers and architects of projects currently being developed are able to be more ambitious. The National Lottery has not only made large sums of public money available,

but it also demands that buildings funded by the Lottery should be distinctive and built to the highest possible standards. The author has worked on a number of Lottery proposals, which typically are budgeting at around £1,000 or more per square metre for a high-quality, distinctive new building. The interactive National Centre for Popular Music, which is currently under construction in Sheffield, is largely funded by an Arts Council Lottery grant. The National Centre for Popular Music's 'radical new landmark building' will cost £8.4 million or £1,853 per square metre at 1996 prices—almost 350 per cent higher per square metre than Eureka! in 1992.[38]

Exhibition costs

Building costs described above usually include basic services and finishes to all floors, walls and ceilings. Exhibition fit-out costs are additional. In the same way that Eureka! was able to develop a high-quality building on a modest budget, its -exhibition costs were also modest, partly because of good internal management and partly reflecting the low-tech nature of many of the exhibits. Fit-out costs are now typically around £1,500 per square metre for low-tech exhibits, £2,000 per square metre for a range of low and high-tech exhibits, and £2,500 per square metre for high-tech exhibits. These exhibition fit-out costs include the costs of development, construction and installation of exhibits, all exhibit structures, graphics, lighting, and all design and other specialist fees (which can typically account for around 15 per cent of the total fit-out costs). Costs per square metre of non-exhibition spaces, such as a shop, cafeteria, storage, offices or workshops, will be significantly lower than these figures, with public non-exhibition spaces (such as a café and shop) typically costing more than the non-public non-exhibition spaces (such as storage or offices).

Individual exhibits usually range in cost between £5,000 and £20,000, depending on the degree of complexity of the exhibit: as a general rule, exhibits using new technology will cost more than low-tech exhibits, particularly if new software has to be written. Typically, each exhibit will occupy around 10 square metres of exhibition space, although there will clearly be considerable variation between different types of exhibits.

Conclusions

This chapter has considered in some detail the financial performance of hands-on science centres and museums in the UK and USA, and has, by detailed analysis of the statutory accounts of three large independent centres, attempted to develop some measures of performance (although these indicators may typify only large charitable hands-on centres, and may not be applicable to centres of different size or type of ownership; indeed, the ASTC survey in the USA illustrates that science centres in the USA are characterised by their diversity). It is clear that hands-on centres in both the UK and USA are heavily dependent on a mixed range of sources of income, but trading activities are increasingly important as sources of revenue, although grants, sponsorship and patronage remain important as sources of revenue and—especially—capital funding.

In the USA, those hands-on centres that have developed most recently are more dependent on trading activities than the older, more established centres, and it is these

newer organisations with a limited range of income sources that may struggle hardest to survive. Meanwhile, competition from new attractions may result in reduced visitor numbers at the older museums and science centres. In the UK, the National Lottery has fuelled competition between visitor attractions in an already overcrowded leisure market, and the financial accounts of Eureka! and the Exploratory indicate that both those organisations have had to increase expenditure on promotional activity, and yet still have suffered a decline in visitor numbers. There is some evidence that although these organisations are only a few years old, they are already entering a decline phase in their product life-cycle, and it is significant that both centres are planning major developments to renew interest in the core product. With such intense competition between hands-on centres and other visitor attractions, good marketing management is essential, and it is this area of functional management that is considered in the next chapter.

5
Marketing

This chapter investigates the demand for hands-on museums and science centres, and considers how effective market planning can identify, reach and satisfy the maximum number of visitors.

Market planning

The Chartered Institute of Marketing defines marketing as 'the management process which identifies, anticipates and supplies customer requirements efficiently and profitably'.[1] The market planning process is simple in concept: it begins with the definition of financial and other objectives for the organisation, and continues with the process of conducting an audit of service provision in relation to existing and potential markets, identifying internal strengths and weaknesses and external opportunities and threats (SWOT analysis). The next stage is to set market objectives for the development of the service for existing and potential markets, which are consistent with the overall corporate objectives and the main findings of the SWOT analysis. The final stage is to devise long- and short-term strategies to meet the marketing objectives, monitoring performance continuously and readjusting strategies in accordance with changes in market conditions.[2]

Hands-on museums and science centres are, by their very nature, market-oriented organisations. The process of learning through interaction is dependent on identifying and satisfying the needs of visitors. In a successful hands-on museum, customers are involved at every stage of product development from front-end, formative and summative evaluation; indeed, the whole purpose of evaluation is to identify visitor needs and thereafter to test whether exhibits meet those needs. Staff are recruited, trained and subsequently deployed to enhance the visitor experience, whilst quality controls ensure that standards of service delivery are consistent. Additional visitor studies can identify the demographic characteristics of visitors, and whether the reality of the visitor experience matches expectations, thereby enabling the centre to measure the effectiveness of its communications strategies. In short, marketing is at the very core of the hands-on museum. Successful marketing requires the delivery of a visitor-oriented service effectively and within the financial resources available to the organisation. Whilst each organisation is likely to have dedicated marketing personnel and a marketing budget, a hands-on museum can only successfully meet its educational objectives if a culture of visitor-orientation permeates throughout the organisation.

This book has been structured to integrate a marketing approach to the management of hands-on museums: it has been written from a marketing perspective, as there is a such a strong link between marketing, product development, human resource management,

operations management, and education and event programming. The role of the hands-on museum in the wider leisure marketplace is explored in Chapters 1 and 9. Chapter 2 helps to explain the underpinning educational objectives of the interactive approach, whilst the development of a visitor-centred product is considered in Chapter 3. Chapters 4 (finance), 6 (operations management), 7 (human resource management) and 8 (education and event programming) all explore good practice in helping to meet overall objectives within the context of sound management. In total, marketing is not an additional feature of management, as the presence of this separate chapter might suggest—it is integrated at the very core of a successful hands-on museum, and underpins the structure of the book.

The approach commonly known as the marketing mix in marketing textbooks (that is, the seven Ps of product, place, promotion, price, people, physical evidence and process) is directly applicable to the successful development and management of a hands-on museum.[3] Managing an effective hands-on museum requires:

1 Developing a product that identifies and meets the learning and other needs of target visitors (product).
2 Building the centre in a location that is accessible to large numbers of visitors in the target groups (place).
3 Communicating the benefits of the organisation to potential visitors and sponsors (promotion and public relations).
4 Setting prices appropriate to the ability of target visitors to pay and in accordance with the financial objectives of the organisation (price).
5 Maintaining very high standards of human interaction to enhance the visitor experience (people).
6 Ensuring new and potential visitors understand the concept of the hands-on experience (physical evidence)
7 Delivering a consistently high-quality product (process).

Whilst good practice in the management of most elements of the marketing mix is considered throughout this book, two important elements of the marketing mix (price and promotion/public relations) are investigated in detail in this chapter. However, since successful marketing requires a targeted approach towards identified visitor segments, the next section provides a further investigation of the demand for the hands-on approach, following the market appraisal outlined in Chapter 1.

Demand

Chapter 1 illustrated that hands-on museums and science centres are popular with visitors: a recent report analysing the market potential for museums in the UK identified that the ability to interact with exhibits, and activities which are attractive to children are two of the key factors attracting people to visit museums.[4] One-third of museum visits are made by children, and children in family (not school) groups represent the most significant market segment.[5] The most recent data suggests that, in 1995, 31 per cent of all museum visits in the UK were made by children, although this includes significant regional variations (most notably, 53 per cent of museum visits in Northern Ireland were made by children, compared to 24 per cent in Scotland). Children make up 32 per cent of

visitors to all types of tourist attractions in the UK, so museums do not differ significantly from the industry average.[6] Since the figure for museums includes all types of museums, it would seem reasonable to deduce that museums which specifically set out to attract families through their interactive displays will achieve a higher percentage of children amongst their visitors.

Chapter 2 demonstrated the importance of the social context of a museum visit, and how there is a real need for families to explore together in a safe and educational environment which is acceptable to all members of the family. Museums, and especially hands-on museums and science centres, can provide an attractive environment for such family exploration. The quality of the museum experience on offer appears to be the main factor affecting attendance levels, but demand is also affected by a whole range of other social, cultural, economic, political and demographic factors.[7]

Demographic trends

An investigation into demographic trends can partially assist in the explanation of this increase in demand, as is shown in Table 5.1.

In 1991, the number of children in the UK was at its lowest for thirty years—there were 11.7 million children under 16. Numerically, the child population moves in cycles, and it is currently on an upward trend. The total population under 16 is projected to be 5 per cent higher in 2001 than it was in 1991, although this conceals age variations within the child population. The number of children aged between 5 and 10 will increase until 2001, but decrease thereafter. The number of children aged between 11 and 15 will increase after 2001.

The size of the child population in part reflects changes in the number of births in the past: the current upswing is a result of children born in the baby boom of the 1960s having children of their own (this is known as a 'baby boom echo'). The high number of children under 10 in 1971 is reflected in the age distribution of the population in 1992, as shown in Table 5.2, with the largest group being those aged between 25 and 34 (in other words, those born between 1958 and 1967, and the most likely parents of today's babies and young children).

Recent demographic trends alone cannot account for the recent growth in the demand for children's attractions, since children make up a much smaller

Table 5.1 Number of children in the UK under 16, 1961–2001 (000s)

	Age 0–4	*Age 5–10*	*Age 11–15*	*Total age 0–15*
1961	4,274	4,585	4,289	13,148
1971	4,553	5,580	4,124	14,257
1981	3,455	4,553	4,533	12,541
1991	3,885	4,409	3,444	11,739
2001	3,844	4,680	3,873	12,398

Source: Derived from OPCS, *Social Focus on Children*[8]
Note: 2001 data based on 1992 projections

Table 5.2 Age of UK population, 1992

Age	*No. (000s)*	*%*
0–4	3,781	6.7
5–14	7,026	12.5
15–24	7,713	13.7
25–34	8,954	15.9
35–44	7,616	13.5
45–54	6,720	11.9
55–64	5,646	10.0
65+	8,933	15.8
Total	56,388	100.00

Source: Derived from CACI[9]

proportion of the population in the UK today than they did in the early part of this century. In 1911 children accounted for around 30 per cent of the population in England and Wales, but this had fallen to around 20 per ccnt by 1991.[10] The UK population is ageing owing to improved birth control reducing the birth rate, and better health care resulting in more people living longer. Whilst the child population is not as important in relative terms as it was earlier in the century, it is currently undergoing a minor upsurge as children born in the boom of the 1960s are currently having children of their own. This upward trend is likely to continue until the early years of the next century, although Table 5.1 shows that the child population itself is ageing as children born in the peak of the recent boom become older. Thus, if demographic trends are a significant factor, organisations planning a family attraction in the years leading up to 2000 should logically be considering teenagers rather than toddlers as a more important target segment of the population.

The population statistics account in part for the growth in demand for children's and family attractions in the early 1990s, and might suggest that there is a growing need for attractions that cater for young teenagers over the next few years. However, demographic trends alone can only tell part of the story, as demand is also affected by numerous other factors, such as the availability of leisure time and income to expend on family leisure.

Leisure time

Mintel surveyed the leisure time of 1,678 adults in the UK in 1994, indicating a wide variation in the availability of leisure time between individuals and households. On average, adults have forty-two hours of leisure time per week, but this conceals divergence between the sexes. Women have less time available than men, with an average of twenty-seven hours per week for those with dependent children, compared to forty-eight hours for those without children. The group with the smallest amount of leisure time is working females, aged between thirty-five and forty-four, with dependent children under fifteen (in other words, parents of the very group for whom most interactive centres are designed).[11] A survey in the USA in 1991 indicated that the average American family had nineteen hours of free time available per week, with only twelve hours for women employed outside the home (21 per cent of the sample stated

that they had no leisure time at all).[12] Whilst the methodologies employed in the two surveys do not make them directly comparable, there is a clear trend in both the UK and USA that family leisure time is an increasingly scarce resource, compounded both by the increasing number of single-parent families and the increasing number of women in employment.

	Leisure-time rich	**Leisure-time poor**
Money rich	Affluent early retired; Working males not in professions; Working females not in professions/not parents.	Full-time professional workers; Working mothers.
Money poor	Part-time workers; Unemployed; Retired people on state benefit.	Working mothers in poor families; Single parents.

Figure 5.1 Who can afford leisure?

Source: derived from *Leisure Forecasts, 1996–2000*[13]

Figure 5.1 plots the availability of time and money on a simple matrix, illustrating that the demand for family attractions is affected not only by a lack of leisure time for family groups, but additionally by a lack of money for low-income families. Single-parent families are likely to be adversely affected by both a lack of leisure time and disposable income. It is a common perception that visitors to museums in general are representative only of a socio-economic and occupational elite. In fact, whilst people in socio-economic groups A/B and C1 are overrepresented amongst visitors to UK museums, people from all socioeconomic groups do visit museums in a distribution that is not that dissimilar to the overall population structure.[14] There is some evidence to suggest that a more potent factor influencing demand is educational attainment—the longer someone has stayed in formal education, the more likely they are to become a museum visitor.[15]

The most comprehensive survey of all visitor research suggests that 40 per cent of the population visit a museum or art gallery at least once a year, 40 per cent occasionally, with the remaining 20 per cent rarely visiting.[16] The Department of National Heritage suggests 32 per cent of the population visit museums every year, whilst 21 per cent visit art galleries (there is clearly some overlap between the two sectors).[17] There is a very broad demand across all socio-economic groups to visit museums, although the ability to pay admissions charges and the lack of available free time are constraining factors. In short, whilst the demand for hands-on museums and science centres can in part be explained by an increasing number of children, the reality is that demographic changes are relatively insignificant compared to broader changes in society affecting income and leisure time.

The lack of leisure time for family visits results in most visitors to museums in the UK travelling for less than an hour on the day of the visit. A survey conducted in 1991/2 showed that 48 per cent of all museum visitors travelled less than thirty miles on the day of their visit, 13 per cent travelled between thirty and fifty miles, whilst 39 per cent travelled over fifty miles.[18]

Families from all socio-economic groups are likely to have very limited leisure time, yet they nevertheless constitute the main visitor segment to museums. The need to explore as a family group in a safe and interesting environment, as described in Chapter 2, clearly pervades all socio-economic strata of society. Families are active in this way until their children reach their teenage years, but this target segment has the great advantage in that it is constantly renewing itself as new families replace those with older children. Thus, it makes a great deal of sense for hands-on museums to target children under 13, both in family and school groups.

Table 5.3 confirms the importance of both the family and schools markets amongst visitors to Techniquest between 1989 and 1994. The museum sector as a whole has a visitor pattern which peaks in the summer months, with 50 per cent of visitors in the four months between May and August. Visitors to Techniquest are spread out more evenly throughout the year, with only 39 per cent between May and August. Although Techniquest is less reliant on the summer months than the museum sector as a whole, its peak visiting months in the survey period all included holiday times: August (summer), April (Easter) and October (autumn half-term holiday). The next most busy months were July (which is mostly in term-time) and February (which includes the spring half-term holiday). Techniquest clearly demonstrates that families utilise school holidays throughout the year for shared family experiences, and although July is popular for school visits, the centre receives more visitors during holiday periods than in term-time.

Table 5.3 Seasonality of visits to Techniquest, 1989–94

	Average no. of visitors to Techniquest	*Average % of visitors to Techniquest*	*Average % of visitors to UK museums*
January	4,543	4.3	3
February	10,014	9.6	7
March	9,112	8.7	7
April	11,427	10.9	10
May	8,898	8.5	13
June	7,323	7.0	15
July	10,501	10.0	11
August	14,424	13.8	10
September	5,614	5.4	7
October	10,903	10.4	6
November	7,377	7.0	7
December	4,583	4.4	4
Total		100.0	100

Source: Derived from data supplied by Techniquest; Museum data from *Leisure Day Visits in Great Britain*, 1988/9[19]

Successful marketing requires an organisation to identify and meet the needs of actual and potential target groups. Marketing theory suggests that market penetration is always likely to be the most effective strategy, and so families and school groups quite rightly provide the focus of attention for hands-on .museums. However, two other target groups

require consideration: over-50s and teenagers are the age groups most underrepresented in the overall museum visiting market,[20] yet they offer some market potential to the hands-on museum. The early retired comprise one group which is rich in both money and leisure time—those very people who are likely to be both mobile and with grandchildren. Persuading these groups to visit either alone, or with their grandchildren, could provide an important source of demand. Young teenagers also provide an interesting target market: rich in leisure time but low in income, there are few leisure opportunities directly aimed at this market segment. With careful programming, interactive centres could potentially fulfil this demand, although a lack of mobility in combination with a lack of money would ensure that this could never be more than a local market. Nevertheless, in the UK the Science Museum has recently developed interactive exhibits aimed directly at the teenage market, and there are numerous examples of good practice in the USA (these are considered in Chapter 8).

Visitors to Eureka!: a case study

In summer 1993, Eureka! The Museum for Children conducted a visitor survey over a six-week period on a random sample of 594 adult visitors.[21] The typical visitor group was found to be a white European family, with four or five members. There were more than twice as many adult females as males, although the sex distribution of children within the groups was similar. Seventy-two per cent of child visitors were between the targeted ages of 5 and 12, although 25 per cent were under the age of 5 (this was unexpected, with only one area catering for the needs of this specific age group). Within the targeted age group, only 11 per cent of child visitors were aged 11 or 12, suggesting that Eureka! was perceived to be for a younger age range.[22] Indeed, only 3 per cent of visitors were aged between 13 and 15, suggesting that Eureka!'s policy of discouraging teenagers was effective. Amongst the adults, 49 per cent were aged between 35 and 44, whilst 27 per cent were aged between 25 and 34 (at 76 per cent, this combined figure was much higher than the national average of 44 per cent in these groups[23]). Visitors over 65 comprised only 5 per cent of those interviewed.

