Hall of Mirrors: the dilemmas of presenting information technology culture through information technology interactives and artifacts

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Abstract

This paper examines how exhibiting computing artifacts. was confronted by the development team of the Powerhouse Museum's new permanent computing exhibition: *Universal Machine. Universal Machine* use a mix of objects, activity trails and computer-based audiovisual and interactive technologies to take visitors on a journey through the origins, meaning and impact of contemporary information technology. It explores the interpretive partnerships developed between objects, new and traditional media, as well as the ways in which experience-based and multiple intelligence education theory informed design and content development.

Introduction

> The eruption of the binary scheme ... is of an incalculable importance. It renders inarticulate every discourse. It short-circuits all that was, in a golden age come again, the dialectic of signifier and signified, of a representing and a represented. It is the end of objects whose meaning would be function ... (Baudrillard 1983)

In *Simulations* Baudrillard attenuates the complex political, social, and historic evolution of western artistic culture. From Renaissance to Post modernism, he charts the creative progress of western society from the *reproductive* tools of craft, to the *productive* technologies of mechanization, and the *simulative* technologies of the digital age. In *Simulations* Baudrillard riles against the captious forces of digital media and warns of confusing ambiguities that blur the distinction between object and representations, things and ideas.

Whilst not singling out museums specifically, Baudrillard's predictions are of enormous significance to those of us attempting to exhibit the material expressions of our cultural heritage, namely the object. In particular those of us collecting the hardware and software that constitute the digital object. However the real confusion arises when collection turns to display and in an effort to meet public expectation, contemporary and historic hardware and software are *seamlessly* reinterpreted via interactive multimedia (IMM). In essence, computers presenting ideas and concepts about computers. In creating such incestuous dependencies it is all too easy for distinctions between objects and presentation tools, messages and the medium to be blurred or distorted.

These are some of the issues that confronted me and my colleagues as we began work on a new computer exhibition: *Universal Machine - computers and connections*. The exhibition opened in June this year and its designers' and curators' were wary that the presentation and interpretation of IT ideas and concepts needed to be carefully considered. Eventually we settled for a mix of direct and mediated experiences using artifacts, activity trails and IMM, a mix that not only embraced contemporary learning theory, but also acknowledged the failings of other exhibitions.

When message and media get confused – the mirror effect

Computer-based interactives, particularly in larger science and technology museums, have become more pervasive. Indeed only recently in my own museum we featured an exhibition that supposedly demystified the computer. In traditional terms the exhibit had not a single object, instead it utilized 36 computer-based interactives. In its rejection of the object the exhibit actively courted young visitors and pandered to their propensity to accept simulations as being equivalent, and in some cases preferable, to raw experiences. Whilst popular, the exhibition left many with impressions and ideas that propagated a potentially dangerous "confusion of the real and the imaginary" (Baudrillard, 1983, 150). Typical of the 36 interactives were two simulations, each made up of a single 15-inch touch screen monitor. One allowed visitors to calculate the time a photograph was taken by examining the length and angle of shadows. The other helped predict the impact of de-forestation on owl populations. Each was intended to elucidate how complex software is used to assist with interpretation and prediction. However, instead of the original software and interface, visitors were presented with specially devised play-centered simulations where they were encouraged to take on the role of scientist. Curators had deliberately overlaid complex role playing scenarios on top of real data sets and modeling software to make the simulation accessible and entertaining. However, their attempts only succeeded in simplifying content to a point where it seemed no expertise was required to either collect, correlate or interpret data. Indeed the visitor was left with the impression that the computer did it all! Consequently large parts of an exhibition intended to demonstrate the increasingly sophisticated use of computer simulations in medical, law-enforcement and environmental professions, instead left many with the impression that one required little ability to work in these areas other than basic computer keyboard skills.

