Supporting actions
The informal learning environment as site of action and observation

by
James M. Bradburne AADipl MCSD
Hoofd Onderzoek en Ontwikkeling
newMetropolis
Science and Technology Center

30 March 1997/revised 19 June 1997/10 December 1997

The science centre community is now nearly thirty years old. Over twenty five years have now passed since Frank Oppenheimer and his band of thinkers and tinkerers at the San Francisco Exploratorium began to explore ways of translating scientific principles into three-dimensional form. Now is a good time to pause and consider the state of our art, and to ask ourselves what kind of exhibits we are building, and what effect they are having on our visitors

If we are very brave, we will look at the institutions we are creating as well, and consider the question that Michael Shortland raised in his article in *Nature* some years ago "..what - if anything - do children learn in them?" The last quarter of a century has seen the development of many different kinds of science exhibits, often representing widely divergent philosophies about how people learn about science. This has had the effect of fragmenting the the field, possibly to the extent that creative thinking about the design of science exhibitions - and about new institutions of informal learning - has been almost stifled. In the light of almost thirty years of collective experience it is also clear that some of the philosophies commonly used in our centres have failed, certainly if one of our goals is to create a scientifically literate - no, a scientifically creative - culture for the 21st century.

In a paper written in 1989 subtitled Truth telling and the Doing of Science[1], I attempted to sketch a provisional history of the science museum as an expression of changes in the history of ideas - notably in the history of science. More specifically I argued that the seventeenth century emphasis on shared observation, an emphasis that largely defined the modern period, had profoundly shaped the development of all our institutions of informal learning, as the paradigm of the natural sciences was appropriated in every field of human activity. Moreover, I argued that the resurgence of idealism in the twentieth century, in both philosophy and in the sciences, had prompted a parallel transformation in the science museum - and that we were witnessing the birth of a 'third generation' of science museums, based on the

---

[1] Truth-telling and the Doing of Science, Conference Proceedings, Mutual Uses of Science and Cybernetics, Amsterdam

active practices of doing science, rather than on the passive receiving of science as a canon of accepted truths[2] . Now, at the threshold of the twenty first century, I argue the emphasis is once again on action, and how it can be supported. Moreover, this renewed emphasis has made it ever more important to look at the ways in which activities become self-initiated, self-organised, and self-sustained.

First of all, let me underline one of the key features that distinguishes the museum from the school, or more broadly, the informal setting from the formal one. It can be summarised succinctly in the words of Frank Oppenheimer, founder of the San Francisco Exploratorium, one of the first, and still one of the world's most innovative science centres. He said 'nobody ever failed a museum'. In a museum, the visitor is defined by the act of visiting - there are no pre-visit qualifications and no post-visit tests. Our visitors are unknown, and, perhaps more importantly, unknowable. If our emphasis is truly to support action, then by definition, our users must be considered unknowable, and, as a consequence, our main task to support the unexpected, rather than the predictable.

By way of illustration of the dramatic shift in thinking about informal learning environments, I would like to use the example of newMetropolis, Amsterdam's soon-to-be-opened national science and technology centre[3] . newMetropolis is, both implicitly and explicitly, a site for new research into strategies for supporting action in informal settings, and research has played and will continue to play a major role in its development.

From the outset, newMetropolis was conceived of as a new kind of informal learning environment - a 'third generation' science centre - according to my 1989 schema (although newMetropolis is perhaps better described as 'fourth generation' - or not as a science centre at all). In 1994, whilst the building development was already in process, NINT director Joost Douma wrote 'Prototyping for the 21st Century - a discourse', as a consequence of the ideas he had been developing with his Associate Director, Dr. Hein Willems. In the preface he explicitly recognised the way in which our institutions have always been expressions of the history of ideas, and underlined the importance of new ideas as a foundation for new institutions: "The reason for writing it has been primarily to develop a vision to guide our development. [...] Science centres and museums alike have always been children of their time and this infant of ours should be able to participate in societal life for as long as possible."

---

[2] I also argued, in Going Public,)in <u>Planning Science Museums for the New Europe</u>, UNESCO/the National Technical Museum Prague, Paris 1993) that the science centre was, almost by default, becoming one of the last urban public spaces, and that new institutions should take advantage of this trend to promote discussion and debate

[3] During the course of the last five years, the project to create a national science centre in Amsterdam has changed its name several times. In 1992, it was known as the NCWT (National Centrum voor Wetenschap en Techniek), in 1993 it was re-named IMPULS Science and Technology Center, and, as of 10 December 1996, it has been re-baptised newMetropolis Science and Technology Center. As these changes in name have in no way materially affected the project itself or its development, the institution shall be referred to as the New Metropolis throughout.