Over half the sample had occupations placing them within socio-economic groups A/B or C1, which is higher than the national average. Less than 2 per cent of the sample were non-white, whilst 6 per cent of the sample came in groups which contained a person with a disability. Eighty-six per cent of the sample travelled from home on the day of the visit, with 7 per cent staying in holiday accommodation and 6 per cent with friends and family. Over half lived within West Yorkshire or the neighbouring counties of Lancashire and Greater Manchester. Four per cent came from outside the UK. On the day of the visit, 80 per cent travelled by car, compared to 12 per cent by train and 6 per cent by coach or bus.

Over half the sample had heard about Eureka! through friends and family, with 23 per cent having received a personal recommendation. Women made the decision to visit in 62 per cent of the sample, with children making the decision in 22 per cent. Forty-five per cent of the sample had decided to visit in the previous week, with 33 per cent planning more than a week before. Seventy-five per cent of the sample were making their first visit, and 25 per cent were making repeat visits (two people stated that it was their tenth visit—the museum had been open less than one year at the time of the survey). The

average length of stay was three hours and forty minutes, although this varied from a minimum of fifty minutes to a maximum of seven hours.

Key market segments

The key market segments for interactive centres are likely—in descending order of importance—to be:

1 Day visitors within a sixty-minute drive.
2 Education and other group visits.
3 Day visitors within a sixty- to one-hundred-and-twenty-minute drive.
4 Domestic and overseas tourists staying overnight.

The following section will investigate each segment in more detail, and will estimate the likely profile of the visitor market for Eureka! The Museum for Children, based on its 1993 visitor survey and published market information.

The primary market

The primary market for a hands-on museum or science centre will undoubtedly be visitors within a sixty-minute drive, particularly family groups with children under 13, but there is potential to attract other segments. These include the leisure-rich, mobile and money-rich early retired, or the leisure-rich, but immobile and money-poor teenagers.

Using standard route-planning computer software, the sixty-minute drive to Eureka! The Museum for Children can be used to identify its primary catchment area. This is oval in shape, with its main axis east-west along the M62 from Liverpool on the west coast of England, to the outskirts of Hull to the east. The north-south axis stretches from Harrogate to the north and Sheffield to the south. Thus, the conurbations of Leeds, Bradford, Manchester, Liverpool and Sheffield are all within the sixty-minute drive. The choice of Halifax as the location for Eureka! was treated with some disbelief by many sceptics in its planning days, but its success demonstrates that it is possible to create a major visitor attraction in a town without an existing major tourist market, if the location is central to a large population.

A comparison between the boundaries of the sixty-minute drive area and 1991 census data reveals that Eureka!'s primary catchment area includes a population of 7.9 million. The primary market penetration rate for major interactive discovery centres is usually considered to be in the region of 2–3 per cent of the population. Clearly, an innovative attraction with a high level of promotion will attract a higher penetration rate than a smaller, less original centre. Eureka! has achieved an average of 400,000 visitors per annum between 1993 and 1995. The 1993 Eureka! visitor survey cited above, in conjunction with the *Day Visits in Great Britain* survey,[24] suggest that around 60 per cent of its visitors are likely to live within the primary catchment area, travelling less than fifty miles on the day of the visit. The Eureka! survey excluded school and other groups (*c.* 100,000 visitors). Of the remaining 300,000 visitors, the survey identified that 13 per cent (39,000) stayed overnight in the region. Thus, one can reasonably estimate that approximately 156,600 (60 per cent of 261,000) non-group visitors come from within this

primary market. This would give a penetration rate of 2 per cent of the population of 7.9 million, which is consistent with industry trends.

The educational market

The second-largest segment of the visiting population is likely to come from educational and other groups, mostly—although not exclusively—from the primary catchment area. The relative importance of this segment will depend on a number of factors, including the relevance of exhibitions to the national curriculum, the degree of competition, and cost (set against perceived educational benefit). For example, the Greater Manchester Museum of Science and Industry attracts educational groups from the primary, secondary and tertiary sectors, accounting for around 40 per cent of its visitors. As a whole-day visit, and with relevance across the national curriculum in several subject areas and at various key stages, its popularity with formal educational groups is clear. Eureka! The Museum for Children, on the other hand, is aimed entirely at the primary market, and actively discourages visits from older pupils. Whilst the educational benefit of a visit to Eureka! is clear, the target population of primary school age is clearly smaller than the broader age range targeted by the Manchester museum, and this may account for why only around 25 per cent of its visitors come from formal groups.

The census indicates that the school age population within the primary catchment area of Eureka! is 1.15 million. Eureka! targets children aged between 5 and 12, amounting to 848,000 children living within the catchment area. As Eureka! receives approximately 100,000 school-age visitors in school or other organised groups (such as cubs or brownies), if all its educational group visitors came from the primary catchment area, its penetration rate in this area would be around 12 per cent of children between 5 and 12. In reality, this figure would have to be adjusted downwards because an unknown number of groups do travel from beyond the primary catchment area.

The secondary market

The third-largest segment is likely to be family groups living between one and two hours from the attraction. The secondary market penetration rate will be significantly lower than the primary market penetration rate, depending on the innovative nature of the attraction, the degree of competition and the level of promotion. Eureka! has 11.4 million people living within a one- to two-hour drive. The 1993 Eureka! visitor survey cited above, in conjunction with the *Day Visits in Great Britain* survey,[25] suggest that around 40 per cent of its visitors are likely to live outside the primary catchment area. Excluding group visitors and those staying overnight in the region, one can reasonably estimate that 104,000 visitors (40 per cent of 261,000) travelled from within the secondary catchment area on the day of the visit. This would give a penetration rate of 0.9 per cent of the population of 11.4 million, which is consistent with industry trends.

The tourist market

About 550 million day trips are made by British visitors each year, mostly by journeys of less than one hour. Tourists are defined as visitors who have stayed overnight in a region

other than their home. In 1992, there were 77 million tourist trips made by British visitors in Britain, and a further 16 million made by overseas visitors.[26] Clearly, the number of overnight visitors attracted to visit a hands-on museum will depend primarily on the size of the local tourist market itself, the unique nature of the product on offer and how well it is promoted to the tourist market. In general, tourists are more likely to visit heritage sites than museums or theme parks (for example, in 1995 overseas visitors comprised 34 per cent of all visitors to historic properties in the UK, compared to 21 per cent of museum visitors).[27]

In Yorkshire and Humberside, overseas visitors comprise 8 per cent of museum visitors, although the 1993 Eureka! survey showed this figure was only 4 per cent for that site. The survey also showed that UK tourists staying overnight comprised 9 per cent of the sample: in total, this gives a penetration rate of 0.3 per cent of the 9.2 million UK people who stayed overnight in West Yorkshire in 1995, and 0.4 per cent of the population of 3.4 million overseas visitors who

Table 5.4 Estimated profile of visitors to Eureka!

	Population	*No. of visitors (estimate)*	*%*	*Market penetration rate (% estimate)*
Primary market (0–60 minute drive time)	7,900,000	156,600	39	2
Group market (children aged 5–12 in primary market)	850,000	100,000	25	12*
Secondary market (60–120 minute drive time)	11,400,000	104,400	26	0.9
UK tourists (staying overnight in West Yorks)	9,200,000	27,000	7	0.3
Overseas tourists (staying overnight in West Yorks)	3,400,000	12,000	3	0.4
Total		400,000	100	

Source: author's extrapolations derived from drive time analysis; census data; Eureka! visitor survey; Yorkshire Tourist Board data; *Sightseeing in the UK; Day Visits in Great Britain*[29]
Note: *this figure is based on the assumption that all group visitors come from within the primary market: in reality, this is not the case, and the actual market penetration rate for groups within the primary catchment area would be lower

stayed overnight in West Yorkshire in 1995.[28] This is consistent with industry trends. This data is summarised in Table 5.4.

Overlapping markets

There is considerable overlap between the major science centre attractions and their primary and secondary catchment areas. Figure 5.2 demonstrates where there is overlap between those science centres and hands-on museums which receive over 100,000 visitors per annum.

Figure 5.2 clearly shows that the major interactive discovery centres in the UK are already competing with each other for visitors, particularly from within the secondary

catchment area. Given that this table excludes hands-on centres with visitor figures of less than 100,000, not to mention other competing visitor attractions, there is evidence of clear competition within the market. Techniquest at Cardiff and the Exploratory at Bristol are within each other's primary catchment areas, yet analysis of the postcodes of 10,620 visitors to Techniquest from July to October 1996 shows that whilst half had Cardiff postcodes, only 2 per cent had Bristol codes.[30] People in the Bristol area may not comprise a significant proportion of the visitors to the rival science centre across the River Severn in Wales, but the close proximity of the two centres does mean that the ability to penetrate the primary market will be much reduced. This problem will be compounded by developments facilitated by the National Lottery, with several of the existing interactive centres planning to expand or redevelop, whilst major new centres are proposed at other locations which will compete within primary catchment areas.

	Exploratory, Bristol	Techniquest, Cardiff	Science Museum, London	Eureka!, Halifax	Snibston, Leics	Newcastle Discovery	Light on Science, Birmingham	Xperiment!, Manchester	Jodrell Bank, Cheshire
Exploratory, Bristol		P	S		S		S		
Techniquest, Cardiff	P						S		
Science Museum, London	S				S		S		
Eureka!, Halifax					S		S	P	P
Snibston, Leics	S		S	S			P		S
Newcastle Discovery									
Light on Science, Birmingham	S	S	S	S	P			S	S
Xperiment!, Manchester				P			S		P
Jodrell Bank, Cheshire				P	S		S	P	

Figure 5.2 Overlapping catchment areas for major UK hands-on attractions

Key: P=overlapping primary catchment area

S=overlapping secondary catchment area

Such intense competition between hands-on centres in the UK, and between hands-on centres and other visitor attractions, necessitates careful market-planning. The next two sections consider how the manipulation of two tools within the marketing mix (price and promotion) can be used to gain strategic advantage.

Price

Prices are set at UK visitor attractions in accordance with a whole range of factors, not all of which are consistent with economic theory. Previous price history, the pricing of competitors, and an assessment of what the market will bear, are typically used to inform pricing decisions. The interplay of attractions with differing commercial and social objectives within the private, public and independent sectors ensures that pricing decisions are complex. In the UK, 60 per cent of all visitor attractions charge an admission price, compared to 51 per cent of museums. Even amongst the charging museums, many subsidise charges: very few publicly owned museums are self-financing through admissions.[31] Maximising revenue from admissions depends on determining the appropriate ticket categories, on setting discounts or indeed on adding surcharges for special events or exhibitions. Pricing decisions are typically marketing decisions, as they can communicate strong messages to potential customers about those audiences the attraction is trying to attract.

The average adult admission charge for all UK attractions is £2.42, compared to £1.82 for museums. Thus, those museums which do charge typically set a lower price than other visitor attractions. The average child admissions charge is £1.40 for all attractions, compared to £1.02 for museums (which is the equivalent of 58 per cent and 56 per cent of the adult charge respectively).[32] It is significant that at Eureka! The Museum for Children, children are charged 80 per cent of the adult admission price of £4.95 in 1997, and adult charges begin for children over 12. These prices communicate strong messages to potential visitors: first, this is an expensive visit for adults and children, so expectations of quality are raised (7 per cent of museums in the UK charged over £4 for adult entrance in 1995).[33] Second, adult prices begin at 13, which is a deliberate policy to discourage visits by children older than the target age group (5 to 12). Third, the child: adult price ratio is significantly higher than the average for other museums and visitor attractions.

The relationship between adult and child prices at children's attractions is interesting. Whilst some parents might consider a high child price to be exploitation, there is logic in charging a high price for those visitors for whom the facility is designed. In fact, Eureka! did consider following the policy of children's museums in the USA where it is common for the adult price to be lower than that for children (for example, Denver Children's Museum charges adults less than children, whilst Cleveland Children's Museum charges the same rate).[34] Children's museums usually cite the objective of encouraging adults and children to learn together, so price discounts to encourage more adults to attend do make sense (and more adults usually means less damage to exhibits). Many private play attractions in the USA offer free admission to adults.[35] Like most other UK visitor attractions, Eureka! does offer free places and adult discounts to school and other group visits in order to increase the proportion of adults in group visits (which is usually much lower in school groups than in family visits). However, pricing tradition in the UK has discouraged the museum from going quite as far as Denver in offering discounts to adults in family visits. Significantly, Techniquest follows the UK national trend of charging children 56 per cent of the adult price of £4.50.

Eureka! has used its dominant position in the children's museum market to maintain and increase its prices since 1992. Its visitor survey in 1993 showed that 80 per cent of

visitors were happy with the admission price—comments related to the fact that people thought that it was expensive before the visit, but they considered that they had received value for money on leaving.[36] Between 1992 and 1997, its prices for adults have increased by 41 per cent, for children by 58 per cent, for schools and groups by 50 per cent, and for families by 58 per cent (and the family ticket admits four compared to five in 1992). Demand for admission to Eureka! is inelastic—it has not dropped in proportion to price increases. The smaller price increase for schools and groups reflects the fact that this market is more price-sensitive than the family market. Overall, whilst these price increases reflect strong demand across all segments, Eureka! does offer substantial discounts to encourage visitors at non-peak times, particularly a half-price discount for visitors after 3.00 p.m. during term-time (when typically there would be very few casual visitors). In the USA, many children's museums offer free or low-cost admission in evenings or at other non-peak times: for example, Please Touch Museum in Philadelphia encourages voluntary donations on Sundays.[37]

Overall, price is an important marketing tool, which can be used not only to maximise revenue from visitors, but also to discourage visitors at peak times and to encourage them at quiet times. It can be also be used to help meet social objectives (by offering discounts), to encourage adults and children to participate as a family (by offering family tickets and adult discounts) and indirectly to limit damage to the exhibits (by encouraging more adults with free or discounted tickets).

Promotion

This chapter has attempted to dispel the myth that successful marketing means little more than effective sales promotion: a visitor-oriented approach integrated within every management function is essential if the hands-on museum is going to achieve broader educational objectives. Nevertheless, promotion is an important marketing tool, and when a museum identifies its marketing budget it is invariably referring to that part of the revenue budget allocated to advertising, promotion and public relations.

Marketing budgets vary throughout the leisure industry, and especially between the public and private sectors. One survey suggested that half of local authority leisure service departments spent less than £5,000 per annum on marketing activities in 1992, with over half having no strategy or plan, and over half also having no one responsible for marketing.[38] On the other hand, in 1995 three public sector museums (Natural History Museum, Science Museum and Beamish Open Air Museum) spent over £100,000 on promotion, whilst two commercial leisure parks spent over £1 million.[39] Amongst the hands-on museums, Chapter 4 revealed that Eureka! spent £159,000 in 1995, suggesting that it recognises the need to spend significant sums on promotion in order to compete with leading museums and other visitor attractions.

Expenditure will vary with the individual needs of the organisation, and at different periods of the product life-cycle, but a generally accepted figure is that 10 per cent of expenditure should be devoted to promotional activities. Indeed, Chapter 4 revealed that whilst the average spend on promotional activity between Eureka!, Techniquest and the Exploratory was 8 per cent, both Eureka! and the Exploratory had increased their expenditure on promotion to 11 per cent of total expenditure in recent years, and yet

despite this both had suffered falling visitor figures. These increases in expenditure reflect the increasingly competitive leisure market in the UK, and equate to an increase from £0.25 to £0.44 per head spend at Eureka! from 1993 to 1995, and from £0.21 to £0.36 at the Exploratory from 1993 to 1994.

Promotional strategies will inevitably be determined in part by the product lifecycle.[40] A new organisation needs to raise awareness of its existence to its target visitor groups, and is likely to place more emphasis on public relations, whilst a mature organisation will need to spend increasing sums on advertising and other forms of promotion to remind visitors of its existence. The key to success is to ensure that messages being communicated through the various promotional channels are clear, consistent and realistic. It is important to remember that the Eureka! visitor survey showed that half its visitors had learned about the museum from friends and family, and almost a quarter had received a personal recommendation from someone who had visited previously. Word of mouth is always the best means of promotion, so the messages communicated should never promise a service that cannot be delivered, as a poor reputation will spread rapidly.

Public relations means developing a relationship with local, regional and national media to gain maximum exposure in the press, on radio and television. Valuable print space and broadcast time may result if the public relations campaign is successful, but this should never be considered free, since it requires considerable time and money to develop a professional image with the media, via press releases, press packs and launches. Museum public relations is still very much in its infancy, and very often it is amateurish, unplanned and unsuccessful.[41] However, for the museum that understands the way in which the media works, public relations can be an excellent and cost-effective way of communicating positive messages to potential visitors, sponsors and stakeholders.

At a local and regional level, the media are often very supportive of museums, and children's museums or hands-on centres can provide the human-interest or unusual news items that journalists are seeking. It is more difficult—but not impossible—to gain coverage in the national media. Eureka! placed a very high emphasis on public relations in the months leading up to its launch, and was successful in gaining media coverage in all the major national newspapers, on local radio stations all over the UK and on numerous children's television stations. For example, prior to opening Eureka! promoted some of the more unusual aspects of its front-end evaluation to the media (notably children's ideas on the world of work), which were seized upon by radio and press, thereby gaining national coverage at very little cost. The television exposure was of enormous importance: very few UK museums can afford to advertise on television (only three spent over £40,000 on TV advertising in 1995[42]), yet Eureka! has frequently been featured on both children's television and educational programmes. In short, understanding the way the media works and taking a professional approach are the keys to successful public relations.

