Mine Games

The science centre as social forum

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Putting science in a social context: the result of six years of experimentation

In a paper delivered in Prague just two years ago, we proposed that the role of the modern science centre is 'to take advantage of its function as a public space, and to reclaim the openness inherent in the practice of science. The science centre must put this spirit of challenge, question and discovery in the hands of its visitors. Finally the science centre must become a place where debate about science, its benefits, its liabilities, its role in modern society, can be conducted in the manner of science itself. In this way our science centres can be a model, not only for other museums, but for debate and democracy in a world rapidly closing in on itself to the exclusion of both.'

The work that we have undertaken over the past eight years has largely been an attempt to recognise the variety and competence of our visitors, to encourage their participation, and ultimately, to endorse their agency by providing them with access to the tools of science and technology. The more comfortable citizens are with science and technology, the more competent they are. The more confident they are in their own skills and understanding, the more fully they can participate in the debate about the uses of science and technology in their own lives.

Around the world people are looking for ways to express their views on the way science and technology affects their lives - issues like acid rain, atomic energy, genetic engineering, destruction of wildlife habitats, and resource development. Traditionally the streets have been the place where opposition to decisions has been shown - often loudly, sometimes violently. In Britain, hundreds of thousands protested the government's commitment to nuclear energy. In Holland, concerned citizens marched in the streets demanding reassurance that milk produced by genetically engineered dairy cattle was safe for Dutch babies. In Germany, environmentalists demonstrated outside of the Bundestag demanding that the government not buy paper made from trees logged in environmentally sensitive areas.

In recent years, we had the opportunity to look at this process at close hand, in British Columbia, a province with a long history of public protest. In recent years the province of British Columbia has been riven by conflicts over our land and its resources. By deciding to allow limited logging in an ecologically sensitive area of the Queen Charlotte Islands, the government made a decision that angered the environmentalists. By declaring the Tatshenshini River system a protected area, the government decision precluded the development of North America's largest copper deposit. Executives of the mining industry marched in the streets, claiming that the decision had been made on political, not scientific grounds.

Unique among our institutions of public education, the science centre can provide an alternative to the street as a forum for debate about the effects of science and technology, for three reasons. First, the science centre is considered by most citizens as neutral territory, where science and technology are presented without political bias. Second, it is a place where discussion and debate can be supported by exhibits with a strong factual content. Finally, the science centre has trained staff who can create programmes theat can be used to guide discussion and debate among its visitors.

Science centre exhibitions : pure science or applied technology?

It was shortly before the clashes at Clayoquot sound and Tatshenshini that the Wake/Bradburne Partnership was invited to develop a new gallery for Science World, a large science centre located in downtown Vancouver.

It struck us that there were two clear alternatives to tackling the subject. On the one hand, the earth sciences could be treated as they have been in traditional science centres. Visitors would learn about geological time, the development of rocks, faulting and continental drift. Following the example of other science centres, we could link geological themes to newsworthy geological events that captured the public's interest - volcanoes and earthquakes. By treating the earth sciences as a subset of geophysics, we would follow a traditional path: separating scientific fact from social issues. We would treat the earth sciences as lofty, aloof, unsullied by concerns of survival.

The other alternative was clearly more challenging. Instead of an exhibition on the earth sciences, we proposed to look at how the geological sciences are applied in a political and economic context: in short, we suggested an exhibition on mining. This exhibition, entitled Mine Games, would deal with the issues surrounding the mining industry in our province, issues that have been increasingly the subject of heated debate in the press, on television, in parliament, and in the streets.

This single change - from earth science to mining - entailed a complete re-examination of the way in which the exhibition would be planned and designed. With a mining exhibition, we could initiate a debate about the future of the province, teaching visitors to evaluate scientific positions arrayed in support of any number of competing positions. An exhibition on mining would call into question the role the science centre should play in the life of the community, suggesting that the role of the science centre is to prepare visitors to participate in the social and political life of their community.

If the exhibition were successful, Science World would become the focal point of a unique social experiment. Visitors would be given the opportunity to learn a wide range of scientific information, not all of it in agreement. They would be invited to explore this information through debate and develop skills that would help them to understand, and to alter, the political process in the province.

Mine Games: putting science and technology in a social context

Unlike most science centre exhibitions the Mine Games exhibition has three unusual goals that make it different from other science and technology exhibitions. These three features are:

1. Creating a social context for scientific and technological issues. Initially, we considered using a real British Columbia example as a means of creating the context for the debate around mining. It soon became clear that by using a real example, we risked having visitors whose minds were made up, reducing their ability to consider the issue from many points of view. So instead we decided to link the exhibition, from beginning to end, by the fictitious town in northern British Columbia - Grizzly, B.C.