In his Discourse Joost Douma positioned the new institution in its historical context, and concluded that science centres should be considered as independent agents, with their own role to play in society, as opposed to merely serving scientists, formal educators, politicians, technicians, and industrialists. Moreover he stressed that science centres should also help to steer the present intellectual revolution in such a way that as many people as possible gain from it and that their quality of life does not decline, but improves, as part of the transition from a high-volume to a high-value economy.

In 1994 newMetropolis came to a major turning point. The science centre had been in the planning stage for over two years, during which time the staff explored a variety of strategies and a series of approaches to design and public education. newMetropolis had a creative staff, and a new and coherent vision in the form of the Discourse. It was just awaiting a way to translate the ideas of Joost Douma and Hein Willems into exhibitions, and into the institution that newMetropolis wanted to be. What was needed was a bridge - a way to move from the philosophical vision outlined in the Discourse into a realisable public exhibition strategy. I joined the project in November 1994, and saw in the project the possibility to continue experimenting with the new ways to move the locus of informal learning away from the specialist and towards the user that had marked my past work with Drew Ann Wake[3] , an ambition fully consonant with the goals defined by Douma and Willems for newMetropolis.

In order to describe a new kind of institution, and develop a new approach to informal learning, it was important to define what we were trying to improve. This was done in a deliberately rhetorical document that served as our guiding principles for the design process - a process that involved us becoming a community of learners ourselves, committed to change, new ideas, and experiment. This document spelled out the 'traditional' approaches in informal learning, and proposed new approaches in their stead. To begin with, the following obstacles were identified:

---

[4] Drew Ann Wake and the author have worked on interpretive projects together since 1976. From 1989 until 1994 they worked together as the Wake/Bradburne Partnership, and realised several projects, including those described below. In 1994, Drew Ann Wake founded her own consultancy, LiveWires Design, based in Vancouver, Canada, and the author took up his current position as Head of Design at newMetropolis, in Amsterdam.

Drew Ann Wake worked in Calgary with the Science Alberta Foundation from 1989 until 1992. The following papers by Drew Ann Wake and the author give greater detail about the Science Alberta Foundation and its projects:

La transhumance de la science:Le developpment d'un reseau des expositions itinerantes
Conference Proceedings of the PRELUDE conference, 1990, Namur

Au-dela de l'oueil nu, Alliage No. 15, Nice, 1992

Science des villes, science des champs, AMCSTI/Infos printemps 1993

Priming the Pump: Building a Science Network in Alberta, in La Science en Scène, PENS, Paris 1996

The Curator's New Clothes: re-inventing the role of the museum professional, Muse magazine, Fall 1993

The myth of the single visitor. 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.

The myth of pure science. Many museum professionals believe that the role of a science museum is to teach scientific facts [...]. These science centres often shy away from subjects the public finds interesting, including issues in which the science and technology are mixed with social, political and moral elements.

The need to beguile. Many science centre designers feel the need to make their subjects more 'fun' - by adding gratuitous interaction, by cloaking conventional subjects in the guise of popular culture, by using new technologies for their own sake. This approach betrays a fundamental belief that the science centre is school with a sugar coating - its goal to trick the visitor into the distasteful task of learning.

Top-down learning. In many science and technology exhibitions, exhibits are reminiscent of textbooks. These science centres have created large numbers of 'hands-on' exhibits designed to elicit specific phenomena or demonstrate certain well-known principles. [These exhibits] have a built-in 'right' answer, which, once discovered, exhausts the potential for further visitor interaction.

The development of a new science centre, particularly one of this size and scope, gave newMetropolis the opportunity to draw together the lessons of the last several years. Clearly, right or wrong, the strategies commonly pursued by traditional science centres are not consistent with the vision expressed in the Discourse. What did newMetropolis want to be instead, and what would this mean in terms of an alternative design strategy? The following positions were central to the newMetropolis design strategy.

Visitors come in groups. The single visitor is rare. Our visitors do not often come alone, but in groups - with their families, with their friends, with their schools. They come to explore new material, make mistakes and learn by sharing experiences together. [...] Visitors learn by being together - they learn by chatting, they juggle ideas, images and facts and influence each other's opinions. [...] The social is emotional, and some of the 'fun' we want to find in our science centres is the same social enjoyment we associate with other group activities such as going out to sports, cinema, and concerts.