For the hands-on museum reaching maturity, it is clearly more difficult attracting the interest of the media via public relations, although new exhibits or events are often seen as attractive news items. Good timing is essential if events are to be promoted before they happen, rather than reported afterwards. Increasingly, however, the mature museum will have to devote time and resources to more traditional methods of promotion, such as advertising, posters and leaflet distribution. The key to success in these areas is to understand the market segments the museum is trying to reach and to target them

effectively through the promotional campaign. Clearly, this means effective leaflet distribution to the primary catchment area through other museums, tourist information centres and hotels. Penetrating the market by reaching people in groups with a propensity to visit museums is always more effective than trying to encourage non-users to visit (although this will be important if the museum has community outreach objectives). Monitoring where the visitor learned about the museum is essential so that future campaigns can be targeted more successfully.

The nature of the print material too is important. Tullie House Museum in Carlisle has a number of low-tech hands-on exhibits in its history galleries, but its promotional material did not emphasise these. In 1996, the museum placed a photograph of children engaged in rubbing seventh century replica stonework on the front of its new leaflet, and this led to an unprecedented 46 per cent increase in admissions revenue.[43] The message here is that the hands-on museum needs to devote attention to the sixth 'P' in the marketing mix, physical evidence: in other words, it must ensure that the service on offer is tangible to potential visitors. Children active in photographs within the museum leaflet can do much to persuade visitors that the hands-on museum is different from more traditional museums.

The education market requires special attention. It is possible to purchase computerised mailing lists of all schools within the catchment area and lists which distinguish between different types of school (for example, between special, primary and secondary schools). However, most education authorities have an internal mail system and many will distribute educational material for non-profit organisations in this way. Some authorities will charge for this service, but even so it is likely to be more cost-effective than direct mail. However, the material distributed must both be distinctive and stress the educational benefits of the service offered if it is to stand out from the pile of mail arriving in the weekly internal mail delivery. If it is not mailed appropriately, it is certain to find an early route to the waste-paper bin. Regular notification of evcnts and new exhibitions, perhaps within a school newsletter, is essential if the museum is to encourage repeat educational visits.

Developing direct mailing lists of all museum visitors is never likely to be cost-effective because of the large numbers involved. However, direct mailing to schools and other groups that have visited before is clearly feasible and offers the opportunity to target individual named teachers derived from computerised booking systems. Friends and membership schemes, or people who have purchased birthday parties, provide similar opportunities to target potential repeat visitors by direct mail.

In total, the channels available to the marketing manager to promote the hands-on museum are vast. Many hands-on museums now use the Internet as a promotional tool, and this is likely to become increasingly important. The development of interactive Internet pages is essential if the hands-on museum is to stand out from all other museums existing in the virtual world. Whatever the medium, effective promotion requires time and resources devoted to it, and it also demands skilled management. Placing an advertisement in a newspaper or on radio is easy, but it is also very expensive and not necessarily cost-effective. Innovative marketing management can help ensure that the hands-on museum stands out within the increasingly competitive leisure market. The keys to success are to have clear communication objectives, to target groups that are sufficiently large and have a propensity to visit, to understand the workings and timing of

the media, and to monitor every method of promotion and public relations through valid and reliable market research.

Conclusions

Marketing is at the very core of the hands-on museum, where there is a strong link between marketing, product development, human resource management, operations management, and education and event programming. Thus, marketing decisions are an integral part of all management decision-making, and effective marketing can help the organisation meet its educational objectives. Successful marketing requires the identification of the needs of target visitors and the subsequent delivery of a visitor-oriented service effectively and within the financial resources available to the organisation. Manipulating the tools of the marketing mix, such as price and promotion, can communicate important messages to potential visitors about the nature of the hands-on museum and science centre. However, most people who visit will do so on the basis of a word-of-mouth recommendation from friends and family. It is for this reason that effective market planning necessitates a culture of visitor-orientation to permeate throughout an organisation, to ensure that the visitor experience matches their expectations. Thus, long-term success of any visitor attraction in the overcrowded leisure marketplace will ultimately depend on the delivery of a quality service to visitors on every occasion, and that requires effective operations and human resource management.

6
Operations management

This chapter details the key ingredients for the successful operation of a visitor-oriented interactive discovery centre.

Introduction

Chapter 2 demonstrated that the quality of the museum experience for any individual is determined by an interplay of personal, social and physical factors. Whilst not all of these are within the control of the museum, it is essential that wherever possible the same level of service is delivered consistently to a high standard in order to maximise the likelihood that every visitor's experience will match their expectations. This is of particular importance given that word-of-mouth recommendation to friends and family is such a significant factor contributing to the decision to make a visit. Unfortunately, visitors do not arrive in equal numbers throughout the day, throughout the week or throughout the year. This means it is more difficult to programme resources and activities to standardise service delivery: too many staff, and the centre is inefficient and wasting resources; too few staff, and it is more difficult to meet educational objectives, and there is increased risk of damage to exhibits. In short, operational decisions are inextricably linked to financial, marketing, staffing and educational programming decisions.

Managing capacity

The intense level of competition within the leisure industry has frequently been referred to in this book, and Chapters 1 and 4 have illustrated that some hands-on museums and science centres have suffered declining visitors in recent years, even though the overall trend is towards an increase in demand. Attracting more visitors through effective marketing is a prime concern of most centres, particularly to encourage more visitors at non-peak times. Most managers would prefer a consistent stream of visitors throughout the day, every day of the year. In reality, of course, visitors cluster at peak times of the day and on peak days of the year. In fact, the hands-on movement in the UK is so successful that many centres frequently reach capacity, with at least three hands-on museums or science centres reaching capacity on twenty or more days in 1995.[1] In total, 5 per cent of all visitor attractions in the UK reached full capacity on at least twenty days in 1995, and 23 per cent reached full capacity on at least one day. For the majority of centres, which never reach maximum capacity, this may seem like a desirable problem to have, but numbers have to be managed for several reasons:

1 To satisfy fire and other safety requirements.
2 To provide adequate levels of visitor comfort.
3 To ensure the quality of the museum experience for both families and educational groups.
4 To avoid disappointing visitors who arrive to find the centre full and with a long queue outside.

The operators of events of fixed duration and fixed capacity (such as a theatre) are able to regulate demand by putting up prices for events at popular times or lowering them at unpopular times. The flexibility to use price to manage capacity in this way is not a viable option for visitor attractions, most of which do not normally have a differential charging system throughout the year, preferring for simplicity to advertise prices that are fixed for a long period. Even those visitor attractions which reach capacity on one or more days of the year will have a great many more days when the facility is underutilised; simply raising prices for the whole year to reduce capacity at peak times may have an overall adverse effect on demand.

Setting capacity limits

The physical capacity of any exhibition space is determined ultimately by the local fire officer, who will impose a safety limit on a building to ensure it can always be evacuated quickly in an emergency. Other restrictions also come into play, such as floor loading capabilities. Furthermore, the level of comfort for visitors—including the ability to access exhibits without queuing—also limits the capacity of the exhibition, and this capacity is often reached well before the safety limit. It is difficult to generalise. Each exhibition space will vary considerably, based on factors such as emergency exits, construction materials and the number and type of exhibits. Based on the author's experience at a range of hands-on attractions, a typical capacity limit at any one time is one person to every two square metres of exhibition space.

The fire limit for Eureka! The Museum for Children was 1,750 in 1992–3, but experience showed that the capacity for visitor comfort was substantially lower. Eureka! averaged 1,118 visitors per day in 1993, but this average conceals variations between days of the week and at different times of the year (for example, visits are skewed towards weekends at all visitor attractions[2]). On a typical weekend day with around 1,500 visitors spread throughout the day, the galleries did not become too crowded, there was a lively atmosphere of excitement and discovery, and there were no long queues to get in the museum, to access the exhibits or to be served in the café. Eureka! was able to admit 4,000 visitors a day without exceeding the safety limit, but on these days when the museum was operating at full capacity, the number of operational problems increased and consequently the quality of the visitor experience inevitably deteriorated.

The overriding consideration is that the museum must have the capability of knowing precisely how many people are in the building at any one time—to do this accurately means not only counting admissions, but also counting people as they leave the building. If there are several exits, this can be quite complex (and expensive if several turnstiles are installed). Nevertheless, an accurate (that is, non-human) counting mechanism with the capability of informing the operations manager of the number of people in the exhibition at any one time is highly desirable.

Imposing time limits

When the hands-on centre reaches its maximum capacity, two factors come into play:

1 Managing visitors inside the exhibition.
2 Managing queues outside.

The operations manager has to ensure that the paying visitors inside the exhibition receive the highest possible standard of service whilst at the same time encouraging a flow of visitors through the exhibitions so that the queue outside also flows regularly. When the exhibition has reached its capacity, it follows that new visitors can only be admitted as existing visitors leave. The only way that visitor flow can be determined accurately is at an attraction where every visitor has a dedicated seat: thus, in a themed ride, such as at the Jorvik Viking Centre, visitor flow is determined largely by the capacity and progress of the cars, whilst at a cinema, visitor flow is determined by the number of seats and the length of the film. The hands-on centre cannot control visitor flows in such a way, and so some have introduced time limitations at peak periods. Experience at a range of attractions suggests that typically around 20–25 per cent of daily visitors arrive at the peak hour. Launch Pad in the Science Museum introduced a system whereby, on busy days, visitors collected a numbered ticket (free once you have paid to enter the museum) and they were not admitted to the exhibit until later in the day at a time corresponding to their ticket number. In effect, this institutes an organised first-come-first-served queue within the museum, spreading the effect of peak hour visiting throughout the day (visitors do have the remainder of the museum to explore whilst waiting). This method enabled the Science Museum to control admissions to Launch Pad, but the length of the visit was not controlled. At the former Inventorium at La Villette in Paris, visitors were admitted for fixed two-hour sessions every day, with a gap in-between for staff to tidy up the galleries. Here, as at the Science Museum, numbered tickets were obtained in advance (although there was a separate admission price for the Inventorium).

At Eureka!, on busy days visitors are given a time limit of a minimum of three hours to visit the exhibitions. In 1992–3, all visitors had their hands stamped with the image of an animal as they arrived, and every thirty minutes the image was changed for new visitors. After three hours an announcement was made over the public address system requesting all visitors with—for example—rabbits or dinosaurs stamped on their hands to make their way to the café, shop or exits. This system equates to the method of giving coloured armbands to swimming pool visitors.

The three-hour limit was determined for a number of reasons: the educational objectives of the museum, together with a need to provide value for money for the visitor, were clearly important. However, these had to be set against an awareness of the throughput required to reach target visitor figures for financial viability. An awareness that children become intellectually exhausted in such an intensive learning environment, coupled with the knowledge gained from experience that damage to exhibits is more likely to occur by tired visitors, was also an important factor. Nevertheless, fixed time limits are not the norm for UK attractions, and many of Eureka's visitors have an expectation that they will be able to spend a full day in the museum. It is essential that the fixed time limit is explained to visitors on busy days if the museum is not to lose an enormous amount of goodwill. Thus, Eureka! is careful to warn visitors on promotional

material and before they enter the exhibitions, that on busy days the visit may be restricted to three hours.

Managing queues

Since almost everyone dislikes queuing, the duty of the operations manager is to manage queues as effectively as possible, so as to maximise the visitor experience in the most cost-effective manner. A great deal has been written about the mathematical theory and psychology of waiting lines—for example, the effects of adding extra servers or of altering queue discipline by prioritising the order in which people are served.[3] There is always going to be a trade-off between cost and queue length. At the new Techniquest, extra tills are brought into play when a queue builds up outside, and visitors do not normally have to wait more than thirty minutes to be admitted, even on very busy days.[4] Adding extra servers reduces the queue length, but increases cost. However, when the building has reached capacity, there is no advantage in speeding up the admission process: indeed, it is a positive disadvantage.

Eureka! frequently has the situation of the museum being filled to capacity and an ever-lengthening queue waiting outside. The safety issue is of paramount importance, as the safety capacity of the building cannot be exceeded. On peak days, visitors arrive at a rate of around 800–1,000 per hour (20–25 per cent of 4,000 visitors), and the museum reaches its capacity level within two hours of opening. Most visitors stay for at least three hours (the 1993 visitor survey suggested the average length of time on site—including visits to the café and shop—was three hours and forty minutes[5]), so there is a period of at least one hour when the building has reached capacity, and when very few visitors are leaving. At this point, the queue hardly moves. However, whilst it is important not to disappoint visitors who have travelled a long way to get there, the first responsibility is to the visitors who have paid. Equally, it is important not to lose custom to another attraction—but this will happen if the queue is badly managed (especially if the weather is poor).

Most queues operate with a first-come-first-served rule—but others enable priority to be given to certain types of visitor. At Eureka!, families with disabled persons were allowed to come to the front of the queue, but complaints were sometimes received from other families about this practice. Another way of reducing the uncertainty of queuing is to introduce a booking system, which effectively substitutes queuing at the point of delivery with a long advance wait and a greater certainty that it will be delivered (and a greater source of complaint if it is not delivered effectively). However, booking systems are not really feasible for small groups, and on busy days, any pre-booked groups arriving and gaining admittance in front of the queue can cause immense annoyance to waiting families. For these reasons, at Eureka! group bookings were not accepted on expected peak days in 1992–3, and they were limited on other holidays and weekends.

Ultimately, the critical issue in queue management is not so much the mathematics of the waiting time, but the customer's perception of it. For example, influencing the perception of queues has been perfected by theme parks which focus attention on the rate of progress of the queue rather than the length of the line by disguising queues around corners or over dips and hollows.

There are two main issues surrounding all service encounters which affect the perceptions of queues and how they are experienced and managed. First, a satisfied customer is one who expects a certain level of service, but who perceives the service actually received to be higher. A disappointed and dissatisfied customer will be one who perceives the level of service received to be lower than that expected. The point is that what is perceived and what is received are psychological phenomena, and queues can be influenced if the perception and expectation of waiting lines can be managed. Second, it is hard to catch up from a bad early experience. It is generally accepted that the success of a museum visit can be determined by the very first service encounter: for example, if visitors are welcomed positively when they arrive they will have a much more positive outlook than if faced with an aggressive and surly uniformed attendant. This is basic customer care, but it reinforces the view that money, time and attention should be spent on improving the very first stage of the service encounter, and that may mean managing queues.

It follows that the operations manager must gain an understanding of the psychology of queuing, and this involves a number of issues.[6] Since unoccupied time feels longer than occupied time, it is important to distract the waiting visitor by entertaining them, by giving them something to do or by providing refreshments. At Eureka!, children were taken out of the queues on busy days and encouraged to take part in ball games, juggling activities and parachute games. Entertainment such as buskers and clowns was provided, whilst servers walked up and down the queue offering refreshments for sale. It is important too to provide comfortable, safe and dry waiting conditions, with access to toilets. At Eureka!, in 1992–3, a covered temporary canopy was hired during winter months to keep queuing visitors dry. Chapters 2 and 3 stressed the importance of visitor orientation, and the queuing period provides a good opportunity to begin the process, by explaining the objectives of the centre or the role that adults can play in the learning process, for example. This will help to reduce potential disappointment later if visitors' expectations can be pitched at the right level before the point of payment.

Anxiety and uncertainty make waits seem longer than known finite waits, and as a result many visitor attractions display signs showing the predicted waiting time. At Eureka! the duty manager used to walk down the queue explaining the situation and reassuring visitors. Waiting in ignorance creates a feeling of powerlessness which frequently results in visible irritation. At Eureka!, visitors frequently failed to understand why—when the building was full—a till was closed down. The reality was that when a building is full there is no advantage in maintaining a speedy processing of tickets, but if this is unexplained it can look remarkably inefficient to the waiting visitor.

In short, by learning to research and understand the psychological context of their own waiting lines, operations managers can have a significant impact on their customers' satisfaction. The sensible solution is to devise a range of strategies to make the time spent queuing pass as pleasantly and efficiently as possible.

Managing group bookings

Although booking systems are not feasible for small groups of people, an effective booking system is an essential operations management tool for larger groups. The aim is to be able to maintain and guarantee a high service performance level whilst reducing queues on site: in effect, queues on site are substituted by a long wait from the time of booking to the date of booking. This can itself lead to increased capacity by persuading people to arrive at unpopular times. The booking system is, therefore, both an operations management tool and a marketing tool (since discounts can be offered to encourage groups to arrive at unpopular times).

In practice, booking systems can cause operational difficulties:

1 Pre-booking raises expectations which must be met.
2 If groups fail to arrive, the facility is idle and income is lost.
3 If bookings are too close, congestion can occur throughout the day.

In short, a successful booking system will try to provide an effective balance between the needs to maximise capacity, guarantee admission, prevent overcrowding and accommodate some flexibility for unforeseen circumstances. The most basic requirement for a booking system is that it permits control over arrival times and thereby over total visitor flow through the facility. For schools and other groups, the booking system provides the assurance to organisers that they will be able to get in to the centre at a predetermined time. The task of the operations manager is to maximise admission whilst guaranteeing a visit of educational value, thereby encouraging schools and other groups to want to repeat their visit. All hands-on centres have an optimum capacity beyond which the learning environment is severely diminished. This is likely to be well under the fire-limit capacity for the building, for the learning environment within a hands-on centre depends in part on the ratio of adults to children, and with cost restraints on school visits, inevitably there will be less adults in a group visit than in a family visit. Thus, the booking system has to predict and prevent capacity overload, and provide alternative dates and times quickly and efficiently to prospective group organisers.

Schools pose a particular problem, since teachers invariably want to determine their own arrival and departure times, and the effective length of the school visiting day is between 10.00 a.m. and 2.30 p.m. Typically, a primary school group (usually two classes to fill a coach) will leave school at 9.00 a.m., arrive at 10.00 a.m., spend two hours on a general visit to the centre, have a leisurely packed lunch (preferably indoors) and allow the children some free play time outside before an intensive directed visit in the afternoon, followed by a short visit to the shop before leaving to arrive back at the school for the bell at 3.30 p.m. Any variant from this norm limits the school’s choice and requires the teacher to make additional plans at either end of the day, which in itself can have a cost implication (a useful marketing ploy for the hands-on centre that cannot cope with full-day visits of this nature is to suggest free locations nearby which complement the trip).