The people of Grizzly, in Yevtuschenko's words "live quietly and crack nuts". Over the last half century, the townspeople have gained their livelihood by logging the surrounding forests. Suddenly, last summer, the traditional pattern of life changed dramatically. First, the provincial government announced that a wilderness park would be established on the outskirts of the community. This sounded the death knell for the local logging company, which had depended on an ever-more precarious supply of timber. Then, only months later, a large copper/gold ore body was discovered barely a kilometre from town. Over the last few months, the townspeople have looked on as the representatives of the mining company evaluate what may be one of the largest mineral deposits in the world. Gossip rages in the restaurants and at the mall, as the residents of Grizzly debate what the future will hold. Should the town cast its lot with the mining company, and gain the jobs and security that a major mine will offer? Or should the town reject the mine and use its spectacular setting to promote wilderness recreation and tourism?

Clearly, there was a temptation to create an exhibition that asked for a clear, yes/no decision: should the mine in the Grizzly valley go forward or not? But early in the project we realized that the 'no' option would provide an easy escape for urban visitors who do not want to engage in discussing the issues. So we elected to create a more complex situation in which visitors are asked to put themselves in the shoes of the residents of Grizzly, and find compromises that will allow Grizzly to have a mine, while the integrity of the environment is maintained. In effect, visitors are charged with the key responsibility that faces all British Columbians today: to find a secure economic future that can co-exist with the environment. What we did in the *Mine Games* exhibition, then, was create a cultural context in which the science and technology of the exhibition could be understood - a framework that would give drive and direction to our audience. The invention of Grizzly and its people gave our audience a reason for pursuing the subject of mining and the earth sciences with passion and precision.

2. Using game strategies as a means of ensuring coherence. In most science and technology exhibitions, exhibits are designed as stand-alone elements, each one demonstrating an isolated scientific principle or phenomenon, each one meant to work best with a single visitor. It had already been observed that these exhibits often failed to capture the interest or attention of a teenaged audience.

We had already noted that teenagers were captivated by games and game playing - chess, Risk, Battleships, Nintendo - and that was our target audience for the Mine Games exhibition. We saw that young people are capable of much more intellectual activity than most of our science centres provide. Secondly, teenagers are attracted to the competitive aspects of gaming. They don't mind engaging in complex thought, as exemplified by the chess, which demands memory, strategic thinking, and problem solving ability. So taking our cue from the chess game, we designed the entire *Mine Games* exhibition as a series of games.

From a design perspective, these games were developed to look like the board games that all Canadian children have at home - chess or Monopoly. Imagine an exhibition hall that contains four gameboards blown up so that each contain a hundred square metres or more. From an intellectual perspective, each of the games is made up of several hands-on activities linked to a computer game. We deliberately made the activities difficult, so that it can take more than an hour to solve all of the clues. And this is the kicker: the visitor must play all of the hands-on activities, solve all of the clues, in order to be able to play the computer game. We begin the computer game begins with a quiz, designed as a job application, and unless you have mastered the information, you will not get the job.

The visitor begins the Mine Games exhibition by picking up a clipboard with 'gameplans' describing each of the exhibit areas. The visitor keeps track of the outcomes of hands-on challenges on the gameplan, and uses these answers while playing the computer games. Significantly, by making the gameplans an integral part of the exhibition experience, the visitor is free to explore the exhibition in whatever order she wants, marking the results on her gameplan as she completes the exhibits. In this way the exhibits can sustain the narrative of Grizzly, their results cumulative, but the entire experience non-linear.

3. Minds-on science. Many museum professionals believe that the role of a science museum is to teach scientific facts - for example, that water boils at 100 degrees. We believe that the role of the science centre is also to encourage scientific curiosity. Why does water not boil at 100 degrees in places that are high above sea level? Our commitment to hands-on and minds-on science has lead us to develop exhibit approaches that encourage visitors not only to learn science, but also to learn to think in a scientific way.

So we developed a twofold strategy. We decided that throughout the exhibition we would ask our visitors to put themselves in the shoes of working scientists. We developed four exhibit areas, one where you work as a geologist, one area where you work as a biologist, one where you work a a mining engineer and finally one area where you play the role of a metallurgical engineer.

Secondly we decided that in each area we would develop a series of hands-on exhibits that are linked by a single problem. In the environmental area, for example, we would say to our visitors: "You are a biologist and your job to find out if there is any place in the Grizzly Valley where you could put 100 million tons of mine waste - safely." All eight of the exhibits in this area would relate to solving this problem, but we were determined that the solutions would not be neat or easy. Indeed, we took pains to ensure that serious trade-offs would have to be made.