However we shouldn't be surprised by this kind of misreading, particularly in a museum. After all the computer, unlike other media, most notably cinema and television which are almost exclusively confined to personal and leisure domains, also frequents the work domain. For many of us our most frequent encounter with computers is in the workplace or school. Consequently the computer has accrued a reputation as an impartial, neutral, reliable and efficient tool for editing, presenting and manipulating *real* data. In essence it is a tool of *realism*, that can be believed and relied upon to present information accurately and without deception. This is in contrast to cinema or television. If I go to see a Hollywood blockbuster like *Armageddon* or *Deep Impact*, whose strengths depend upon special effects, I'm not necessarily expecting a believable storyline. Instead, I expect to be impressed by a series of unbelievable images. Our attraction to these special effects is an acknowledgment of the movie as a construction. Much like computer games we do not expect to believe what we see. In contrast when a museum visitor encounters a computer-based interactive running a scientific simulation they do so believing it to provide *real* insight into the work of a scientist. In essence the intervention of the museum to develop a useable and fun narrative not only reduced the simulation to a shallow simulacra, but also inadvertently invested the computer with abilities that in the *real* world are carried out by human scientist.

In an attempt to avoid such confusions the *Universal Machine* development team took numerous precautions to carefully preserve the integrity of software and hardware objects. At the same time we tried to utilize IMM, together with contemporary learning practice and theory, to develop learning experiences that might lessen the likelihood of such confusions. We identified three specific problem areas:

- interpreting computer simulations
- the diminished authority of IT hardware
- working with visitor expectations and prior knowledge

Interpreting Computer Simulations

One of *Universal Machine's* seven themes is visualization and simulation and within this we explore how interactive simulations are increasingly being utilized by scientists to help interpret complex data sets. After some considerable searching the museum settled on a locally developed system known as the WEDGE. Co-developed by the Australian National Universities (ANU) Plasma Research Laboratory and Super Computer Facility, the WEDGE allows scientists to see and interact with mathematical models, CAD engineering layouts or molecular structures that would otherwise be difficult to comprehend.

The ANU were commissioned to build a WEDGE for *Universal Machine* which was identical to that used by the university's own researchers. This included running the same 3-dimensional models developed and used by ANU plasma physics researchers. These models, unlike our previous example, were not just interactive but also immersive. A visitor using a three dimensional mouse could 'drive' the models so they fully envelop the group. Critically this immersive quality is what provides the WEDGE with what Stephen Greenblatt calls its *wonder*. That is the power of the experience 'to stop the viewer in his or her tracks, to convey an arresting sense of uniqueness, to evoke an exalted attention.' (Greenblatt 1990). It is this quality of *wonder* which in turn allowed the museum to use original simulations which in themselves had little intrinsic appeal. Thus we were spared the assay of reinterpreting or replacing simulations. Uppermost in the minds of exhibition developers when choosing the WEDGE, as opposed to other screen-based simulations, was also its capacity to accommodate more than one visitor at a time. Theoretically the WEDGE can be built as large or as small as one wants, in this case a design was commissioned to accommodate five visitors. In this sense the WEDGE was deliberately constructed to support family or group learning.

Over the last ten years museum researchers, including Falk and Dierking (Dierking 1994) and Uzzell (Uzzell 1993), have successfully demonstrated that families and children in school groups, use museums as important social learning environments. In 1993, Uzzell published the results of a series of museum visitor studies, which compared and contrasted the accuracy of students working alone to those in groups. Uzzell observed that group performance was significantly superior to individual performance, and that social interaction and exchange facilitated students moving beyond their individual experience and empowered them with the multiple interpretations of others. Like school groups, families tend to interact and develop meaningful learning experiences when allowed to operate as a cohesive visiting unit. The visiting family more often than not acts as 'model museum visitors,' reading labels, participating in some activities etc. Falk and colleagues studies also suggested that as much as 15 to 20 percent of the duration of an average family visit may be spent discussing exhibits as a group. As Dierking and Taylor's research has shown sons and daughters question parents and in turn parents explain and illustrate concepts to children. In the case of IT this dependence is very often reversed. In this way the family or group becomes a powerful secondary mediator for learning. It is then hoped the WEDGE experience will induce multiple perspectives and discussion which when exchanged might empower each group member with the accumulative experience of the collective.