There is a clear need to programme arrivals, and there may also be a need to programme departures to prevent overload later in the day. In addition, there will

certainly be a need to programme the use of indoor eating facilities. There are three basic ways to handle groups:

First, staggered arrival times permit a flow of visitors throughout the facility. This may or may not be accompanied by a suggested departure time. This method has the advantage of preventing queues at the entrance, but may well be unpopular if a school wants to arrive at 10.00 a.m. and is given an arrival time later in the morning. If there is no fixed departure time, this system may cause congestion later in the day, severely diminishing the educational experience.

Second, groups can be offered a fixed time-period for their visit. In 1992–3, Eureka! divided the school day into three two-hour periods (10.00 a.m. until midday; midday until 2.00 p.m.; and 2.00 p.m. until 4.00 p.m.). In addition, schools had to book one area for their own priority use for the first hour of their visit, and were permitted a more general look around the museum in their second hour. Time for eating and shopping was permitted outside these hours, but schools were not allowed back into the exhibitions after the two-hour period. This system did permit Eureka! to control the overall number of school visitors within the museum and it also allowed unpopular periods to be sold at a discounted rate (Eureka! experimented with the sale of afternoon visits at half price out of the summer season). However, this booking system was not popular with teachers when they first confronted it: for one thing, it was very different from most systems operated within facilities in the UK, and therefore it took some understanding. Second, it was inflexible. Typically, the 10.00 a.m. until midday time-slot was the most popular with teachers, and certain bookable areas (the Me and My Body exhibition, particularly) were booked up much further ahead than some of the others. Thus, many schools were not able to visit when and where they wished or for as long as they wished. The system was introduced to permit the largest number of children to use the facility at a reasonable cost whilst still maintaining a stimulating learning environment. After the initial surprise at the controls imposed by Eureka!'s booking system, feedback suggested that most teachers accepted the overall benefits of the system.

Third, groups can be given priority or exclusive use of the museum for a fixed time-period. The educational benefits of this method are obvious, but few centres (other than the very smallest) are in an economic position to be able to offer their facilities to just one group at a time, even for the shortest time-period. This would have the undoubted advantage of preventing clashes of ages and interests, but is simply not financially viable for most organisations. Centres offering exclusivity must also take care if their facilities are also open to the public: although most centres will receive few family or general visitors on school days, the offer of exclusive use of a facility implies that no other visitors will be using it simultaneously. The Children's Museum of Manhattan has reached an interesting compromise: the morning session is reserved for educational groups, and the afternoon session for families.

All booking systems require certain policies to be adopted and operational decisions to be made in the event of groups arriving early, arriving late or failing to arrive at all. In the first instance, the author's experience is that a group given a late-morning arrival time against their wishes will frequently ignore the arrival time stated and still arrive at 10.00 a.m., and it takes a lot of courage to keep a large group waiting outside in the rain! In the second instance, it is a difficult decision to decide who gets priority between the group that arrived on time or the group that arrived late through no fault of its own. If the

system is inflexible, a decision to accommodate a group arriving late can cause severe operational problems for other groups within the museum. Although the centre must have operational procedures, the operations manager may have to negotiate with group leaders on each occasion to arrive at a satisfactory compromise.

Groups that fail to turn up at all represent lost capacity that could have been sold to other visitors. One solution is to give the booking provisional status until a deposit is paid or payment is made in full. Failure to pay the deposit would render the booking void and permit the space to be reallocated. Such a system has its operational advantages, but again will not be popular with teachers who often have great difficulty getting payment from parents for visits until the last minute.

A further problem is that of groups which have paid in advance but arrive with less visitors than they predicted (for example, owing to illness) and demand a refund. An appropriate policy needs to be developed for such cases. A policy of no cash refunds might well result in a teacher personally refunding parents, with an inevitable loss of goodwill to the centre. Similarly, a policy of offering free tickets for subsequent use might be of little value if the group has travelled a long distance.

The discussion above primarily concerns school bookings during term-time. Additional complications are provided by requests for bookings at weekends, and by the varying term-times within different local authorities. If the catchment area for the centre is regional rather than local, the centre will inevitably attract schools from authorities with varying holidays. Thus, on what is a normal school day within one local authority, a centre may be full of families from other areas (with subsequent operational problems of delivering a quality service to both categories of user). This was a considerable problem in the early days at Eureka! The solution was to research all the holidays of every authority within ninety minutes' travelling time and to programme every day into one of three categories twelve months in advance, as follows:

1 A school day (a school day in every authority).
2 A peak holiday (a holiday in every authority).
3 A weekend day or non-peak holiday (a holiday in some authorities).

Staff resources, school and family programmes, and the ability to pre-book a group visit were allocated accordingly. It was decided that no group bookings at all would be permitted on peak holidays, as on those days long queues would develop and any preferential treatment to pre-arranged groups would cause considerable resentment. This was unpopular with leaders of non-school groups such as brownies and cubs, who were encouraged to book at weekends or non-peak holidays when some limited group booking was possible (but without any priority use of space).

Booking systems

Having defined the nature of the booking system to be introduced, a decision needs to be made whether or not to computerise, and—if so—whether or not to purchase existing software or to specify a bespoke program. A manual system is clearly cheaper to set up and operate, but is prone to suffer from human error and permits only one booking point. Any facility of a large size is likely to want to introduce a computerised booking facility,

with all the consequent benefits of multiple booking points and market intelligence such as report-writing facilities.

It is essential that the specification for a computerised booking system enables the museum to:

1 Provide instant visual reference of unused capacity at a given time and date of main centre, together with the availability of any additional facilities (such as picnic space, classroom, educational workshop).
2 Minimise the booking entry time as most bookings will be by telephone by teachers using breaks and lunch periods (and several teachers may be trying to book simultaneously; this has a consequent effect on number of booking points, and the working hours and breaks of booking staff).
3 Be user-friendly so that users can operate the system with a minimum of training.
4 Calculate prices as necessary and automatically generate an invoice together with a confirmation letter with booking details laid out clearly.
5 Be flexible for future needs and expansion, and price changes.
6 Provide a booking reference number so that future enquiries can be quickly dealt with.
7 Generate reports that will inform market intelligence and future operational decisions.

The computerised booking system's great advantage over a manual system is that it can provide instantly generated reports of group visitor figures or projected visitor figures (for example, the number of group visitors by selected time-period, or by local authority). Whilst there is a need to minimise the booking entry time, there is also an opportunity to collect substantial additional information which will inform the education marketing process, such as the age of children to be brought, the main curriculum area to be studied or the method of transport to be used. Thus, the education manager and the marketing manager must agree on essential information that must be collected, and prioritise desirable information that should be collected.

Managing lunchtimes

The management of school groups over the lunch period is one of the most neglected areas of museum and science centre planning. With certain exceptions (such as the Natural History Museum Education Centre) this is almost invariably overlooked by the designers of hands-on museums and science centres used by schools, but is an essential requirement if the visit is to last more than two hours. Even in mid-summer, teachers cannot rely on the use of outdoor facilities, and coach drivers dislike schools eating on board their vehicles. Packed lunch provision for all the school children expected during a day (for both morning and afternoon visitors, as well as those staying for the whole day, will want eating space) can cause enormous logistical problems for hands-on museums and science centres at a time when staff also require breaks. With three separate sessions of two hours, each with ten classes of thirty children, Eureka! could have requests for 900 spaces for packed lunches on any one day! Teaching spaces are rarely available for use as eating spaces for the whole lunch period (which can be well over two hours in a busy centre if cleaning time is included), whilst café operators understandably are reluctant to permit school groups to take up valuable eating spaces which could be otherwise sold to

paying diners. Eureka!, Techniquest and the Magician's Road at the National Railway Museum all provide railway coaches for the use of schools over the lunch period. One option (which schools are unlikely to take up with any enthusiasm) is to offer schools the chance to purchase a packed lunch from the café; another is to provide additional facilities, staffed and cleaned separately, for which a charge could be made.

The reality is that picnic facilities do not satisfactorily combine with space that can be used for other purposes—either teaching or restaurant—and schools are unable or unwilling to pay an economic price to operate such a space or to purchase packed lunches.

Managing breakdowns

There is no greater single cause of complaint at hands-on centres than that of broken exhibits. It is a well-known truism that if 5 per cent of the exhibits are not working, then visitors will complain that 'half the exhibits are broken', and if 10 per cent of the exhibits are not working, then they will complain that 'nothing works!'. At Eureka!, in 1992–3 every exhibit was visually checked daily in a pre-opening schedule by the enablers, who also ensured there were plenty of stocks of consumable items where appropriate. Throughout the day, breakdowns reported to or by enablers were logged at the front desk, and appropriate action was instigated. On a weekly basis, every exhibit was checked in a thorough audit for its mechanical condition, and for the standard of its graphics and general decoration. The weekly audit informed the operations manager of the percentage of exhibits broken at one moment in time each week, helped to ensure that action was taken to improve the physical state of the exhibits, and helped identify those exhibits which broke down on a regular basis (which therefore required major redevelopment or scrapping). Thus, the museum was able to respond to any complaints with a quantified analysis of the number of exhibits out of action, and, in terms of exhibit development, to learn from experience which potential new exhibits are likely to cause problems.

Techniquest operates a similar policy, and goes one stage further with a board in the reception area which details the proportion of exhibits broken at any one time, as well as giving the names of key staff on duty. This simple panel communicates a message to the visitor that Techniquest is an organisation that monitors its performance on a continual basis.

One problem facing the operations manager of a hands-on centre is identifying just what constitutes an exhibit that does not work. This might seem a simple problem to solve, and it is if the breakdown is mechanical or electrical. Far more difficult is the exhibit that does work from a technical perspective, but is so complex to interpret that it does not work from an intellectual perspective. In other words, if the exhibit does not work for its intended audience, for whatever reason, then it is the visitor's perception that the exhibit is broken. Furthermore, physical abuse of an exhibit is far more likely to occur if the visitor cannot immediately understand what they are supposed to do. As Chapter 2 reinforced, if an exhibit does not work for any reason at all, the centre must accept responsibility—it is invariably the fault of the developer for having designed an exhibit that is too complex or is unreliable. Ensuring a good working relationship between the exhibit designer, interpretation staff and exhibit builder is of paramount importance.

Formative evaluation of prototypes can eradicate many problems in terms of both physical design and graphical interpretation at an early stage, and is therefore an essential part of the exhibit development process.

If a visitor does complain that an exhibit is broken, it is unacceptable to show the visitor that the exhibit really does work, but they have not followed the instructions properly. This is a particular problem in the use of new technology: visitors failing to achieve the desired objectives in a computer exhibit may well feel that they have failed, when in reality the exhibit has failed them. This has a potential demoralising effect on a visitor inexperienced in the use of new technology, and may act as a deterrent in the future. Thus, an exhibit that is designed to promote access to new technology might do precisely the opposite. In short, designing appropriate interpretation for a broad cross-section of the visiting public is a complex task, but is a major factor in determining whether or not an exhibit is perceived to work. There is no substitute for effective evaluation.

Whilst every hands-on centre aims to develop exhibits that never break, and to repair any exhibits that do break within minutes, the reality is often quite different. Typically, at most centres on less busy days technical staff can stay on top of maintenance and breakdowns, and few complaints are received. However, on busy days, breakdowns and subsequently complaints typically increase in relation to the increase in the number of visitors. A family that has queued for two hours will justifiably be disappointed if several of the exhibits that they visit first fail to work for them. The problem is exacerbated if high-profile, centrepiece exhibits fail to work, for it is these key exhibits that are often the most popular, and certainly those which will shape visitors' perceptions of the museum if they fail to work adequately. The operations manager of every hands-on centre will know the visitor threshold at which breakdowns start to occur, and consequently when complaints arise. Similarly, they will know the key exhibits that have a skewed importance in determining visitors' perceptions.

When an exhibit is reported as broken it must be immediately recorded and checked. A central location for an operations desk—possibly linked to the information desk—to record all breakdowns and complaints is desirable. If the fault has been reported by a visitor, it is helpful if that visitor is asked to show the precise fault to a member of staff. Thus, if the fault is one of interpretation rather than breakdown, then the misunderstanding can be rectified. A good enabler will later explain the problem to a member of the interpretation team. If the exhibit has broken mechanically, then there are a number of possible courses of action:

1 Is the exhibit safe? If not, can access be prevented by barriers or by closing off the gallery? Can power to the exhibit be shut down?
2 If the exhibit is safe, but not working, it should be labelled accordingly. It is disappointing for a visitor to find a broken exhibit labelled as such, but it is far more frustrating to find a broken exhibit that is not identified. The visitor may feel that they have failed, when in fact the exhibit has failed them.
3 The operations manager will then have a decision to make regarding the priority with which the exhibit is repaired, and this will depend on whether the exhibit is a key attraction, whether it is essential for a workshop session and whether appropriate technical staff are currently available.

4 Can the exhibit be repaired in situ? Many exhibits are fixed to the floors and walls of the gallery, and removal is difficult. However, it is sometimes possible to repair an exhibit when the gallery is open: a broken exhibit with a helpful technician working on it can actually enhance its educational potential (albeit at the cost of holding up the repair). The author has many times refilled or repaired the cash dispenser at Eureka! in front of wide-eyed children astounded to see so much money! The secret life of machines and how they work fascinates the inquisitive child in most of us! For safety reasons, of course, access to the exhibit must be prevented by temporary barriers and the technician must learn never to leave tools or ladders if they are called away from the repair.
5 If the exhibit must be removed for repair, is there a duplicate or alternative exhibit that can be introduced as a temporary replacement? In an ideal world, every hands-on gallery would have the luxury of a duplicate exhibit. In the real world, this is impossible—but it is possible to hold stocks of parts that frequently need repair. As Chapter 2 demonstrated, wherever possible, the hands-on centre should standardise common parts (such as pumps, bearings and motors) and only utilise parts that are widely available locally. It is unhelpful if an exhibit cannot be repaired because a part has to be shipped from abroad. Specifying the use of standardised parts and the provision of good access for repair are integral parts of the design brief for hands-on exhibits.

Managing complaints

Even popular and effective hands-on centres will sometimes receive complaints. If the centre values its visitors' opinions and wishes to receive repeat visits, it will make it easy for customers to deliver suggestions and to make complaints, and these will be acted upon quickly and efficiently. Nevertheless, it would be misleading to assume that a complaint and suggestion system alone can give a full picture of visitors' satisfaction and dissatisfaction. Studies of consumer behaviour in the USA suggest that 25 per cent of customers are dissatisfied with their purchases, yet only 5 per cent complain.[7] It is not suggested that this data from research on product purchases in the USA is directly applicable to a visitor attraction in the UK, but the fact remains that most people feel their complaints are trivial, that they will be made to feel foolish or that no remedy will be offered. In short, complaint levels alone are not a measure of visitor satisfaction, and monitoring complaints is no substitute for visitor survey data.

Most visitors with complaints will simply make a decision never to return, or to return less often. Again, consumer research in the USA suggests that whereas a satisfied customer will tell three other people about a good product experience, a dissatisfied customer will tell eleven people. If these tell others, good and bad word of mouth grow exponentially. Furthermore, the customers who are most upset are often those who had previously been the best customers, whilst those who have their complaints resolved successfully, often become loyal customers thereafter.[8]

An effective complaints process makes it simple and clear for visitors to complain, for example, by providing a central and clearly signposted point inviting suggestions (usually the visitor information desk) and by designing standardised complaint forms, detailing

channels of communication and action taken by different staff. Staff should be trained to resolve problems speedily and successfully. Studies show that the faster a company responds to complaints and the higher the compensation offered, the greater the ensuing satisfaction.[9]

A clear policy also needs to be drawn up regarding suitable compensation: for example, will the centre offer a refund of admission or complementary tickets for a repeat visit (thereby gaining possible future café and shop sales)? At what level of authority will money be refunded? If an acknowledgement of error is made, a policy needs to be drawn up to respond to requests for compensation for transport and other costs, which can be substantial and greatly exceed admission prices if the complaint concerns a school or group visit.

The final stage in managing complaints is to discover and correct the system failures that are the root cause of the problem. In addition to making it easy for visitors to complain, as Chapter 3 has stressed, regular visitor surveys need to be conducted to ascertain the level of visitor satisfaction and to invite suggestions for improvements. Asking if the visitor would consider revisiting the centre or would recommend friends to visit provides a good indication of visitor satisfaction. Another method is to recruit 'mystery shoppers': that is, individual assessors are asked to visit the centre unknown to staff and fill in a standard questionnaire reporting on visitor service.

In addition, a good manager will regularly walk around the centre trying exhibits and talking both to staff and visitors. It was no accident that the offices at Eureka! were built so that staff had to travel through the exhibition spaces to reach their desk. A manager who is seen to be active on the exhibition floor will not only be more aware of system failures that lead to visitor complaints, but is much more likely to command the respect and confidence of staff and thereby be in a position to correct any potential human resource problems.

Conclusion

The role of effective operations management of a hands-on centre is to provide a consistent and high-quality service that meets educational objectives, but which can be delivered within the financial and other resources of the organisation. Since word of mouth is such an important promotional tool for visitor attractions, consistency in service delivery is vital for the effective management of a hands-on museum or science centre. This requires that the visitor experience is the same for every visitor, whether they arrive at the peak time on a busy Bank Holiday, or whether they arrive an hour before closing time on a Friday afternoon in December. Indeed, these two extremes are likely to be when most difficulties arise. In the former, resources are stretched to the limit: it is the time when a building is at full capacity that hands-on exhibits are most likely to break down and when most complaints will be received. Conversely, at less busy times, there is a great temptation to cut back on staff and other resources, and in these situations it is difficult to deliver a comprehensive visitor service. Staff are a vital component in the delivery of any service. Given the importance of the human element in hands-on learning and the ability of a well-trained staff to offset any operational problems, high standards of human resource management are essential for the effective management of a hands-on

museum or science centre, and it is towards this area of management that attention is turned in the next chapter.