Science is messy like culture. Science is never pure. Science is not merely a series of facts, but a set of ideas, activities and skills in which many competences are called into play. People rarely relate to science in the same way as the trained scientist, separated from the rest of the world. Instead they see science and technology as intrinsic parts of broader social, political and ethical issues.

4

The real is radical. Real science is not school science. Doing science is an intrinsically rewarding activity, and inspires some to take up careers in science. By taking as a starting point the real enjoyment working scientists get from science, exhibits are more likely to be convincing and enjoyable. The visitor should find in the science centre the same pleasure the scientists experiences in doing science - defining problems, testing hypotheses, finding provisional solutions.

Bottom-up exploration. Our visitors are competent. They are already experts in some things, and they often know more than they know how to say. Visitors create their own understanding, and the science centre gives them opportunities to create new knowledge during and after their visit. [...] In the science centre, the visitor is in control, and the visitor charts his own course - learning is bottom-up.

One of the most telling criticisms of many earlier science centre exhibits was the little time visitors engaged with them, the relatively low percentage of completion, and the low percentage of exhibits actually engaged with during a typical visit. Clearly something wasn't working[4] . Part of the solution seemed to lie in redefining what sort of activity should be happening in the first place. Thus instead of looking for 'learning' in terms of observable cognitive gains - a series of facts learned - we had to look for sustained engagement with the activity. Instead of looking at our job as creating 'exhibits' to show visitors scientific principles, we had to look at them as 'supports' that helped structure and sustain interaction between users. This shift entailed two important moves away from the way designers and educators had traditionally looked at their role. First, it meant that our task was to support action (or better, interaction), rather than broadcast facts - we had to become an informal learning environment, not an exhibition. Second, we had to see our visitors as users, which is to say that our success could no longer be measured in terms of numbers of visits, but in terms of repeated, thus sustained, action.

We therefore established several criteria by which we could assess whether we had improved the informal learning environment. In this we followed the work of the American psychologist of creativity, Mikhail Cziksentmihalyi, who described in 1990 what he called the 'flow' experience[5] , which he argued characterises most intrinsically rewarding human activities from sport, to music, to art appreciation. Activities that manifest 'flow' are self-initiated, self-sustaining, and often self-structuring. Cziksentmihalyi defines flow as "a subjective state that people report when they are completely involved in something to the point of *losing track of time and of being unaware of fatigue and of everything else but the activity itself.'* [italics in original] The experience should ensure that the opportunities for action are more or less matched by the visitor's ability to act at any given time. In order for this experience to be self-sustaining, it must also create the possibility for increasing complexity, to differentiate new challenges in the environment, to integrate new abilities into our repertoire of skills." In order to continue the

---

[5] A biting critique can be found in Shortland, M. No business like show business Nature Vol. 328, 1987

[6] Cziksentmihalyi, M. Flow New York: Harpers; 1990

'flow' experience, the visitor should want to return, to try the exhibit again, to do it better a second, third, or fourth time.

A second challenge was to maximise the variety brought to the experience by the user, while at the same time retaining the coherence necessary for effective learning How could we create informal learning environments that became self-structuring and self-sustaining? How could we support the conditions for the 'flow' experience? How could we shift the focus from the exhibit as end-in-itself to the exhibit as a support for human activity - discussion, dialogue, debate? How could we develop exhibits that registered the activity of the user, and made it available to other users? Finally, how could we develop exhibits that genuinely changed as a consequence of the user's activity and intentions?

Another way of looking at the challenge of supporting action in an informal setting is to examine the tension between variety and coherence. This tension can be described in several ways. Fundamentally it is a tension born of the desire to support the greatest number of coherent experiences for the greatest variety of users. However, traditionally coherence has been purchased at the price of a loss of variety - the scientist's taxonomy, the curator's schema, the designer's storyline all mitigate against the user's freedom to shape the experience of the museum himself according to his own needs. Conversely, an increase in variety often comes with a corresponding loss of coherence - the user is left to his own devices to create an infinite variety of confusing and incoherent experiences. When we hear the science centre is under attack, and watch its attendance drop sharply, we can see the consequence of neither delivering the variety nor the coherence demanded by the late 20th century user. Given the proliferation of media that seem to promise both in abundance, the institution must take a critical look at the opportunities it offers.