The Diminished Authority of IT Hardware

Despite its *wonder* it was evident that the process of simulation, indeed the basic human desire behind the need for complex computer-based simulations, was not easily conveyed through the WEDGE alone. Indeed the team surmised that if something more than a mere sampling and with it basic understanding of the potential of current scientific simulations was to be imparted, the WEDGE would need to be further supported. To promote better understanding of the historical, functional and intrinsic human desire that begets simulation and visualization technologies, further contextualization was needed. Eventually we settled on a mix of audiovisual reproductions of screen-based simulations and pre-computer simulation objects. A 1956 medical simulation known as the Transparent Woman and a showcase of different timepieces all helped explain the general principles and motivations behind the very human desire to simulate and visualize. Critically this mix of AV and non-computer based simulation and visualization technology was chosen to counter another perceived problem with the presentation of IT objects – the diminished authority of IT hardware.

As institutions primarily concerned with the collection, conservation and presentation of material culture, computer hardware, as a category of object, on the surface seems un-problematic. However from a collection and conservation perspective it is not without challenges, especially when attempting to maintain working systems. However it's the interpretation and presentation of computers and computer components that as this anecdote reveals is not only problematic for visitors but also curators.

It was late on Friday afternoon, I was just leaving the office. The phone rang and the caller explained she was from an Australian company that manufactured FRAM (ferro-electric random access memory) integrated circuits in Colorado Springs, USA. Would the museum be interested in some early prototypes?[1] We talked for over an hour, and after an agonizing weekend, I took delivery of her precious parcel on the Monday morning. Hardly able to contain my enthusiasm I tore open the parcel. Then I caught a glimpse of one of the circuits - my heart sank and my enthusiasm evaporated. I unwrapped 4 black integrated circuits, 30 mm long by 10 mm wide, the only detail of any consequence was the 36 zinc pins protruding from each side of the casing. Whilst FRAM circuits are amongst the most sophisticated examples of late twentieth century microelectronic engineering and represent a significant Australian innovation, they were to say the least aesthetically uninspiring, indeed quite boring. What's more the black casing and pins gave few if any clues as to how FRAM technology worked.

It is clear that some computer-based artifacts are often difficult for curators, let alone museum visitors to *read*. Unlike many material cultural artifacts, their scale and uniformity of appearance means they are rarely considered by many to be objects of beauty and allure. Complicating matters further is the fact that many digital computers reveal little of their origins or operation through their form, and indeed because the technology is so familiar, are often taken for granted and of little curiosity. Doron Swade (Swade 1988) has eloquently termed this dilemma as that of the diminished authority of the modern object. Unlike *classical* artifacts, which reveal function and use through form, many modern objects defy functional interpretation.

For an institution concerned with education through the process of collecting, conservation and display of objects, this presents quite a problem. For over 100 years object-based learning has remained central to museum education, however our understanding of the complex interplay between visitor and object that gives rise to object-based learning has changed markedly as epistemological and pedagogical research has evolved. From these a number of educational theories and practices have developed, of which the direct-experience-based model is the current one most widely used in science museums. Exponents of the direct-experience model contend that it is the kinesthetic, spatial and visual stimulus of engaging objects that help visitors develop a range of skills from observation and reporting to deduction. Direct-experience learning divides our world into two distinct realms: the physical world where objects exist and events happen, and our minds, which are capable of memory and conscious thought. By allowing visitors to encounter *real* objects, labels and a variety of media, we immerse them in a physical world, where they see, hear, touch, taste, smell and do. It is human nature that visitors should then seek to understand these direct-experiences. This means they must use their minds to find *regularities* and *relationships* between these new primary experiences and existing concepts and principles.[2] But what happens when these direct experiences are not engaging, or offer few clues as to the origins or function of an object?

Fortunately, the problem of diminished authority is not insurmountable. Indeed many semiotic theoreticians would contend that such diminished readings were not inherently object-centered problems. Cultural theorists like Barthes would contend it is the consensus of a group at any moment in time, not exclusively the intentions of the designer or manufacturer of a technological artifact, that establishes cultural significance and extracts meaning. This group is normally a contemporary of the artifact and operates in historic hindsight, a hindsight that is only partly informed by the artifact itself, and reliant principally on traditional historic sources. This group, in our case curators, is then in the privileged position through interpretation, to reinvest the artifact with a new set of signifiers. Rather than regarding artifacts as filled with pre-given meaning which needs to be teased out, we should as Barthes suggest 'regard them as an empty site' eternally open to signification. Thus a material text like Charles Babbage's *Difference Engine* is open to infinite readings as it continuously confronts new readers in altered historical situations, and whilst only the material signifiers remain constant, the signifieds are repeatedly created and lost through the historical act of re-reading. This re-reading is a matter of translation rather than recovery. We read into text (objects), rather than out of it.