7
Human resource management

This chapter investigates good practice in managing the human resource at interactive centres, particularly in the management of front of house staff and volunteers.

Introduction

The human skills required to manage a hands-on museum or science centre are similar to those required to manage any other visitor attraction: staff fulfil all the main managerial roles of administration, operations management, human resource management, marketing and commercial development, educational programming and events management. However, the importance of human interaction towards the success of the interactive museum experience requires that the very best practices in recruitment and selection, equal opportunities, and training and development are implemented. These are essential if the problems typically associated with hands-on museums, such as fatigue or 'burn-out', are to be avoided. Volunteers, too, are an essential component of many hands-on museums, requiring careful and well-planned management if this important human resource is to be utilised effectively. Many museums—particularly in the USA—have altruistic aims towards both paid and unpaid staff, and devise innovative programmes to recruit and train people to offset broader societal trends of injustice or educational deficiency. This chapter outlines how many hands-on museums in the UK and USA have implemented good practice in human resource management.

The nature of human interaction at hands-on museums

At all visitor attractions, staff are integral to the delivery of the service: this builds in an element of unreliability as it is difficult to maintain consistent standards of exchange between staff and visitors. It follows that managing human resources to achieve this consistently high standard of delivery is always important at any visitor attraction. However, the nature of hands-on museums involves additional factors:

1 The intangibility of the service. Visitors do not always know what to expect at a hands-on centre, so staff can play an important role reassuring both adults and children, for example, by indicating acceptable standards of behaviour for children.
2 The nature of the audience. Given that the majority of visitors are young children and that the nature of the exhibits can make them very excitable, visitor behaviour is often unpredictable—staff have to be prepared to deal with any situation.

3 The nature of the experience. Most interactive centres have educational goals, and mediation by staff can enhance the learning process by guiding parents to help their children learn more from their interactions with the exhibits.
4 The nature of the exhibits. Interactive exhibits have to be built to very high standards to withstand continual use and abuse. However, even the best-designed exhibits sometimes break down, and interactive centres need versatile technicians able to juggle several maintenance tasks simultaneously safely and in good humour, often in a public arena. They are a precious resource.

Evaluative research at the Science Museum's new gallery, Things, has identified that the quality of the visitor experience is greatly increased by adult interaction, whether that adult be a parent, teacher or explainer. Throughout the study, it was observed that children spent longer on exhibits and were more focused when there was adult interaction. For school groups, informative and lively explainer-led briefings helped to focus the attention of the children, and the research led to a recommendation for an expansion of explainer-led activities on the exhibition floor (such as simple demonstrations or discovery boxes for visitors to explore).[1] Falk and Dierking reinforce the importance of the human resource in enhancing the museum experience, suggesting that: 'Ultimately, the human link between the exhibit and the visitor is likely to be the most important determinant of public understanding and learning.'[2] Indeed, they suggest that there is evidence that personal interaction increases the likelihood that a museum experience will be memorable, in some cases years after the event:

> Giving each person a little attention, making her or him feel special and important, almost guarantees that the museum experience will be both positive and memorable… People, especially well-trained and committed people, are still the key to high quality education.[3]

There are also good marketing reasons to improve human interactions with visitors, for, as Gillian Thomas has noted, the presence of a smiling adult is remembered more than the exhibit that did not work.[4]

Organisational structure

The Association of Science and Technology Centers in the USA periodically surveys traditional science museums, children's museums and hands-on science centres across the world, and has found that there is no typical size or organisational structure. The 1987 survey received responses from 131 institutions, including eighteen located outside the USA. Of those centres providing information on staffing levels, the survey found that, on average, they employed 28.5 full-time equivalent staff.[5] As one would expect, the size of the work-force is related to the size of the centre: the very small centres (<1,858 square metres) had the equivalent of 17.5 full-time members of staff, the small centres (1,858–6,968 square metres) had 46, the medium centres (6,968–18,580 square metres) had 118, and the large centres (>18,580 square metres) had 242.[6]

There are many variations in organisational structure, as might be expected in such a diverse group of institutions, but typically staff are organised into three hierarchical chains: operations and finance, marketing and development (fundraising) and programme (often including separate exhibits and education functions).[7] The survey concluded that there is no one preferred organisational structure, since much depends on the size and nature of each institution. For example, curators and conservators will only be employed if the hands-on centre combines its functions with those of a museum. In hands-on centres, the education and interpretation manager(s) are integral to the exhibit development programme and are likely to be employed at a senior level—a role they do not always have in more traditional museums.

The ASTC survey found that staff costs represent between 50 per cent and 70 per cent of the budget in the centres surveyed.[8] This figure is verified by the available financial data for UK centres (see Chapter 4), in which staff typically cost around 50 per cent of the revenue budget. Given the importance of the human resource to the visitor experience and its significance as the main element within the revenue budget, it clearly makes sense to recruit, train and manage the human resource wisely. Furthermore, the investment of resources in recruitment and training is high, so a high turnover of staff is very costly.

The role of front-of-house interpretation staff

The largest group of staff within hands-on museums and science centres are those employed front of house to assist in the interpretation process. They are known, or have been known, variously as pilots (Bristol Exploratory), enablers (Eureka!, Light on Science at Birmingham), helpers (Techniquest, the Inventorium), explainers (Science Museum, Exploratorium), interpreters (Boston Children's Museum), auxiliaries (Natural History Museum), hosts (Ontario Science Centre), demonstrators (Technology Testbed at Liverpool) and gallery assistants (Launch Pad).[9] Although there is no consensus between centres on the appropriate name for front of house interpretation staff, and although each centre has its anomalies, there is in fact remarkable similarity between the roles of staff who work with hands-on exhibits.[10] This similarity in roles is due in part to the fact that European centres are largely modelled on those in the USA—particularly the early pioneers of the Exploratorium in San Francisco and the Boston Children's Museum.

Explainers at the Exploratorium, San Francisco: a case study

At the Exploratorium in 1988, ninety full-time and 118 part-time staff (including forty-five part-time explainers) were assisted by twenty-five weekly and seventy-five special-event volunteers.[11] Between 1969 and 1986, 900 teenagers 'chosen only for their enthusiasm and diversity' were employed as part-time paid explainers—the primary front of house staff on the museum floor.[12] Frank Oppenheimer's philosophy was to employ explainers with a reciprocal role: the students served the museum and its visitors, and in return were not only paid but gained valuable work skills.

Explainers were recruited three times a year for an average session of four months, with the short time-period chosen to enable more students to follow the programme, and to minimise the effects of burn-out. Although their primary role was to explain science to

the visiting public, students were selected less for their science background than for their curiosity, friendliness, enthusiasm and diversity.[13] Over half the explainers recruited came from a non-white background. The basic requirement for being an explainer was the ability to establish immediate rapport with children and adults.[14] Once selected, they attended intensive training sessions for fifty hours over three weekends, and thereafter received regular training from museum staff.

> The social milieu is as important to the success of the programme as are the exhibits. The explainers depend very strongly on each other's help, and this fosters feelings of interdependency and co-operation among students with quite different backgrounds. Furthermore…mentor relationships between staff and students readily form.[15]

Staff morale remained high partly because of the frequent introduction of new exhibits and prototypes.[16] Research into the long-term effect of the explainer programme found that it had had a positive effect on students' interest in learning, and in learning science in particular. Students gained increased self-confidence, developed new learning skills and became more positive towards working in a multi-racial environment. They also held more positive attitudes to work than teenagers in other jobs.[17]

Interpreters at Boston Children's Museum: a case study

One of the stated aims of the Boston Children's Museum is to 'attract and support a diverse staff who share a commitment to children and bring creativity and expertise to the work of the museum'.[18] In the early 1960s, the children's museum was primarily a white institution in terms of its visitors, its board and its staff. From the late 1960s onwards, a more diverse staff was recruited to take forward the museum's ambitious multi-cultural programmes, such that by 1991, when the museum employed the equivalent of 105 full-time staff, people of many racial and ethnic backgrounds held positions at every level.[19] The museum makes particular efforts to make community contacts to ensure that there is a diverse pool of candidates before making a selection, a process which is always slower than simply placing an advertisement in a newspaper. However, although the museum actively seeks to recruit from a diverse range of applicants, they also reinforce the importance of selecting the best candidate.[20]

The Museum Education Interpretership Program at Boston Children's Museum attracts applicants from around the world, in order to provide experience to individuals interested in exploring careers in museums or in informal teaching environments. The main role is to interact with visitors, with a secondary role of security, cleaning and stocking exhibits with consumable materials. There are no formal prerequisites for the post, in order to encourage the broadest possible range of people to participate. Applicants are recruited three times a year, either for five months or for a twelve-week summer season. Successful applicants follow a ten-day induction programme by senior members of staff, which includes four days of intense orientation on the philosophy, exhibitions and operation of the museum, followed by two days shadowing existing interpreters, and four days of mixed training and interpreting. Every exhibit has its own training manual detailing its philosophy and objectives, and every member of staff has a

detailed training programme, with a daily one-hour training session. The training programme closely parallels the philosophy of the museum, with an emphasis on customer care and interactive learning.[21]

The Exploratorium and the Boston Children's Museum provided role-models for the European science centres and children's museums, but there was plenty of evidence of good practice elsewhere in the areas of equal opportunities, volunteer recruitment, employment of student apprentices, and staff training and development.

The Science Teacher Career Ladder at the New York Hall of Science: a case study

At the New York Hall of Science, an initiative entitled the Science Teacher Career Ladder is designed to attract women and black groups into science professions. In 1991, sixty black undergraduates taking science and education courses at eight participating colleges were employed as part-time explainers for fifteen hours a week, on a ten-week programme (repeated three times a year). Their role was to welcome and assist visitors, and to perform demonstrations. The broader aim was to help the trainees develop confidence and scientific knowledge, and to improve their communication skills. Each explainer had a written job description, received two days induction training, participated in a thirty-minute daily training meeting, and was appraised halfway through the programme and at its end. In addition, they received credit towards their courses, and were paid for both training and work. Some explainers continued the programme after 150 hours, and evaluation has shown that many have gone on to become maths or science teachers. In addition, high-school-level 'junior explainers' were employed as apprentices to the student explainers to assist weekend, evening and summer activities. Some of these children were paid, others received credits towards their school courses.[22] Student internees were also employed as demonstrators at Boston Museum of Science, where the student intern programme was funded by local companies.[23]

Volunteers at US hands-on museums

The ASTC survey found that the 125 institutions responding had an average of ninety-eight part-time volunteers each (the full-time equivalent of eleven posts), 28 per cent of whom worked in education or programming. Half the centres employed a paid volunteer co-ordinator, whilst a further 7 per cent recruited a voluntary volunteer co-ordinator (in the others, co-ordination of volunteers was thought to be decentralised). Sixty per cent of volunteers were aged between 18 and 59, with 15 per cent 17 or younger and 25 per cent over 60.[24]

Boston Museum of Science has an extensive volunteer programme, with 450 volunteers giving 60,000 hours in 1991—the equivalent of twenty-five full-time staff (each volunteer was expected to work twelve hours a month). Volunteers were recruited three times a year, undertook a two-day induction programme and had a further thirty-minute training session every day. Like the New York Hall of Science and Boston Children's Museum, every exhibit had its own training manual. All volunteers had a job description, and most had a written contract.[25]

The Children's Museum of Indianapolis also has an enormous volunteer programme: in 1990, 152 full-time and eighty part-time employees were supported by 555 adult volunteers giving 23,297 hours and 737 youth volunteers giving 53,429 hours.[26] Youth and adult volunteers are so important at Indianapolis—the world's largest children's museum—that they have their own centre there. Similarly, at Please Touch Museum in Philadelphia, 100 volunteers supported thirty full-time and twenty part-time staff. They had a formal interview and job description, and received regular training. They assisted in all aspects of museum work, both front of house and behind the scenes, and there was some overlap between the roles of paid and unpaid staff.[27] There was a similar overlap between roles at the Children's Museum of Manhattan, but at that museum volunteers did not have a job description. Brooklyn Children's Museum, on the other hand, employed no volunteers at all in 1991, as local government cutbacks had resulted in the loss of the volunteer co-ordinator, and remaining staff felt their jobs were threatened by volunteers.

European hands-on museums

The US science centres and children's museums influenced the recruitment, selection, and training of front of house staff at embryo European hands-on museums. At the Inventorium at La Villette, helpers were employed to reassure the adults in family groups, to reduce anxiety amongst school groups and to make sense of the exhibit content. They had to check equipment, conduct minor maintenance, control access, ask questions to encourage children, answer questions and demonstrate or run educational programmes. Their roles had to be clear, both to the helpers themselves to enable them to carry out this multiplicity of tasks effectively and to a general public perhaps more accustomed to tour guides or surly uniformed attendants. Volunteers were also employed at the Inventorium, but had a different role from paid staff to avoid any conflict.[28] At Eureka! The Museum for Children, the role of enabler was designed primarily to enable visitors to enjoy and learn more from the exhibits. Enablers also welcome and oversee school and other groups, run activities for families at weekends and holidays, entertain queues and have an important security and safety role. In 1992–3, the enablers at Eureka! were a key part of the education and interpretation team. There were eleven full-time enablers on open-ended contracts (after a succession of short-term contracts) and a large number of casual staff. Both casual and contract staff were paid at the same rate and were responsible to four team leaders (who each had one main area of responsibility: schools liaison, events, house-keeping and volunteer co-ordinator). The team leaders and enablers were managed in turn by the visitor services manager, who operated alongside two education officers and a curriculum support teacher responsible to the Head of Education and Interpretation.[29]

On a daily basis, enablers followed an hourly rota between locations, except on school days, when they welcomed groups and stayed with them. Eleven enablers were employed to run essential services on school days, fifteen at weekends and nineteen on peak days. At weekends and on peak days, additional enablers were employed to run special events or entertain the queues. This approximates to one enabler for every 273 square metres of exhibition space on school days, and one to every 158 square metres on peak days. This makes an interesting comparison with the Inventorium, where one enabler had been

employed for every 300 square metres of free-access exhibits, but one to every five children for Discovery Room exhibits.[30]

In some exhibition areas, no enabler was needed other than to encourage and reassure visitors, and to ensure their safety. Other exhibits, such as the factory exhibit's production-line, could not operate at all without an enabler present, and this was clearly unsatisfactory as the exhibit was inevitably unused for a significant proportion of opening hours. Some exhibits, particularly those involving role-play, were much enhanced when an enabler was present. An evaluative study in 1992 suggested that in the bank exhibit at Eureka!—where an enabler was always present—role-play was well-structured and effective in educating children in the role of money and exchange. However, in the shop exhibit the enabler was often preoccupied helping children operate the till; in that area little role-play was observed and the activities were more chaotic.[31]

Initial recruitment for enablers at Eureka! took place two months before the museum opened to the public. Advertising in the local and regional press encouraged 400 applicants, and twenty-four enablers were eventually recruited from seventy-five interviewees on a mixture of full- and part-time short-term contracts. It would have been possible to recruit only graduates, trained teachers or nursery nurses, but it was Eureka!'s policy at that time to offer opportunities to people with a wide range of skills and experience. They all had three things in common: experience of working with children, likeable personalities and youth. Eureka! justified its policy to recruit only young people by arguing that enabling is physically very demanding work, although with hindsight this policy was discriminatory. On the other hand, Eureka! successfully attracted applicants from a range of different cultures, which gave great diversity to the enabling team, although the museum had more difficulty recruiting men from any background.[32]

The first batch of enablers had intensive training over a one-week period by the education team, senior managers and by various fire and other safety officers. Thereafter, every day began with a thirty-minute team meeting to discuss the day's programme and to offer an important daily channel to communicate information between enablers and their managers. In addition, in term-time Monday afternoons were devoted to a long-term training programme designed after a comprehensive audit of training needs, and this was delivered either by one of the education team or by outside specialists. Thus, in the first year this included a range of activities, from training by Theatre in Education professionals, to learning how to use sign language.[33]

After the initial period on short-term contracts, many of the original enablers were able to negotiate successfully for open-ended contracts. Based on experience in the USA, the Director had argued that short-term contracts would prevent enabler fatigue and 'burn-out', but the enablers at that time wanted security, and after an expensive investment in recruitment and training, it seemed sensible to encourage loyalty in an enthusiastic core work-force. The result was that it was not necessary to undertake any further major recruitment within the first year of operation. However, large numbers of casual staff were recruited for weekend and holiday work, and for these recruits a short induction programme of training was developed, which was also delivered to volunteers, youth trainees and students on placement. This consisted of half a day with the education team on the underpinning philosophy of Eureka! and its exhibitions, half a day with enabler team leaders on evacuation training and core exhibit training, and a full day

shadowing an experienced enabler acting as mentor; on the third day the new enabler worked on their own.