Let us look in more detail at the games that make up the Mine Games exhibition below:

1. High Stakes!

The game, High Stakes, is based on the premise that the visitor is the exploration manager of a small mining firm. First, visitors visit eight hands-on exhibit stations to examine the rock and core samples. Each of the stations provide the visitor with one clue as to the location of the mineral deposit. The visitors record their clues on a map and a cross-section of the claims. If the clues are recorded carefully, the visitor's map will define the target areas where the two major deposits may be found.

Next, visitors play a computer game that challenges them to run a drilling programme that will delineate an ore body. The game begins when the visitor raises money for the drilling programme. The player always runs the risk of running out of money before the heart of the orebody is discovered. The player may also incur fines for running afoul of the environmental regulations for the region. Any one of these problems may force the player out of the game - at least temporarily.

The underlying tension of the game lies in the fact that the visitor must run the drilling programme as efficiently as possible, while respecting the environment and the concerns of the local community and the native band.

These exhibits are unusual in that they are an exercise in three-dimensional imagination. With only eight clues, the visitor is asked to visualise the structure of the rock below. This is a complex intellectual exercise, but one that has proved exciting and challenging to the visitors. Many return two or three days in a row, in order to discover the location of the ore.

2. Wild Things

This game challenges visitors to develop an environmental plan that will accommodate the tailings that will be produced by the mine - 100 million tons of tailings over its lifetime. These tailings may cause some environmental complications. Acidic water and dissolved solids may be carried into the local water supply, destroying fish habitats. The visitors are challenged to dispose of these huge quantities of tailings in an environmentally safe manner. The player discovers that there are five sites that could be used for disposing of the tailings, each of which has important vegetation, wildlife or other environmental concerns.

The hands-on exhibits ask visitors to evaluate each of the tailings disposal sites in terms of the fish, wildlife and vegetation that will be affected. After completing the exhibits, visitors are directed to a three-dimensional map of the Grizzly Valley, with plastic beads representing the millions of tons of tailings. Five hollow moulds represent the volume of tailings that can be held by each of the sites. By filling different moulds with beads, visitors can explore options for solving the puzzle.

Finally, visitors proceed to the computer game, where they test what they have learned by taking a simulated walk through each of the four tailings disposal areas, identifying wildlife and vegetation. Finally, when they have chosen one site on which to build their tailings pond, the computer simulates the results of their decision on the environment. In this dynamic framework, visitors will have the opportunity to test their strategy for protecting the environmental integrity of the Grizzly Valley.

The Wild Things game is unusual because there is no single 'correct' answer. Visitors are asked to make a decision among a series of options, each of which has drawbacks. The game has led to vigourous debate on the exhibition floor as family members discuss the best strategy. Several couples have disagreed on their conclusions in the Wild Things exhibit area and one couple joked to a staff member as they left 'Science World will be mentioned in the divorce proceedings...'

3. Blast It!

The game Blast It! is based on the premise that the visitor is a mining engineer for NorthStar Mining. The goal is to re-open the old mine tunnels and reach the high grade ore deep underground. The visitor must understand the use of the rock bolts to keep the loose rock from falling in and blocking mine tunnels. In the pillar game, visitors determine the minimum number of ore columns required to keep the mine from collapsing. Finally the visitor must devise a ventilation plan which to ensure that air reaches all the parts of the mineshaft.

The visitors record their decisions on a plan of the mine. This sketch is consulted as the player begins the computer game, which takes the visitor deep into the heart of the abandoned mine. The visitor navigates towards the high grade ore, taking care to place rock bolts in the mine ceiling at critical points. Successful choices enable the player to find the deposit. Reckless explorers find that they run out of battery power deep underground, or that the mine collapses on top of them.

This game provides an opportunity for open-ended exploration. Unlike many science centre exhibits, which give the visitor the same response every time, the Blast It! exhibits allow visitors to experiment with more subtle engineering phenomena such as tolerances and limits.

4. BoulderDash!

The game BoulderDash! is based on the premise that the visitor is a racer who competing in a tough mountain bike race. The first challenge is to choose the ideal mountain bike frame for the terrain. To meet this challenge, the visitor must explore the characteristics of three different metals used in making bicycle frames: steel, aluminum, and titanium. Then the visitor must choose the components ideally suited to its end use - riding the wild hills outside Grizzly.

The visitors record their decisions on a graphic representation of a bicycle. This sketch is consulted during the computer game. Players "ride" their bicycles through the valley. Successful choices of materials and components enable the player to finish the course in record time. Unskilled designers find that their bicycles are slow to finish or meet with disaster on the slopes of the Grizzly Valley.

The tension of BoulderDash! lies in the fact that components that are ideal for one part of the trail represent a serious disadvantage on another. The choices that our visitors make in the hands-on exhibits are reflected in their success as the bicycle they have chosen hurtles down the slope towards town. Those who have selected their components judiciously end the race with a flourish, with the townspeople of Grizzly cheering them on to the finish line.