At the exhibit level, the tension can be seen by taking two examples. One has the visitor construct a catenary arch out of carefully shaped blocks that illustrate the principle perfectly - but in only one way. The other is an open-ended play area where the visitor can use a variety of blocks to make a variety of bridges that all stand - but why? Neither exhibit is sufficient to create the conditions for the self-structuring, self-sustaining activity that characterises what Cziksentmihalyi calls 'flow' - nor what would characterise user-driven learning. Neither exhibit fully supports its user. What kind of activity would we look for in an effective support to informal learning, a support that maximised both variety and coherence at the same time? Two familiar examples allow us to describe such supports - language, and games. Both are self-sustaining, self-organising, and tend towards maximum variety at the same time as maximum coherence. Both constrain the user, but at the same time unlock an infinite variety of structured activity. Both rely on the user's ability to decode 'patterns of intention' latent in the structuring of the environment, and use that information to structure new activity. Both can be used as models for the design of successful exhibits.

How can we create learning environments that show some of the positive characteristics of language, or of games? How can we create and support experiences that are self-organising and self-sustaining?

Let me briefly describe two settings you will find in newMetropolis. Both are in the same thematic zone, and both share a concern with interactions, or exchange. In theoretical terms, both settings illustrate the properties of dynamic systems - the first system places an emphasis on equilibrium states, the second, on flow. Both take advantage of the user-language of games - the first is a finite game with closure rules and a time limit, the second, what Carse calls an infinite game[6] .

They are called Superbankiers and Get Connected, respectively.

Superbankiers is a game about money. Money is at the heart of the global economy - making it, investing it, spending it. Superbankiers looks at the skills needed by modern banking. The entire area is a single game comprised of several individual computer games. The player has Dfl 50 000 and fifteen minutes to make as much money as he can by using a combination of the computer games. Each of the individual games is computer-based, and treats a different activity in the spectrum of creating wealth - from work, through saving, investment, and speculation, all the way to counterfeiting. In the central trading ring, visitors are put in the shoes of a broker, and see how information and events influence the behaviour of three very different markets: tulips, cattle and currency futures. A tulip market is affected by local information, a cattle market by European information, and the stock market, by global information. Thus a cold winter may spell disaster for tulip prices, while an earthquake in Tokyo may ravage the value of your Phillips shares. The player is coached through the game by a pair of video hosts, who suggest different strategies and comment on the player's performance. In the final analysis, however, it's the player who calls the shots.

After two weeks of operation, it was clear that this game still needed a great deal of development. However, certain things are quite clear. First of all, the user must be aware that the entire set of games comprises a single, large game - something neither common, nor immediately obvious. Second, despite their relationship in the greater game, the obstacles in each of the individual games must be minimised. This is particularly apparent in the trading ring. As originally designed, it mirrored the real trading floor, and is played in rounds, or 'rings' of three minutes. This means that players entering during a round have to wait until the next round begins. Moreover, as the larger game would have that you can only trade what you have earned, players are discouraged from beginning with the trading ring.

From the outset, it was clear that our visitors have different expectations. They want to start with the trading ring, and they want to start right away. The architecture of the zone clearly suggests first, that the ring is the central element, and second, that it can be played with others - and clearly the conclusions visitors draw from these clues mitigate against playing the game the way its designers had originally imagined. In fact, real use has pointed out to the designers the contradictory messages being sent by the exhibition architecture, the graphics, and the rules of play. Our first step, therefore, is to reconcile these contradictions and modify the game so it takes advantage of the users intuitive responses. This we are doing by making the trading ring a continuous market, thus allowing players to enter the market at any

---

[7] Carse, R. Games and Infinite Games

time, and to begin play as soon as they wish. We will know soon whether these modifications unlock new visitor activity, and allow them to 'see' the way the larger game can be played by using a combination of different strategies.

Get Connected is a network of computer stations, each equipped with its own video camera and microphone which allows players to communicate with each other. The central feature of this area is an interactive game based on 'Quartet' (the English equivalent is 'Fish') developed in conjunction with the Media Lab, in which players negotiate with each other to exchange 'cards' to complete different sets, using a dynamic interface which responds to their choices and prompts new ones. The cards are images that corresponded to sets such as flags, wild cats, towers, and so on. Every card belongs to at least two sets. For instance a flag of Spain could belong to the set 'flags' or the set 'Spanish'. A Picasso painting could belong to the set 'art' or the set 'Spanish.' This game is inherently more open than Superbankiers, and the player can adapt his activity to suit the circumstances. If there are fewer than ten players in the ring, the empty places are played by intelligent agents - phantom players.