At the Science Museum, in 1986 Launch Pad had been staffed by six gallery assistants in laboratory coats. By 1994, the museum employed thirty explainers—who, like those at Eureka!, were highly motivated outgoing young people. Their role is not only to explain scientific principles behind the exhibits, but also to encourage visitors to ask questions and to learn from each other. Rather than providing ready-made answers, explainers are trained to encourage visitors through a self-directed process of discovery. Again like those at Eureka!, their role is to demonstrate activities, brief school children, monitor the condition of exhibits, ensure the gallery is used safely and control crowds. The Science Museum looks for a combination of skills and personal qualities: a good understanding of science is important, but being an excellent and enthusiastic communicator is more important. Also like Eureka!, the museum invests heavily in training on issues such as the science behind the exhibits, learning styles, the national curriculum, presentational skills and assertiveness.[34]

Enabler 'burn-out'

One consistent problem at all interactive centres which employ enabling staff on long-term contracts is that of enabler fatigue or burn-out. Many US museums avoid this problem by only recruiting staff on short-term contracts, whilst the changing exhibits at the Exploratorium help to maintain staff morale. At both the Science Museum and Eureka! the ongoing programme of training was designed not only to improve the skills of the enablers but also to offset the effects of burn-out. This is important as it is not always possible to ensure variety in the work or to reward responsibility. It is common for enthusiastic enablers to want more responsibility as education officers or exhibit designers. At Eureka!, some enablers were able to achieve promotion, to move into responsible administrative positions at Eureka! or to transfer their skills elsewhere. Clearly, the human element at interactive centres is an expensive resource, and it should be nurtured and utilised as effectively as possible. At Eureka! enablers were encouraged to make suggestions to improve exhibits, whilst teams across all sections and layers of the organisation were introduced to develop programmes of activities and events. Similarly, at the Science Museum, explainers are encouraged to develop new ideas for exhibitions.[35] In 1993, the Science Museum, Eureka! and Light on Science at Birmingham were all investigating the possibility of explainer/enabler exchange.

Both Eureka! and the Science Museum have a policy of employing only young people as enablers/explainers, in an attempt to reduce fatigue. This policy was heavily criticised as ageist by human resource managers at other hands-on museums at a British Interactive Group seminar on the Human Element to Hands-On Learning in April 1993. In comparison, the Exploratory in Bristol employs people of all ages as pilots,[36] whilst Techniquest employs helpers of all ages amongst its fifty-five—mostly casual—front-of-house staff. Techniquest avoids the problem of fatigue amongst older helpers by reducing the length and frequency of shifts.[37] Techniquest also implements many other elements of good human resource management: it has clearly defined training objectives for its helpers together with clearly defined criteria for appraising front of house staff.

Other organisations are responding rather differently to the need for explainers and enablers. Some UK museums which are introducing hands-on exhibits into their existing museums are transforming existing museum attendants—whose role is primarily that of security—into museum assistants with an active educational role. For example, former attendants at Colchester Museums are now encouraged to welcome groups and lead museum tours.[38] Indeed, Hampshire County Council Museum Service and South Eastern Museums Service have produced a training manual for interpreters and demonstrators in hands-on centres and museums covering key skills such as listening, questioning and presentation.[39]

Volunteers at the Archaeological Resource Centre

The response of the Archaeological Resource Centre (ARC) in York to the effects of fatigue and burn-out is to employ only volunteers front of house. It is the view of Andrew Jones, the ARC's manager, that as there is never a satisfactory number of paid staff at hands-on centres for visitors to receive the optimum attention, the obvious solution is to employ volunteer staff. The ARC invests heavily in its volunteers, particularly in recruitment and training. All prospective volunteers (including students on placement) must make an introductory visit, after which they must make a formal application. If accepted, they are given two hours' training in safety and emergency procedures, and a training manual and checklist of training modules. Responsibility for training is shared amongst staff, and new members are encouraged to identify their own training needs. A regular programme of reviews and informal seminars is conducted, not to mention monthly parties for staff. The ARC has realised that if a volunteer is unhappy, they will quickly leave the organisation. Thus, it is important that the ARC offers something in return to reward loyalty, and it could be argued that the most important reason for working with volunteers is that it makes management more responsive to staff needs.[40]

People volunteer at the ARC for many reasons: as a first step on the career ladder, to meet people or simply to get back into work after a period of unemployment. Thus, students, the unemployed (including those returning to work after a family) and the retired are key volunteers. In total, the ARC has around fifty volunteers and offers work placements for around 200 students per annum (mostly archaeologists or students of heritage management). There is a long tradition in archaeology of volunteer and paid employees working alongside each other, and this reduces any potential friction. In return for its heavy investment in recruitment and training of volunteers, the ARC achieves its aim of educating the public in archaeology, helps keep the centre lively and interesting, and its staff rarely suffer from burn-out. As Jones observes, 'Volunteers and students are not a cheap solution to staffing interactive centres, but they are a good way of avoiding many of the least satisfactory aspects of hands on centres.'[41]

Best practice in human resource management at hands-on centres

Essentially, good practice in human resource management is applicable to any organisation: it begins with job analysis, to specify the work that needs to be done to meet the organisational goals, and the relationship between post-holders within the

organisational structure. The ASTC survey has shown that there is no one organisational structure which is appropriate for all hands-on museums and science centres—it depends very much on the size and individual nature of institutions. One particular issue is where to place front-of-house staff—the main element in the staffing budget—within the organisational structure. Should they be the responsibility of the operations manager or, because of the educational nature of hands-on museums, should they be the responsibility of the education manager? There are arguments for both chains of command: if the front-of-house staff are responsible to the education manager, much of that person's time will be diverted from educational programming to the minutiae of daily operations management. On the other hand, if they are responsible to the operations manager, there is a risk that their educational role is diminished and they become more like the traditional museum attendant. Many museum services, like the Colchester example cited above, are trying to retrain their attendants to play a more active role in the visitor experience. Since the human element to interactive learning is so important, education staff should at the very least be responsible for the training and development of front-of-house staff.

As in most other organisations, every job (whether paid or voluntary) should have a job description specifying the tasks and duties to be completed, working conditions, lines of authority and expected results. An unambiguous job description clarifies to whom an employee reports and how performance will be measured, whilst the lack of a job description can lead to misunderstanding. Every job should have not only a job description detailing the tasks to be completed, but also a person specification listing the criteria against which candidates are measured for selection. If each of the criteria has a measurable performance indicator, there is less likelihood that decision-making will be based on subjective values.

The process of recruitment and selection requires targeted advertising to reach a broad spectrum of potential candidates, followed by objective selection of the best candidate. There are many suitable methods of selection, but the typical method is to short-list those candidates matching the requirements of the person specification on the application form, followed by an interview to measure those criteria not covered by the application form. Applying a standardised interview format to all interviewees, together with measurable assessment criteria for each category on the person specification, helps to ensure objective decision-making and non-discriminatory selection. A police check on anyone appointed to either a paid or a voluntary post dealing with the public is essential to ensure that they do not have a criminal record of indecent assault on children.

In reality, the selection of front-of-house staff can be highly subjective, since many organisations cite a pleasant character or an ability to interact with visitors in a short space of time as being an important characteristic of post-holders. This underpins the need for a person specification detailing measurable characteristics required of post-holders: clearly, it is possible to measure qualifications and prior experience of working with children, but even large science centres such as the Exploratorium and the Science Museum in London claim personal characteristics are more important. The logic is simple: front-of-house staff have around one minute to create a positive interaction with visitors, so the old adage 'you only get one chance to make a good first impression' is extremely important. The challenge, therefore, is to reduce subjective decision-making:

one solution is to devise a test which is a realistic approximation of an interaction with visitors on the museum floor, and to subject all interviewees to this test.

Equal opportunities is an important issue for all employers: in the museum world, many institutions wish to broaden the visitor base (perhaps to justify public subsidy), whilst there are others—such as the New York Hall of Science —which have training objectives to address inequalities in society. In the UK, equal opportunities are encapsulated by UK and European Community (EC) legislation: discrimination by sex, marital status, race and disability are all illegal. Boston Children's Museum, which has a long history of addressing equal opportunities issues, is a model of best practice. That museum advocates taking time to ensure that jobs are advertised and promoted through community contacts to a broad range of communities, but stresses that is essential that only the best candidates are appointed. Thus, the key to good practice is to devise appropriate strategies to cast the net as widely as possible, but then to appoint the candidate who best meets the criteria set out in the person specification.

In the UK, discrimination by age or sexuality is not illegal, but is considered unacceptable by most equal opportunities employers. Ageism is a problem in interactive museums, as many employers are concerned that the environment is too tiring for older people. However, there are many examples of museums in the UK and USA which have successfully harnessed the skills and abilities of older people: one way is to offer the opportunity to work shorter shifts, as at Techniquest in Wales.

Good human resource management continues after recruitment and selection with staff induction, job-specific training, appraisal, and continuing training and development. There are many examples of good practice in induction training, although the Interpretership Program at Boston Children's Museum provides a model for others to emulate. A training policy, alongside training needs analysis, will help identify the training needs of individuals in accordance with organisational goals. Ongoing staff appraisal should ensure that staff know what is expected of them and understand how their performance relates to organisational goals, and will enable them to receive recognition for their achievements. The process can help prevent demotivation by ensuring that staff feel part of a team and, as performance appraisal is a two-way process, it can also help managers receive feedback from staff.

There are a number of alternative ways to avoid the potential problems of fatigue and burn-out amongst front-of-house staff. The response of many hands-on museums is simply to employ staff only on short-term contracts: this does ensure a continuaily changing work-force, but requires a heavy investment in induction training. If the organisation has broader training aims for its employees, as does the Exploratorium or the New York Hall of Science, then this policy can help achieve these objectives by making more places available. However, many other hands-on museums employ staff on longer-term contracts and implement a well-planned staff training and development programme to help offset the problems of fatigue and burn-out.

Front-of-house staff are the largest item on the revenue budget for hands-on museums, typically accounting for 50 per cent or more of annual expenditure. One response to the need for more staff on the exhibition floor is to recruit volunteers, and many centres—such as the ARC in York, Boston Museum of Science or Indianapolis Children's Museum—have successfully employed volunteers either as the main work-force, or working alongside paid members of staff. In some institutions, volunteers and paid staff

are interchangeable, but a more common practice is to employ volunteers to do additional tasks (with a job description) in support of the paid work-force. This strategy avoids the problem faced by Brooklyn Children's Museum in 1991, when staff cuts resulted in staff feeling threatened by the possible recruitment of volunteers. However volunteers are integrated, they should never be seen as a free resource, as they require co-ordination and management like any other employee group. Indeed, if the museum does not respond to the special needs of its voluntary work-force, it may well find that a high turnover of volunteers is in fact a very expensive resource in terms of training.

In conclusion, best practices in recruitment and selection, equal opportunities, and training and development are largely interchangeable between many organisations. The importance of human interaction to the museum experience in hands-on museums and science centres requires that organisations implement the highest standards to manage both their paid and volunteer staff. If they are unsuccessful, the quality of the interaction with visitors will be diminished, and there is every likelihood that front-of-house staff will fall victim to fatigue or burn-out, which will result in a high staff turnover and expensive recruitment and training for the museum.

8
Managing educational programmes and special events

This chapter outlines the ways in which UK and US hands-on museums and science centres manage their educational programmes, special events and outreach.

Introduction

Education is at the heart of all activity within the hands-on museum or science centre. Every exhibit is developed and selected for educational reasons, staff are trained to help visitors use the exhibits more effectively, and every exhibit or activity is evaluated against specified learning objectives. As part of the informal education sector, the hands-on museum defines its audience in broad terms, but most of its educational strategies will be concerned with encouraging existing users to make greater and more effective use of the centre, or with developing new users of the service by innovative programmes or outreach activities.

Existing visitors, or groups of people who share the same characteristics of those visitors, are the groups which are the easiest to reach, and strategies to reach these people are likely to be more cost-effective than trying to reach those who have not previously visited the centre. Chapter 5 has shown that the main groups of existing visitors are likely to be families and schools. Encouraging more visits to the service by these groups involves market penetration strategies, such as more effective promotion or changing the pricing structure. It can also be achieved by service development, such as developing curriculum materials for schools, school and family workshop activities, children's clubs or special events such as sleepovers. A traditional museum placing hands-on exhibits within its existing galleries is also an example of service development, aiming both to attract more visitors and to improve interpretation in the gallery.

Encouraging existing visitors to use the service more often or more effectively is very much easier to achieve than developing new audiences through outreach. The personal characteristics, opinions and behaviour of people who have shown a propensity to visit can be measured relatively easily by market research and evaluation studies, and educational and marketing strategies can be developed to meet their identified needs. These groups comprise the core market—and therefore the main source of earned revenue—for all museums, and their interests should be nurtured so that they continue to use the services provided. Non-visitors are much more problematic: not only do the characteristics of these groups have to be identified, but market research to discover their interests and opinions (non-user surveys) is complex. Furthermore, changing their current non-visiting behaviour pattern in favour of visiting a hands-on museum or science centre

will always be difficult. This may be achieved by market extension strategies (such as raising awareness through improved promotion or concessionary admission prices targeted at specific groups of non-users) or by diversification strategies designed to develop new services for these groups. These might include developing exhibits and programmes for the under-5s, for teenagers or for the early-retired and senior citizens. These programmes are likely to be expensive to develop, and the outcomes are more unpredictable. As such, only hands-on museums with a sound financial base are likely to commit scarce resources to outreach activities. However, many hands-on museums and science centres will have specific corporate objectives identifying a commitment to developing programmes for a broad audience, so programmes will need to be developed to reach these groups effectively. Given the difficulty and unpredictability of outreach activities, it is vital that the hands-on museum clearly identifies in its mission statement and educational policy those visitor groups for which it intends to provide.

It is a fundamental principle of hands-on museums and science centres that whilst they are likely to assist more formal educational institutions such as schools to meet their curriculum needs, such museums and science centres are valid educational institutions in their own right. Chapter 2 has demonstrated that there are sound educational reasons why many people learn more effectively in an informal environment, and as such the hands-on museum is not simply an extension to school. Chapter 5 has shown that families within a sixty-minute drive are likely to be the main visiting groups to hands-on museums, with schools the next-largest segment. Whilst 33 per cent of visitors to UK museums are children, families rather than schools provide the main market segment. One commentator has suggested that school groups comprise 10–20 per cent of visitors to some independent museums, although there is clear variation between different types of museum depending on their objectives, programme, educational resources and marketing.[1] Indeed, annual throughput of school children in educational groups to UK museums can vary from less than 5 per cent to more than half of total admissions. Although less important than family groups to most museums, schools do provide an important market for museums in the UK, not only because they visit on school days when the museum would otherwise be empty (thereby helping to offset fixed costs of opening), but also because children visiting with school often bring back their parents on a family visit. Indeed, it has been claimed that two children in every seven visiting one traditional UK museum with a school group returned within two months with their parents.[2]

Museum education in the USA

Chapter 1 has identified that the current boom in hands-on museums and science centres in the UK and Europe stems from the successful development of hands-on museums as effective institutions of informal education in the USA. In 1987, the ASTC survey received responses on education from 123 science museums, children's museums and hands-on science centres, 97 of which are located in the USA (approximately one-third of the sample were traditional science and natural history museums). An independent review of the findings commented that the main feature of the research was the diversity of activities taking place within museums and science centres. As museums and science

centres, they concentrated on providing the casual visitor with a range of educational experiences centred around exhibits. However, it was noted that they were increasingly involved in outreach activities, attracting new audiences to existing services but also diversifying to become multifaceted cultural resources of local communities, serving a broader base than simply their visitors.[3]

For general audiences, over half the respondents to the research claimed to be offering eight different types of programme: demonstrations and lectures (94 per cent), classes and workshops (94 per cent), special events (88 per cent), guided tours (67 per cent), field trips (66 per cent), films or space shows (64 per cent), student interns (64 per cent) and planetarium shows (52 per cent). Other activities for general audiences included performing arts (46 per cent), sleepovers (44 per cent), travel programmes (43 per cent), science clubs (34 per cent), speakers' bureaux (36 per cent) and radio/television programmes (32 per cent).

For schools, over half the respondents were offering five different types of educational programmes: classes and demonstrations at museums (94 per cent), in-service education for teachers (81 per cent), classes and demonstrations at schools (67 per cent), curriculum materials (66 per cent) and loan kits (53 per cent). School programmes also included science fairs (44 per cent) and career workshops (30 per cent). The survey did not include explainer programmes or publications, both of which are important educational tools helping a museum reach into its community.[4]

In total, 88 per cent of respondents to this survey reported that they were offering three or more educational programmes. These included a very broad range of educational activities for general audiences, which were distributed across all types of museums in the survey, although there was some variation in size and type. The smallest museums reported fewer sleepovers and travel programmes than larger museums, whilst the largest museums were more likely to offer films and guided tours. The hands-on science centres, 63 per cent of which have either a library or resource centre, were more likely to offer planetarium programmes and science clubs than the museums.