However there is little doubt that the object can hinder or assist the processes of re-reading. So when wanting to discuss how technology functions, having overt and alluring signifiers is certainly beneficial. But where such signifiers are absent in the case of our FRAM microchips, or as we will see with Charles Babbage's *Difference Engine*, there are a variety of ways and means of assisting visitors to procure functional as well as other readings.

All material cultural artifacts require other sources of information, be it labels, graphics or audiovisual, to help release some of their knowledge potential. Thus it was to the unique *affordances* of IMM that the *Universal Machine* curators and designers turned. The term affordance was coined by the psychologist James Gibson to describe the potential for action, the perceived capacity of an object to enable the assertive will of the actor. Technology and media are affordances to the extent that they promise extended human capabilities of seeing, hearing, and uttering. IMM's unique affordances of malleability, editability or what we more commonly refer to as interactivity, allows it to deliver highly personalized information. In turn this customized information can promote learning by engaging learners in a process of minds-on problem solving, that at the same time allows conclusions to be validated within visitors own, and not the museum's, constructed reality (Hein 1988). In essence IMM used in collaboration with a sample of Babbage's *Difference Engine* allowed the museum to provide what we hope will be a successful functionalist interpretation of the object. These partnerships between IT objects and IMM were only one of the strategies we developed for functional interpretations; another utilized humor and interfaces inspired by multiple intelligence theory.

The exhibition title *Universal Machine* is intended to invite visitors to consider some of the similarities and differences between humans and computers. Of central importance in the exhibition is the fact that much like the multi-talented and multi-functional human, the computer is emerging as a similarly flexible tool that can be put to work on almost any problem. Unlike other machines that are designed to undertake a single specialized task, the computer is a general-purpose device; it is a universal machine. So in developing our *What* *is a Computer* section of the exhibition we devised a number of principally associative strategies that used associations with more familiar objects and indeed human tasks, to expand visitor's perception of what a computer is and at the same time explain how it works.

A key consideration in addressing functional apprehensions was the graphic and three-dimensional design of the *What is a Computer* section. Experience had taught the team that too often this particular story was treated in a very formal and textbook fashion with predominantly graphic and text-based presentations of binary code, microchips, etc. This dry, dehumanized presentation can quickly compound visitor's feelings of alienation and is neither fun nor inviting. To avoid this we commissioned the British engineer, television personality and cartoonist Tim Hunkin to research, design and illustrate *What is a Computer*. Tim Hunkin, best known for his BBC-TV series *The secret life of machines*, was brought on board as his work is infused with humor, flair and a healthy irreverence. These we hoped would allow us to build a design vocabulary that empathized with visitors by laughing at popular misconceptions, confusions and apprehensions we all have with computers. The cartoon humor Tim conceived was carefully focused around human events and commented not only on the marketing and production of computers, but also on how it carries out tasks that were once undertaken the exclusive preserve of people. Another strategy devised was to explore functional similarities and differences between computers and other machines. Therefore in discussing how computers are increasingly taking over the task of modeling in architectural practices, delicate, alluring and meticulous architectural models were exhibited and used as signifiers. Another strategy was the development of IMM and other interpretive devices that in their variety of interface and content experiences embraced multiple intelligence (MI) theory.

Typically Western education has emphasized two intelligences, one concerned with maths and the other language. However in 1983 with the publication of his book *Frames of Mind*, the Harvard professor Howard Gardner argued that there was both societal value for, and physical brain evidence of the existence of a range of human intelligences. Gardner postulated the existence of Multiple Intelligences (MI) and developed a theory that in education terms described and explained how people learned and preferred to interact with their physical, emotional and social worlds. Gardner postulated the existence of seven intelligences: musical-rhythmic, bodily-kinesthetic (agility and dexterity), interpersonal (social), intrapersonal (self-awareness), and visual spatial, in addition to logical-mathematical and linguistic.[3] Gardner contests that most people exhibit an average aptitude in five or six and may excel in one or two intelligences. Importantly for the museum, Gardner also contends that if we use activities, interfaces or content that actively engages one or more of these intelligences then we are more likely to attract and possibly promote learning amongst those who favor that intelligence. So in the *What is a Computer* section we provided IMM and object experiences that overtly utilized stimulus akin to many of Gardner's categories:

- *musical-rhythmic* - A 1981 dancing demon program running on a TRS80 demonstrates the limited scope of early personal computers.
- *bodily-kinesthetic* – Banks of highly tactile switching mechanisms as well as specially modified keyboards allow visitors to encipher and decipher binary code.
- *interpersonal* – For those more socially inclined a 1978 version of Pong tennis was included and could be played by two competing visitors.
- *visual spatial* – An edge detection system allows visitor to play three-dimensional tennis.
- *logical-mathematical* – an ASCII interactive explains how keyboard actions are processed into pixel data on a computer screen.

Working with visitors' prior knowledge

Experience has taught us many visitors' misreadings and confusions with IT also have origins in visitors' own preconceptions and prior knowledge. After all, as Gaby Porter contends, "Museums [can] work by making meaning of objects."(Porter, 1991) As curators we like to think this meaning is somehow intrinsic to the object and accessible to all, but as Barthes suggests an object's meaning is constantly evolving and much of this process is beyond the control of curators and designers. After acquisition, the process of primary, and later secondary research adds an interpretive layer, which is then extenuated by the process of selection, juxtaposition and ultimately interpretation in the exhibition. Whilst some in museums now appreciate the transforming effects of these practices on an artifact's meaning, many are still content to delude themselves that the process ceases in the showcase, where the object is transformed into *reality* itself, to be consumed by a passive spectator (Porter, 1991).

However this is not the case; visitors are rarely, if ever-passive recipients and ultimately the meaning that counts is created within their 'eyes, head and heart.' (Silverman 1995). Within the visitor themselves the process of meaning making is every bit as complex, if not more so, than that which takes place in the museum. We now commonly accept that visitors can no longer be considered empty vessels, but instead learn by selectively accruing knowledge that more often than not tallies 'with their previous encounters and experience.'[4] Thus the role and value of prior knowledge cannot be underestimated. Indeed there now exists a considerable body of evidence that shows that learning proceeds primarily from prior knowledge, and only secondarily from presented materials.[5]

To better understand the prior knowledge visitors might bring to *Universal Machine* the museum commissioned a front-end evaluation of the draft exhibition brief in June 1998. A series of in-depth interviews and six focus group sessions were conducted over a period of two weeks. Group discussions were mediated by a professional facilitator using a combination of specially devised video presentations, daily diaries and artifacts participants brought along. Not surprisingly, we found that attitudes towards computers varied according to how conversant people were with the technology. Those with a self-confessed limited understanding, (in our sample predominantly parent and primary teacher groups) although eager to learn about computers, were at the same time somewhat in awe and a little scared of the technology. They saw the computer as an agent of positive economic change, but at the same time were concerned it promoted anti-social behavior. They had a *Jetsons* meets *Terminator* vision of the future. This group also perceived computers to have little history, most believed the technology originated in the early 1960s. On the other hand the self-confessed knowledgeable groups, (in our sample the secondary schools teachers, tertiary lecturers, Cyberyouth and industry specialists groups) not surprisingly tended to be very comfortable working with computers. At the same time they were not excited about the immediate future. In truth they believed the future would be much like the present and were skeptical that computers would change society much in the next ten years.

It was evident that *Universal Machine* would need to address at least two diametrically opposed sets of prior knowledge. One simultaneously utopian and fearful, the other comfortable in perpetuating the status quo. As a curator this presented an interesting dilemma, as we had to go-out and consciously find stories that illuminated concepts and ideas that might dispute, and where appropriate reinforce these views. This in itself was challenging but ultimately we were able to populate the exhibit with a range of stories that aligned then challenged visitors' previous knowledge. These included stories and sections on societal cyborgism, implanted and wearable chip identification tags, industrial robots and interface to name but a few. These issue-based stories provided ample opportunity to challenge and in some cases enforce, visitor's preconceptions. However in our initial design we realized that few if any of these stories offered visitors an opportunity to respond or react. Later we concluded that we would need to move beyond a mere challenge and that there would be educational merit in trying to cement gains by providing visitors with an opportunity to use their new ideas creatively.