In many significant ways, Get Connected is among the closest newMetropolis has come to creating an environment in which the activity - and its content - is completely user-driven. Get Connected registers every player's activity, and makes this activity available to other users. At the same time, the user decides for himself among an unlimited number of strategies for game play - the players are free to shape the game in any way the wish, regardless of the original assumptions of the designers. This open-ended, endlessly modifiable game structure, which is continued as long as there are players to play it, we hoped to get close to what Carse calls an 'infinite game.' And, just as Superbankiers starts with the trade as the fundamental unit of financial transactions, in the centre of the circle of video-conferenced computers in Get Connected is a circular bench around which people can sit. In the centre of the circle are projected surprising and sometimes startling images, which we hope will prompt people to initiate conversations - the fundamental act of communication.

Our experience with the first 15,000 visitors again showed us the importance of the user understanding, and more importantly, appropriating, the intention of the activity. When the game was first put on the floor, the emphasis was on the process of exchange. An introductory sequence explained the 'rules of the game', how to make sets, how to exchange, and established a value for each successful exchange, in one of four languages. After very little time it was clear that the experience was confusing. The user was not prepared to follow the introduction, and was more interested in using the microphone and video link to contact other players than in playing the game. This in itself we took to be a positive signal, and in fact we observed teenagers using the video links to flirt with each other. In one case a teenaged girl covered up the video lens when contacted by an unknown young man - in another case we saw a young couple chatting briefly, an hour later we saw them spooning in a corner. Clearly the exhibit could be called a success - at least in some respects!

We saw that users grasped the idea of making contact, and that they engaged quickly in communicating with each other - contact was sustained. What was missing, however, was a clear and intuitive

8

understanding of the latent possibilities of the exchange, of structuring the nature of the contact. The graphic interface was modified several times to make the exchange process more clear. The cards of the other players were displayed more easily, the cards to be exchanged were highlighted, the length and complexity of the introduction were reduced. None of these modifications seemed to increase the amount of structured activity among users. The game was originally based on the children's game 'Quartet', but at the time it was felt that this was too simple a structure to maintain user interest, hence the decision to create sets of images corresponding to various social and cultural categories.

We decided to take a more drastic measure. We replaced the sets of images with real cards - from ace to ten, in the four suits. Almost immediately we noticed an increase in structured and sustained activity. Visitors whose microphone failed could be heard to shout to other visitors 'I'm looking for tens!'. Another modification also increased structured activity. This was to replace point reward for making sets with a time reward. The user was given a fixed amount of time in units on a 'phonecard' to start with, and the number of units decreased with time. More units could be added to the card by successfully completing sets. These changes were implemented only a few days ago, but the increase in activity, co-operation, engagement, and concentration is very noticeable. Some players now manage to stay in the ring over twenty minutes, and we are beginning to notice repeat users (who have already purchased year subscriptions) who come in regularly to play the game.

Our next step will be to extend the game to users on the Internet, who will be able to shape the play in Amsterdam from sites around the world.

These are only two examples drawn from a great many. But every exhibition cluster has been designed with the goal of supporting self-directed action. Some use the user-language of games, others the languages of problems, others still the language of variables. The New Metropolis is an open laboratory, an experimental site for exploring different ways to support action.

In conclusion, I would argue that to meet the challenges of the next century, our institutions too can be seen as support systems and their exhibits as supports, whereby both variety and coherence are maximised. What do I mean by this? Following De Zeeuw[7] , a support system is open to any individual without any form of prior constraint other than the desire to use the system to maintain or increase their competence. A support system suggests to users a specific form of use, and possible extensions to this use, where a flow of information will provide the user with the additional resources needed, and, at the same time, be available to other users. A support system has only linguistic constraints on the information flow, and these constraints constitute the 'user-language' of the support system. A support system supports the activities of the user, which stem from the user's own interests, experience and existing competence. A support system does not impose a model of the user, nor a model for the activities or the variation brought by the user. A support system maximises variety on the part of the

---

[8] De Zeeuw , in de Zeeuw, G. and Glanville, R. eds. Collective Support Systems and their Users, Amsterdam: OOC/Thesis; 1991

users, and maximises the continued use of the support system in such a way that this activity is augmented and encouraged. In this way, the support system serves as a means of recognising, responding to and enhancing the user's competences. Seen in this way, it seems clear that new institutions such as newMetropolis should put the emphasis on the user - not by modelling him in advance, but, like a good library, allowing for and supporting the activity of an infinite number of unknown and unknowable future users. It is in this spirit that newMetropolis began its experiment in June, and it is in this spirit that we will evaluate its future success.