For schools, 64 per cent of respondents were offering three or more educational programmes, with over 50 per cent serving more than 25,000 school students per year. An average of 24 per cent of the annual attendance at the museums and science centres visited in school groups, with the smaller institutions generally gaining a higher proportion of school groups than large institutions. The report speculated that the large institutions have physical constraints on the number of classes they can accommodate, and that many of these are major tourist facilities attracting visitors over long distances. The museums in the USA were more likely than the non-US museums to hold classes or demonstrations at schools, or indeed to loan kits or artefacts to schools. In addition, new museums were less dependent on school visitors than older museums, and offered fewer classes, teacher training workshops or curriculum materials. Only 44 per cent of new museums had classroom facilities, compared to 74 per cent of the whole sample. Thus, the report speculated that for new museums in their initial stages, schools are less of a priority than exhibit-based, public-oriented programming.[5]

Public and school programmes often fall within the remit of separate departments within the larger US science centres. For the 94 US science centres reporting in the ASTC survey, an average of 10 per cent of public space and 14 per cent of operating budget were devoted to educational programmes, with a similar additional amount for

public programmes such as theatres and planetaria. For the US centres, the total expenditure on education and public programmes was 27 per cent of all operating expenses, whilst income from special events, programme fees and publications brought in 19 per cent of total revenue. Education programme staff comprised 19 per cent of all staff, receiving 14 per cent of wages (suggesting that education staff received less than the 'average rate of museum pay). Wages for all other public programme staff cost an additional 14 per cent of the wage budget. Thus, education and public programming are major staff employers in US science centres. In addition, approximately 53 per cent of all volunteers in US science centres were assigned to education departments, with a median number of 23 per museum (the median is considered a better indicator than the mean, since some museums employ high numbers of volunteers: for example, the California Museum of Science and Industry reported 620 in the education department alone).[6]

US case studies

The ASTC survey asked respondents how they evaluated the success of their educational programmes, suggesting that there had been less research in this area than on exhibits. Since most visitors to US museums pay an additional fee for education programmes, there is a temptation to neglect educational objectives in favour of programmes which are primarily popular and enjoyable. Respondents suggested that a successful education programme is likely to offer hands-on activities in a non-threatening environment, high-quality staff and programme content, access to 'real' artefacts and scientific phenomena, and a flexible structure offering day-care, after-school, holiday and weekend programmes appropriate for busy parents trying to juggle home and work schedules.[7]

Many of the best programmes witnessed by the author in the USA are attempts to expand the visitor audience beyond schools and white family groups. For example, the Children's Museum in Boston has a long history of multicultural and community programmes, employing strategies that have gone a long way to opening the museum to new audiences.[8] At Brooklyn Children's Museum, located in a multicultural and run-down district, the Kid's Crew involves over 1,200 local children annually aged between 7 and 15, about forty-five of whom arrive after school every day on their own and engage in museum activities free of charge. In 1991, Brooklyn Children's Museum was the only cultural organisation in New York to allow children to visit without an adult. From the age of 10 some members of Kid's Crew train as Junior Curators, who undertake voluntary assignments in almost all areas of the museums, acting as interpreters, assisting with programmes or simply working in the cloakroom. By the age of 14, Teen Interns are paid a wage and given even more responsibility, alongside receiving basic training in job-hunting and work-related skills. Brooklyn's unique approach, called the Museum Team, combining training experiences with close supervision from supportive staff, makes the museum a role-model for many other youth-serving cultural institutions in the USA. On Friday nights in the summer, the museum holds rooftop parties for families, and the summer annual event in the surrounding park has attracted 15,000. A safe haven from street life, substance abuse and crime, Brooklyn Children's Museum is a museum reaching out into its local community.

In a much more prosperous part of New York, the Children's Museum of Manhattan also serves its local community. It keeps its school and public programmes quite separate,

with schools visiting in the morning and public programmes throughout the afternoon, along with after-school facilities for children whose parents are at work. The author visited an early-childhood class, the purpose of which was as much to offer a supporting role to parents as to provide play opportunities for children. Please Touch Museum in Philadelphia has a similar role, with graphics throughout the museum designed to support parents simply in the role of parenting. Whilst around 155,000 people a year visit Please Touch, a further 50,000 are reached by various community outreach programmes. For example, Travelling Trunks are twenty-four kits of exhibits and activities which are available to community sites and events. There is a disadvantaged children's fund, provided by local sponsors and patrons, and on Sunday mornings visitors can pay as much as they wish. In 1991, this averaged $1.60 compared to a normal admission of $5, but the voluntary admission price ensured that the museum was well-utilised.

New York Hall of Science has a clear mission to overturn the poor performance by black children in the subjects of maths and science. In the same way that the Children's Museum in Boston tackles multicultural issues through its exhibits and programmes on offer, New York Hall of Science meets its educational objectives through a variety of strategies. Its Science Career Ladder is described in Chapter 7, but at the bottom rung of this ladder, high school children come in to the museum and link with college explainers, working as laboratory assistants, on special events or running birthday parties and sleepovers. At New York Hall of Science, the special events and public programmes are most impressive, including massive sleepovers, family workshops, Science Halloween, discovery activities and a big summer event. Significantly, these events are totally self-supporting.

Each children's museum and science centre has its own individual character, determined by local community needs. Perhaps the most impressive range of programmes are those aiming to reach adolescents—traditionally one of the least likely to visit museums out of school. For example, Brooklyn Children's Museum has its Museum Team, whilst Boston Children's Museum has an Early Adolescent Programme, together with a Youth Advisory Council in which staff and teenagers work together to design and provide appropriate programmes. However, without doubt the most impressive youth programme is provided by Indianapolis Children's Museum: the museum has its own gallery designed specifically with and for teenagers, its own Youth Advisory Council, its own news bureau (with a weekly page in the local newspaper) and—most impressive of all—the Museum Apprentice Programme. In this programme, teenagers are encouraged to become volunteer interpreters in one of the four main galleries. Around 100 children work in each of the galleries, coming in two days a week in term-time and four days a week in holidays. Of the 450 participants in the apprentice scheme in 1990, 20 per cent were non-white, and 60 per cent were female. Children are recruited every six months: at first there is an open evening with parents, then children select one gallery and they receive a full day's training. Thereafter new apprentices are trained by more experienced apprentices. Long service is rewarded by badges or T-shirts, and there is a waiting list to participate in the programme. The apprentice programme encourages young people to gain a deep knowledge of one subject area, but more importantly it helps them develop social interaction skills with a diverse range of people outside their daily environment. The museum believes the social benefits of this programme far outweigh the loss of any accuracy in interpretation of the exhibits. The main disadvantage is the high cost of

administration—there is one supervisor for the apprentices in each gallery, but the museum does not know until the day before which children are coming in, and schedules have to be drawn up for the children to change activities every half hour.[9]

UK case studies

Science centres and hands-on museums in the UK have tended to base their education and public programmes on those witnessed in the USA, adding new initiatives to reflect the local character of the community to be served. As in the USA, a new centre is likely to concentrate on establishing a core market of families and schools in the early stage of its life-cycle, before trying to extend its audience through outreach activities as it reaches maturity. Eureka! The Museum for Children's strategy for family groups in its early years was to organise a series of themed events at weekends and in holidays which would provide not only added value for visitors but also an incentive to make a repeat visit. For schools, the strategy was to raise awareness of the facilities on offer, promoting the museum as widely as possible throughout the region through the distribution of free curriculum materials (sponsored by a range of organisations in the private, public and charitable sectors), the organisation of structured in-service education for teachers (INSET) days, the provision of numerous free open evenings for teachers and opportunities for teachers to make free preview visits. All school visits to Eureka! had to focus on one of eight bookable spaces, and the education team developed a series of school workshop activities providing—at additional cost—added value to the visit. In short, Eureka!'s initial objective was to establish a core visiting market in the areas of school and family groups, based on strategies of raising awareness and providing added value to the visit.

The Exploratory at Bristol adopted a similar strategy for its school visits. With funding from the Gatsby Foundation, in 1993 the Exploratory developed curriculum materials for primary-age school groups, encouraging all schools visiting the centre to focus on themes (called 'Pathways') linked to the science national curriculum. The idea was based on a scheme developed by the Exploratorium in San Francisco, in which pupils are encouraged to focus on two or three related exhibits before going on to investigate freely the rest of the centre. At the Exploratory, all schools following the Pathway programme spent forty-five minutes in groups of half a class with two trained members of staff, and a further forty-five minutes elsewhere in the centre. Curriculum materials for teachers suggested related activities that could be carried out in the classroom before and after the visit, and provided insight into children's preconceptions and misconceptions. The programme was entirely dependent on charitable funding, and the Exploratory had previously had to shelve a number of similar schemes through lack of funding.[10]

Developing curriculum materials and delivering a staff-intensive educational programme is an expensive strategy, but essential if the hands-on museum or science centre is to survive in the highly competitive UK educational visit marketplace. Funding from COPUS or one of the educational charities supporting public understanding of science initiatives is one way to help develop educational programmes. Only the very large institutions with substantial public or charitable backing are able to develop extensive educational programmes, but many smaller centres are able to take part in initiatives like Science Week, which is a national celebration exploring science,

engineering and technology, co-ordinated by the British Association for the Advancement of Science. However, some successful programmes can be self-financing. The Science Museum has extensive education and public programmes, and, like Eureka! and the Exploratory, it has borrowed ideas extensively from the United States. For example, in 1993 it was the first museum in Europe to hold a sleepover or campin, and its monthly Science Nights now regularly attract 400 children and are self-financing.[11] With organised activities, experiments, story-telling and torchlit tours—not to mention the opportunity to sleep under a lunar module—there is little wonder the programme is so successful. Indeed, other UK science centres have copied the idea, whilst the Science Museum has also had a Women's Science Night.

Now in its third phase of development, Techniquest is perhaps the most mature science centre in the UK, and its education programmes closely resemble those of a US science centre. On site, around 80,000 school pupils visit Techniquest each year, making up around one-third of all visitors. The centre structures its school visits around weeks of activities linked to the science national curriculum, for both primary and secondary pupils. Pupils attend a presentation of around forty minutes in either the Science Theatre or the Planetarium, and afterwards are guided around the centre by focus cards linking exhibits to the themes being investigated. In addition, the centre has a Discovery Room containing a collection of Discovery Boxes for children to explore (which are very reminiscent of the discovery rooms at Boston Museum of Science). Beyond the centre itself, around 25,000 pupils each year are reached by Techniquest Kits, which consist of five hands-on exhibits on one of five different scientific themes. The kits are hired out to schools for half a term, with the rental price of £100 including delivery and collection. Techniquest also hires out a portable planetarium, operates Pan-Tecnicon (an outreach programme bridging the gap between arts and science) which distributes £300,000 on behalf of the Millennium Commission in thirty grants of £10,000 to organisations promoting science in Wales through activity and performance, and runs a joint M.Sc. programme in Communicating Science with the University of Glamorgan. In total, these programmes represent the activities of an organisation not only penetrating its existing school and family markets with new exhibits and events, but also meeting broader public understanding of science objectives by developing activities to reach out to new audiences.[12]

The hands-on museums and science centres in the UK are rapidly developing educational and public programmes that match the US science centres at their best. There are, however, some clear differences. The UK centres do not tackle race issues as directly as the US counterparts, and whilst the Science Museum has developed interactive exhibitions appropriate for young teenagers, the author is not aware of any youth apprentice programmes on the scale of those at Indianapolis Children's Museum, Brooklyn Children's Museum or New York Hall of Science.

Hands-on exhibits in the classroom

Museums in the UK have for many years operated school loans services and other outreach programmes, such as mobile museums, enabling teachers to use museum artefacts within the classroom. Now the hands-on centres are following suit, and several

mobile travelling exhibitions that can visit schools are in operation (including Techniquest's Kits and Science Projects' SchoolWorks).[13] This section investigates an innovative scheme in Nottinghamshire, where four science and technology trailers are available for hire by local primary schools, and considers whether the classroom or science centre is a more favourable learning environment.

The great strength of the permanent hands-on centre is that it enables parents and children to explore, discover and discuss together, with trained staff whose role is to assist adults and children in the learning process. The system works well for families, who typically comprise three-quarters of all visitors. A school visit to a children's museum or science centre can undoubtedly be both fun and inspirational, but in order to capitalise on the opportunity teachers need to structure the visit and follow-up work back at school very carefully. With fewer adults to assist in the discovery process, and without reinforcement back at school, there is a potential danger that the visit could just add to the mystification of science—the very opposite to the intended objective. The philosophy of the travelling science centre is that the exhibits encourage children to ask questions in a controlled environment, and they look to the teacher for support or confirmation of the ideas. Thus, the activities are the starting-point for further research and investigation within the classroom itself. The concept under discussion here is whether a hands-on exhibition within a school, backed up by comprehensive curriculum support materials, places the teacher more in control of the learning environment than a visit to a science centre or children's museum. As such, is the travelling science centre more attractive to teachers than the permanent centre?

The Primary Science and Technology Trailers are an imaginative joint initiative between Nottinghamshire Education Committee and the Greater Nottinghamshire Training and Enterprise Council, who jointly funded the capital and development costs, although subsequently the operation is self-financed by hire charges to schools. The objectives are:

1 To provide stimulating activities which enable children to experience and control scientific phenomena.
2 To extend the range of scientific equipment normally available to schools.
3 To support the development of curriculum activities within schools.

There are four trailers which are used to transport the exhibits, which the organisers prefer to call activities. Each has a theme with between twelve and thirteen activities, and comes with teachers' guidance and curriculum support materials prepared by the local science advisory team and local teachers. The trailers are hired to schools on a weekly basis, being towed by the vehicle operating the local museum artefact loan service—the operator helps unload and load the activities, but does not interact with the pupils. Once left, the activities become the school's responsibility. The trailers are promoted with many suggestions as to how they might be used in schools, for example:

1 As a stimulus at the beginning of a topic or as reinforcement at the end.
2 As the centrepiece for a whole-school science week.
3 As a focus for open evenings for parents and governors, with children taking a lead role.
4 To provide links with secondary schools, or for older pupils to work with younger children.

The programme was launched and trialled in November 1993. The author undertook small-scale qualitative and quantitative research into how the first twenty-five schools used these trailers from January to June 1994, after the initial trial period, aiming to investigate the operation of the scheme from the teachers' perspective.

The activities were visited by all primary-age year groups, and by older children in special schools. Over three-quarters of the schools reported that the trailers became the focus for a whole-school experience, whilst almost half held a special science week. Almost every school grouped the activities together in one place (typically the hall or a spare classroom), although several schools reported that some individual activities were taken back to the classroom for further investigation. The time each group spent with the activities varied enormously from less than fifteen minutes to over two hours, but the mean was around one hour, which is the equivalent of five minutes per activity (and much longer than one would expect in a hands-on museum or science centre). Over three-quarters of the schools reported that children had an opportunity to revisit the activities—either in a timetabled lesson, during breaks or after school with parents—and it is in offering this opportunity to revisit that travelling science centres score heavily over permanent centres.

Teachers questioned in the survey were remarkably uncritical about operational details of the scheme. There were, for example, very few complaints about breakdowns or maintenance (which is surprising considering the activities are left entirely in the supervision of the school). Most operational problems concerned the fact that the activities—whilst portable—were bulky in a busy classroom. As one might expect, several teachers commented that effective curriculum support materials are essential as teachers simply do not have time to prepare for major new initiatives.

The subject of cost-effectiveness brought a very interesting range of responses. The weekly rental of £150 (in 1994) was at that time the threshold beyond which schools would not be prepared to pay for a week's travelling exhibition. Most teachers commented that the trailers represented excellent value against a one-off visit, enabling more children to take advantage of the resource than would be able to take part in a visit. Several teachers noted that whilst the trailers represent excellent value for money, they are not as glamorous or as exciting for the children as a visit. Many commented that an out-of-school visit could awaken an interest in science, whereas the trailers might be seen as being just part of another school day. Furthermore, many emphasised the additional social benefits of a day out with their class, commenting that for inner city children the social experience of the trip is more important than the work undertaken during the visit.

It is significant that teachers reported in the survey that they felt out of control in an environment which encourages children to explore, when they cannot be everywhere at once and where they cannot rely on the quality of the interactions of their parent helpers or of the museum enablers. Teachers certainly appreciate being in control of the learning environment with the hands-on activities in their classroom. In this case they are able to prepare more effectively than is possible for a visit, to enable the children to go back and revisit the activities, and to contain the excitement and external influences. One noted: 'Being in school is more conducive to learning than being on a trip, where the main objective is to off-load spending money.'

It is not surprising, therefore, that teachers in Nottinghamshire value the Primary Science and Technology Trailers, and the completed questionnaires were littered with

comments such as ‘It’s a great scheme’, ‘Keep them coming’, and ‘Can they be extended to more curriculum areas?’ Children’s museums and science centres play a distinctly different role in children’s learning, providing enrichment outside the school curriculum for those with economic and geographic access to them. Harsh economic realities, combined with the fact that the teacher is more in control of the learning environment within the classroom mean that innovative schemes like the Nottinghamshire trailers can make a significant local contribution to the public understanding of science.

Museum education in the UK

The UK has a fine tradition in the field of museum education, and indeed, many of the concepts for the hands-on movement—such as the benefits to be gained from direct first-hand experience of artefacts and phenomena—derive from this tradition. A recent report into museum education in the UK, *A Common Wealth* by David Anderson, found that there is irrefutable evidence, exemplified by case studies of museums of all sizes and types, that museums can make a unique and vital contribution to education, particularly in the field of informal learning.[14] However, despite citing many examples of excellent practice, the report found that provision for education in traditional museums is patchy. The report involved the most comprehensive survey ever made on museum education in the UK, with 566 responses to a first questionnaire in 1996, and 88 to a second questionnaire to the 210 organisations which showed that they provided three or more types of educational service or activity (from a range of twenty-three categories). This research found that only 37 per cent of museums responding to the survey provided three or more types of activity, and in total only 51 per cent of all museums made any provision whatsoever for education. Only 23 per cent had an education policy, whilst only 24 per cent of registered museums have an education specialist on their staff. Furthermore, only 36 per cent of museums had any kind of teaching space, and less than half carried out any sort of evaluation of their educational service.

There are 755 specialised education posts in 375 museums services in the UK, representing only 22 per cent of all registered museums. Education specialists comprise just 3 per cent of all paid and voluntary museum staff. Only 25 per cent thought a degree was desirable for their education staff, and only 15 per cent an education qualification. In more than 40 per cent of museums, education staff receive a lower salary than equivalent curatorial posts, and the majority of these have inferior conditions of service. Only 33 per cent of museums had a structured input by education staff into planning exhibitions or events.

It is significant that whilst 64 per cent of respondents said their governing body believed education to be an essential part of service delivery, most museum managers put education lower in their list of priorities than collections management and display. Indeed, 28 per cent regarded museum education as advantageous rather than essential, and 2 per cent viewed it as of little or no value. Since many of these museums are likely to have gained charitable status for their educational provision, many are almost certainly infringing legislation relating to charities.

Where an education service exists, the most common forms of provision are information for schools, services for primary-age children and lectures and publications

for adults. Students and pre-school children are in the next category, with minority communities, people with disabilities and the unemployed the lowest priority. Only 15 per cent of museums have a disability policy, and 7 per cent a multicultural policy. Even when a service is available, it is frequently available only to a very small percentage of users in that group.