Again curators and designers turned to IMM. However, if the museum was to provide this kind of empowering creative experience, we realized that we would need to move beyond the closed-architectural IMM paradigm that characterizes many museums, including my own. The majority of IMM at the Powerhouse utilizes structured and prescribed knowledge domains to induce learning, i.e. philosophically they are explicitly instructional (also known as Objectivism) devices that overtly use the computer as a tool. As a tool, the role of computer-based IMM in the museum is traditionally to help visitors learn and enjoy by creating a solution to a problem. However this problem-solving approach is ordinarily prescribed and takes place within specific circumstances that necessitate instructionalist, as opposed to constructivist design approaches. This is because designers of museum-based IMM often have to work within the technological confines of existing software and hardware, and the attention and time constraints of visitors. Consequently the majority of museum-based IMM has been characterized by a set of discrete and limited outcomes that ordinarily provide few opportunities for customization or creative expression. Here the computer is employed as a tool, rather than as a communication medium that is both multi-directional and multi-functional. It is this re-conceptualization of the computer as a communication rather than presentational medium, that took place when we decided to design the "Build Your Own Homepage" interactive.[6]

Using a series of specially designed HTML templates and web cameras visitors are given the opportunity to design their own homepage in the *Sufer's Paradise* section. Once created, visitors' pages are stored on the museum's web server and after the visitor returns home they can be retrieved. The degree to which visitors can customize and personalize these pages was made as extensive as possible and included visitors being able to chose up to three pages to link their page to, taking their own photograph and embedding into the page a range of object images from the exhibition. Most importantly visitors were asked to respond to the following questions – "What was my first experience of a computer" and "What would a world without computers be like?"

When used as a medium, as opposed to a tool, the computer can enhance the very nature of how and what the museum communicates. Critically we recognized that such a re-conceptualization would allow the museum to crossover into the constructivist arena of learning. As a medium the computer not only facilitates inter-subjectivity, that is communication between learners, but also intra-subjectivity, that is communication between the learner and him/herself (Repenning et. al). This in essence was the kind of self-reflection we wished to inspire not only in this interactive but throughout the exhibition. With any luck some of the diverse strategies we put in place might inspire some of our visitors to ponder upon their views both new and old.

Overall the exhibition provided a unique opportunity to apply the seemingly endless research now emerging on computers and computer use. Later this year we hope to conduct a summative evaluation as well as visitor tracking studies to see which of our strategies have been successful. However the real challenge will be maintaining the cutting-edge nature of the exhibit. To keep on top of the ever-changing nature of computers, both as content and presentation devices, we will need to incorporate regular upgrades. Providing we can convince management of our need for such upgrades, we should then be able to further refine our approaches to marry research drawn directly from *Universal Machine,* with that of constructivist education theory.

Notes

1. Manufactured by Ramtron Ltd, FRAM technology represents a significant breakthrough over conventional memory products as it offers the ability to retain information in the absence of a power source.

2. David Ausbel and colleagues defined "meaningful learning" as the linking of new information to existing concepts and principles in a learner's knowledge structure. The network of relationships formed during this process enables a learner to recall learned material after extended periods of time and apply the material to new situations or problems. From D. P. Ausubel., J. Novak., & H. Hanesian (1978). *Education psychology: a cognitive view.* New York: Holt, Rinehart & Winston.

3. Recently Gardner postulated the existence of an eighth intelligence - Naturalistic.

4. In Jeremy Roschelle's *Learning in Interactive Environments: Prior Knowledge and New Experience,* he contends that somewhat less frequently, an experience causes a small cognitive shock that leads the learner to put ideas together differently. Much more rare, learners undertake major transformations of thought that affect everything from fundamental assumptions to their ways of seeing, conceiving and talking about their experience. While rare this third kind of change is most profound and highly valued.

5. Compelling evidence is Ipresented in E.V. Glaserfeld's 1984 essay; "An introduction to radical constructivism". From P. Watlawick (Ed), *The invented reality,* New York: W.W. Norton. Also see L.B. Resnick's 1983 article; "Mathematics and science learning: a new conception". *Science,* 220, 477-478.

6. The Powerhouse Museum "Build Your Own Homepage" experience was in part based around a similar installation I observed in September 1998 at the Tech Museum of Innovation, San Jose.

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