5. Helter Smelter

Helter Smelter is the exhibition's demonstration area, where some of the aspects of mining technology not amenable to hands-on exploration, such as smelting, can be demonstrated to the public in the context of group activities such as the making of coins, the casting of bells or the beating of metal gongs. In times when no demonstrator is present, visitors are challenged to create a metal sculpture, using the properties of metal to put together a three-dimensional metal puzzle.

6. Hotseat!

Central to our exhibition strategy was the creation of an electronically-supported, multi-media interactive theatre - a forum for public debate on the role of mining in the province. As the issues that face the mining industry in British Columbia are at once scientific, social, economic and political, the interactive theatre seemed to us the ideal vehicle for meeting the challenge of making the science centre a forum for debate. When we began designing the Mine Games exhibition, we took two starting points for the interactive theatre. First, we rejected systems which limited the audience's answers to yes or no questions. Second, we sought to find new ways to empower the visitor, to recognise their competence and to encourage their participation, in order that they can regain control, in some measure, of the information they are being asked to absorb. Interactive theatre is one means of reaffirming the visitors' control over information.

The result is an 75-person interactive theatre experience called Hotseat! Hotseat! is a circular amphitheatre sheathed in copper, located at the back of the exhibition space, immediately adjacent to the exit. On either side of the entrance, the structure is clad in aluminum plates, showing the traces of newspaper headlines. Inside the theatre are six sections of steep tiers seating up to 75 people. Above the entrance, visible from any point in the theatre, is a large, 16-screen videowall.

Hotseat! is presented as if it is a live television show taking place during the first public meeting between the NorthStar Mining Company and the townspeople of Grizzly. The president of NorthStar presents his plan for the mine and the residents respond angrily. They concede that the company may have chosen to develop the mine plan in a scientifically responsible way, but they point out that much of their local plans, heritage, and traditions would be at risk. The waste rock dump threatens the habitat of the local grizzly bears, and the tailings pond threatens to destroy an historic fort which draws tourists to the community.

The talk show host, a Science World staff member, plays the role of facilitator, asking the audience to develop a land use proposal that will satisfy the conflicting interests in the region. In order for the audience to come up with reasonable suggestions, they can call upon the opinions of experts, who also appear on the videowall.

The central goal of Hotseat! is to show visitors how their knowledge of science and technology can be brought to bear on complex social issues such as the planning of a new mine. The game is co-operative and not competitive - the goal is to reach a consensus.

So what have we learned from this experience? First, science is itself a process of questioning, exploration and debate. The strength of science is that this very process ensures its truths as a consequence of debate, discussion and finally consensus. The results of science attain their authority precisely because of the process of science. An exhibition strategy that reflects this process, rather than putting a premium on the facts of science, is more true to the constructed and vital nature of science. Visitors appreciate being put in control of exploring difficult issues, and take great pride in weighing options and proposing solutions. They seem to enjoy actively looking for solutions - rather than having them given to them.

Second, science is not an activity conducted outside society, on a distant island far from real human concerns. Science is a social practice, and a practice used to justify technical means to social and political ends. As a consequence, exhibitions on science should reveal the relationship between social and scientific issues, and how science can supply technical answers to social problems only when the issues are formulated and resolved socially and politically. Visitors seem to have no trouble accepting the fiction on which the Mine Games exhibition is based - and of recognising its relevance to very real issues in the province's life - jobs, the environment, native rights. They seem prepared to accept the challenge of putting scientific issues into the context of a wider discussion of possible futures for the town of Grizzly - and for the province of British Columbia.

Finally, science museums are not merely extensions of the school, nor are they only showcases for the proven results of past scientific investigation. Increasingly, science museums and science centres must be considered as among the last unappropriated public spaces, spaces where issues can be discussed, debated, and perhaps in some small measure resolved. It is place where new competences are passed on, and new understandings evolved. Armed with competence, information and understanding, the science centre visitor can thereby play a greater role in society, and in some measure be said to be a better citizen.

The purpose of our institutions of informal science is in part to empower our citizens, and they can only do so by taking into account the full agency of those citizens. In a world increasingly dominated by technology, and by those who would direct or dominate that technology, science centres must contribute to the public understanding of science by showing that despite the rising tide of technical answers, the questions underlying are not solely technical questions, but social ones that the citizen has the competence to understand. Moreover, it is the responsibility of the citizen is to engage with these issues, and to become part of the broader debate on the uses of science and technology in contemporary society. The Mine Games exhibition puts the visitor in the centre of social debate on science and technology - the the visitors seem ready, willing, and able, to take that responsibility. In putting an emphasis on the complex relationship between scientific argument and social debate, the Mine Games exhibition puts the science centre at the heart of the democratic process, and creates a new role for the science centre in the coming decades.