In total, whilst there are many examples of excellent practice, the report highlights the dire straits facing the issue of education in many types of museum. There is no consistency between type or size of museum. Provision, where it exists, lacks any rationale, with two museums with similar types of collections often offering very different types of service. This is largely attributable to the fact that museum provision in the UK is not statutory. Whilst many museums were begun in the nineteenth century as major instruments of public educational policy, over a period of time the concept of public learning in museums has diminished. Increasingly, museum education has been seen as a specialist service to formal education, usually limited to schools, and which has very little connection to traditional museum work of collection, conservation and documentation.[15]

Museum education in the UK and USA: a comparison

The ASTC research cited earlier in this chapter is not directly comparable with the UK survey: it was conducted nine years earlier, with a smaller sample skewed towards hands-on centres in the USA, but also including some traditional museums and some museums outside the USA. Nevertheless, the evidence is fairly conclusive that educational programmes are more dynamic and widespread in science centres and hands-on museums in the USA and elsewhere than in traditional museums in the UK. In the science centre or hands-on museum, educational objectives are paramount in every decision made. In the UK traditional museum, education is rarely a priority compared to collection care, and is often seen as a mere adjunct to formal education provision rather than as a valued educational service in its own right. This is reflected in the number of staff dedicated to educational provision in the two surveys. In the USA, there are far more educators on the museum staff than in the UK: 19 per cent of paid staff and 53 per cent of volunteers in the USA, compared to just 3 per cent of both paid and unpaid staff together in the UK. In the UK, typically less than 5 per cent of museum expenditure is dedicated to education, compared to 27 per cent in the USA on education and public programmes.[16]

There are some similarities in provision between the two surveys. The UK research shows that most educational programmes are targeted at primary-school-age children, and that people from multicultural backgrounds or with disabilities are of lower priority. Significantly, the USA research also found that the audience most frequently served was children in elementary schools, followed by junior high and high school students, whilst the least number of programmes reported were targeted specifically for disabled audiences, followed by minority groups and females.[17] As far as the school market is concerned, the percentage of school children visiting US science museums in school groups (24 per cent) is slightly less than that achieved by UK science centres (which typically achieve 25–40 per cent of visitors in school groups), but significantly greater than the level for UK museums as a whole. The figures for the latter are not cited in *A*

Common Wealth and are difficult to quantify with any degree of accuracy, but are estimated to be less than 15 per cent of visitors on average, varying between 5 and 50 per cent at different museums.[18]

US science museums would seem to be leading the way in their provision for both school and general audiences. The trend in the late 1980s was towards increasing outreach programmes for both the public and schools, towards reaching out to minority groups, very young children and senior citizens, towards more partnerships with other educational and non-educational organisations in the community, and towards playing an active role as sources of information on current scientific and technological issues, thereby helping to foster lifelong learning.[19]

A vision for museum education in the UK

Whilst the research within *A Common Wealth* presents a depressing picture of the state of museum education in the UK, the report also provides a vision for museums and museum education in the future which bears a remarkable similarity to the philosophy of hands-on museums and science centres. David Anderson looks towards those museums which have made education the foundation-stone for their existence, where education is intrinsic to their very nature, driving every activity. In these new museums, education staff are involved in exhibit development, and research and evaluation form an integral part of museum practice. As resource-rich learning environments, the value of learning by first-hand experiences of real things is paramount, but these new museums accept that a range of simple and new technologies can be utilised to encourage open access and exploratory learning for adults as well as children. This has offered them a renewed purpose, enabling them to attract diverse audiences and play a more dynamic role in cultural development and economic regeneration, which in turn attracts greater support from local communities, sponsors and the media. These museums, it is argued, are part of a broader cultural movement supporting informal education and self-directed learning by individuals, families and social groups within the community. They are educational establishments in their own right: museum education is their *raison d'être*, and not simply an additional service provided to support schools or other formal education providers.[20]

In short, what David Anderson is describing is a traditional museum which—like the hands-on museums of today—places the needs of its visitors at the forefront of all decision-making. Of course, a traditional museum has responsibilities towards its collections, but the museum of the future is likely to incorporate a range of devices—artefacts, hands-on exhibits, new technologies, live interpreters and special events—to help visitors make sense of their surroundings. Chapter 9 explores this concept further and questions the likely future for hands-on museums and science centres.

9
The future for hands-on exhibitions

This chapter considers the future for hands-on exhibitions in the face of increasing competition, declining public subsidies and new technology. Whilst the great strength of the interactive movement is its diversity, it is argued that the very best management practices must be implemented if hands-on museums and science centres are to differentiate themselves from the commercial leisure sector and achieve broader social and educational objectives.

Both traditional and hands-on museums are part of an increasingly complex leisure market, and must compete for the visitors' time and money with a whole range of other leisure attractions in the public, private and voluntary sectors, many of which have very different objectives. Even amongst heritage attractions, the evidence is clear that, whilst the number of visitors to museums has increased in the UK in recent years, the number of places to visit has grown even more rapidly. Research shows that attractions that appeal to families, and which combine both education and entertainment, are the most likely to be successful in attracting visitors. This factor helps explain the dramatic growth in the provision of hands-on museums and science centres since the 1960s in the USA and, since 1985, in the UK and Europe.

Meanwhile, traditional museums have been encouraged to redesign exhibitions to emulate the success of the hands-on museums and science centres, with the dual objectives of helping those museums to maintain or increase their share of the visitor market and to improve the educational effectiveness of exhibitions. There is evidence that, as a result of the intense competition for visitors, many museum attractions (including some of the hands-on museums) are facing static or declining visitor numbers alongside declining revenue budgets from public sources. These museums are therefore suffering reduced income both from public subsidy and from their trading activities. This situation is heightened in the UK, with new or redeveloped schemes funded by the National Lottery adding to the already overcrowded market of visitor attractions. In addition, there is uncertainty as the third generation of attractions—incorporating the very latest in new technology—impact upon both museums and the leisure industry as a whole. Significantly, the 1996 Association of Science and Technology Centers' Conference in the USA focused on changing technology and the economic climate as the key challenges facing science centres and museums.[1]

Thus, the uncertainty in the leisure market places considerable pressure on the hands-on museums and science centres:

1 As increasing numbers of traditional museums emulate the hands-on approach.
2 As increasing numbers of commercial leisure attractions compete for visitors' time and money.

3 As changing technology offers new interpretation opportunities to both museums and commercial leisure operators.
4 As declining public subsidies necessitate increased market awareness and commercialism from not-for-profit organisations.

At one time, traditional museums held a monopoly on the visitor market. There was no need for the curator to take too much interest in the needs of visitors, as the care and safety of the artefacts was of paramount importance, and revenue was assured from the public purse. These first-generation museums were object-centred and publicly funded, and they focused on formal education. Target visitors were rarely defined, usually expressed in vague terms such as 'everyone in the local community'. Success, if it was measured at all, was determined by critical acclaim and by the number of visitors (but as these institutions were usually free, their numbers were totally unreliable). At the other end of the spectrum, and catering at first for a very different target market, the first theme parks arrived providing entertainment on a commercial basis. The experience was still largely passive, but visitor satisfaction was the key to commercial success. In both the traditional museum and the theme park, education and entertainment seemed to have been at the opposite ends of the same spectrum. Indeed, the ninth of Mickey's Ten Commandments for the Disney enterprise was 'ounce of treatment—ton of treat': in other words, every educational message must be diluted, as if it was distasteful medicine.[2]

The second generation of museums, the hands-on centres, have challenged both traditional museums and the commercial leisure providers in many areas. Most importantly, they have shown that education and entertainment do not have to be mutually exclusive. The hands-on museums and science centres can provide exciting, innovative and fun exhibits that are historically authentic and scientifically accurate. The growth in visitors has shown that the public appreciate safe places where families can learn together informally, whilst evaluation studies show that people really can learn and have fun at the same time. The success of these attractions has provided a significant threat to traditional museums, many of which have adopted a hands-on philosophy of their own, thus creating further competition for visitors in the heritage visitor market.

Whilst both first- and second-generation museums are in competition for the same visitors, their basic objectives are not dissimilar: the main difference is one of strategy rather than of objective. Clearly, it is a core function of traditional museums to collect and conserve artefacts, although this is not always the case for children's museums, and is rarely so for science centres. However, whether or not they collect artefacts, both first- and second-generation museums exist to promote public understanding of real objects or real phenomena. Whilst the methods of interpretation might change over time, the essential function of museums and science centres as informal educational institutions based upon real objects or real phenomena has not changed. Whilst hands-on exhibits may well have replaced some glass showcase displays, and whilst constructivist exhibitions may be replacing didactic displays, the basic objective of the museum to present and interpret the world around us is essentially the same. The underpinning message, not the medium by which is transmitted, is of paramount importance.

Since most museums are in the public or voluntary sectors, their objectives are largely educational rather than commercial, and the differences between first-and second-generation museums are not as great as between commercial leisure providers and the museum world in general. Nevertheless, many museums have been forced to adopt a

more commercial approach in order to offset declining revenue from other sources, and this has made the distinction less obvious to the visitor. For example, at least two proposed UK hands-on museums plan to incorporate motion-simulation cinemas in order to bring in revenue to offset expenditure elsewhere. Some US museums and science centres incorporate IMAX cinemas, and, as one critic has noted, they are just as likely to show a rock music film as a science film if helps bring in revenue.[3] Increasingly, museums and science centres must earn more of their income from trading activities. In the USA, with declining revenue budgets from public sources, earned income as a percentage of revenue now exceeds 80 per cent at many science centres. The need to generate income in a competitive environment can place a strain on an organisation with educational and social objectives, and may cause some centres to lose sight of their original mission: indeed, the Franklin Institute in Philadelphia has been described as resembling a cross between a theme park and a day-care centre.[4]

In many ways, the hands-on museum experience offers little threat to the commercial leisure industry as a medium since it is labour-intensive and high in operating costs, whereas the theme park industry is interested primarily in vast throughputs of visitors in a controlled environment, the very antithesis of learning in an informal centre. If hands-on learning could be financially viable, it seems certain that the theme park operators would have grasped the nettle many years ago. With teachers in the UK increasingly under pressure to fulfil the requirements of the national curriculum, schools can no longer justify end-of-term treat visits. The theme parks cannot afford to ignore the educational market, because school visitors can fill the parks at periods when there would otherwise be high overhead costs and few visitors. However, their response has been to concentrate on promotion to schools, often producing curriculum materials in an attempt to raise the educational profile, rather than changing the core product by introducing hands-on learning.

Whilst the theme parks may not have yet gone down the road of providing interactive learning spaces, the commercial leisure industry has emulated the museum sector in other areas, for example in the growth of commercial aquaria and family entertainment centres. On both sides of the Atlantic, one response to the rapid growth of the family and children's market has been the development of organisations such as Fun Factory, Discovery Zone, Planet Kids, Planet Fun or Action Stations, which have seen the commercial potential of learning through play.[5] These have taken the interactive play element, together with a commitment to security and safety, and placed it in a commercial environment with an emphasis on a high turnover of children staying for a short period of time, usually limited to one hour. Unlike in the hands-on museums, adults play very little part in the process, often being relegated to a café or, as in Action Stations, to a child-centred computer area (adults often have free admission too). There is a heavy emphasis on providing birthday parties and on membership schemes, both of which encourage repeat visits. Whilst these centres do recognise the educational value of play, education is not their prime objective; commercial success is the fundamental goal, and there is no doubt that if children's play ceased to be profitable, other attractions would replace them.

The cross-fertilisation of operations between the commercial leisure industry and the museum world must be confusing to potential visitors, and clearly has mixed advantages and disadvantages to both types of organisations. There is serious concern amongst

members of ASTC in the USA as to whether not-for-profit informal education establishments such as hands-on museums can survive if they become indistinguishable from commercial operators. One commentator has argued that hands-on museums must differentiate themselves from commercial theme parks, stressing that their fundamental differences must be articulated if the hands-on centres are not to lose their own special identity and hence fail to meet their own objectives.[6] Whereas the hands-on attraction increasingly needs to earn its income from trading activities, its main measure of success will be whether it is satisfying the needs of visitors in terms of education and enjoyment. In the commercial operation, whilst some family entertainment centres and aquaria might claim educational objectives, typically entertainment and educational objectives are considered to be in conflict, and the only real measure of performance is financial profit for the owners or shareholders. Visitor enjoyment is important to commercial leisure operators as this will determine whether they repeat the visit or recommend it to friends. However, social and educational objectives are unlikely to be a main concern. The theme parks may have developed curriculum materials for their sites, but this would appear to be more of a marketing response to declining educational visits rather than representing any fundamental change in their mission.

The great strength of the hands-on museum and science centres is that they provide authentic experiences. Whether the centre is based on a collection of artefacts, a historic site or the presentation of scientific phenomena, these are all ‘real’ experiences which can provide competitive advantage over the fantasy world of the theme park. Furthermore, in the hands-on museum, the visitor is in control and manipulates the chosen activities, usually at their own pace. As a result, every visitor’s experience is a unique result of their interaction with the exhibits. In the theme park, the activity is controlled—it may be thrilling, scaring or exciting for the visitor, but every person receives a very similar experience.

In short, whilst the boundaries between hands-on museums and the commercial leisure sector are undoubtedly blurring, it is essential that hands-on museums do not lose sight of their original objectives in the need to remain financially viable. Indeed, the differences can provide competitive advantage. Not only do hands-on museums need to focus on their mission, but they also need to communicate effectively to visitors that whilst museums, commercial theme parks and family entertainment centres are all competitors for visitors’ time and money, in reality they are all offering perfectly valid, but quite different types of experiences.

There has been much discussion in the museum world about the impending third generation of museums incorporating cutting-edge technologies. One commentator in the USA predicts that within twenty-five years museums will no longer be recognisable as we know them today: they will cease to be institutions whose prime role is to collect and interpret collections, but rather they will become vast repositories storing our collective human and earthly past in the form of artefacts, but also incorporating multimedia to store photographs and video, music, dance and stories. Thus, the distinction between museums, libraries, archives, schools, shopping centres, parks, zoos, art galleries and performing arts spaces, and even social service centres will blur: indeed, we may not even need to leave the privacy and comfort of our own homes to visit these new institutions. This process of hybridisation, it is argued, has already begun, with many museums incorporating features not normally attributed to museums, and its further

progress is inevitable.[7] Similarly, in the UK David Anderson's vision for the future is one which embraces an expanded concept of museums, with them playing a more active role in community development as part of a broader cultural movement supporting informal education and self-directed learning.[8] Thus, new technology may provide new income-generating opportunities for these hybridised, expanded forms of museums, but it will also require them more than ever to maintain a focus on their objectives if they are to deliver effective services.

How museums will incorporate new technology cannot be predicted with any degree of certainty. Existing technology already enables museums to exist in virtual form on the Internet or on CD-ROM, whilst virtual reality enables buildings to be reconstructed over archaeological remains, without damage to the site itself. Vast databases will enable visitors to gain access to collections in store, again without any danger of theft or damage to the objects themselves, and possibly without even leaving their homes. Visitors will also be able to receive museum guides personalised to their own interests, with a commentary automatically switching on as the visitor approaches selected exhibits.[9] These innovations are likely to be commonplace in museums within a few years, and the future horizons are limited only by the creativity and imagination of designers.

First- and second-generation museums are content-driven, based on interpreting authentic sites, objects or phenomena. There is a danger that, with new technology, the emphasis will move away from authenticity to virtual reality.[10] However, in the same way that second-generation museums are integrating hands-on exhibits to help visitors understand artefacts or processes, there is no reason why new technology should not assist in the interpretation process alongside a diversity of media. Technology, whether it be the hands-on exhibit or the touch-screen computer, is simply the tool with which the museum interpreter communicates with the visitor—it is not an end-product in itself. The commercial leisure industry will incorporate new technology in its leisure products, using the novelty value of the technology to produce high returns over a short product life-cycle. The museum world, with its commitment to real objects and phenomena cannot afford to be seduced by the technology in this way if it is to differentiate itself from the commercial operator and fulfil educational and social objectives.

The museum of the future is likely to incorporate a whole range of interpretative devices—including artefacts, hands-on exhibits, live interpreters and new technologies—to help visitors make sense of their surroundings. Each interpretative tool has its own advantages and weaknesses, and should be used selectively to help visitors access and gain understanding of the objects, sites or phenomena in question. Not only is there a danger that the museum seduced by new technology could quickly become dated, but there is a very real possibility that today's children may react against a diet of virtual reality and that there will be a return to the fashion of museum artefacts being shown in glass cases. There is very little evidence yet to support this view, although one commentator has suggested that children are no longer stimulated by special effects exhibits, and renewed interest in more traditional displays is already happening.[11]

One lesson to be learned from this study of hands-on museums and science centres is that there is no one way to create or manage an effective exhibition, and it is the diversity of visitor attractions in the heritage and leisure industries that ensures that public demand is high and that there is no shortage of innovative new ideas for exhibitions. In the UK, charitable funding, the National Lottery, EC sources and commercial sponsorship have

all contributed capital for new projects in recent years. Raising capital to develop a new hands-on attraction is less problematic than ensuring the long-term economic viability of the project in the future, and it is for these reasons that the Millennium Commission and the Heritage Lottery Fund demand a very high standard of forward planning.

In an era in which public revenue subsidy has declined significantly, the key to economic viability depends on sound business planning, beginning with the development of a well-defined core product evaluated at every stage with a defined target market. Thereafter, the implementation of the very best practices in all aspects of marketing, financial, operations and human resource management will help to maximise attendance and visitor satisfaction, thereby helping the hands-on museum achieve the broader social and educational objectives that differentiate it from commercial leisure operations. The hands-on museum of the future will need to focus clearly on these objectives, communicate them effectively to visitors and other funding bodies, and implement sound management practices if it is to survive in an already overcrowded marketplace. Only then will the hands-on museum be able to implement programmes to ensure that its exhibitions are accessible and engaging to as many people as possible, and that more people are empowered to interact with and make sense of real objects and scientific phenomena.

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1
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Index