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Title of paper

'Understanding the audience, telling a story and using variety: keys to effective communication in science exhibitions'

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Abstract
The general public is more likely to enjoy and be educated by science and technology exhibitions which address their wide range of needs and behaviours. To attract and interest this broad audience you have to determine what they know now and what they will benefit from learning. You have to understand the different learning styles and interests of different age groups, the good and bad ways a subject is taught in schools and presented in the media, which ways of presenting a subject appeals to one or both genders, how individuals behave differently from groups and many other preferences of people. An important way of thinking about the audience is to consider that for any given subject few people are experts, several are somewhat informed and interested, and most are likely to be disinterested or not even know that the subject exists. This last group makes up the majority of the public that most science and technology exhibitions are trying to reach. Yet displays are often only appropriate for the 'informed' and the 'expert'. Some keys to appealing to the 'uninformed' is to use narrative, variety, humour, surprise, beauty, the strange and the familiar and to integrate various display media. This paper illustrates these methods and discusses ways of understanding the general public.

Introduction: do students learn science in school?
Formal science and technology education in schools seems to be ineffective for most students. The educational reality is that most students leave school with either a poor understanding of science or with a lifelong dislike for the subject. Therefore in addition to curriculum reform there has been a pressing need to use alternative ways to educate people about science and technology. These include informal science learning contexts such as science centres and museums, zoos, aquariums, botanic gardens and science related field trips to name a few.

A lot of resources has gone into building, staffing and maintaining science centres around the world even in cities that already had museums with science related displays. Most of these museums were old style stuffy places with displays of objects in dusty showcases and stuffed animals usually arranged in exhibitions about a specific academic subject such as 'horology', 'microscopes', 'minerals' or 'land mammals in South America'. Most students on a school excursion to these types of museums mainly find it to be a boring experience. For many sad reasons most of these science museums are unable to evolve from their traditional style of static, unchanging, academically organised displays. Rather than forcing the museum to change, local communities invest in making an

interactive science centre, which requires a substantial exhibiting venue and staffing infrastructure. The science centre and museum often end up competing to attract visitors.

Do students and adults learn science in science centres?
I believe that the loosely associated selection of interactive exhibits which make up many science centre exhibitions are ineffective educational tools for most sections of the general public. People who have a poor understanding of science and technology are unable to learn from interactives without additional supporting information. Therefore the typical science centre exhibition has staff or volunteers in the gallery to explain to the visitors what the interactives are supposed to demonstrate. Often visitors complain that these 'explainers' are intrusive, confuse more than explain, talk amongst themselves and have other short comings. Yet science centres have stubbornly persisted with this interactive/explainer model and have convinced themselves that it is sufficient that visitors are having a good time even though they aren't learning anything or, worse, reinforcing their scientifically incorrect notions.

A need to continue to evolve
In the reaction against traditional museums and their focus on collections science centre staff refused to display historical or contemporary objects without considering their educational and communicating potential. Exhibitions went from being object dense to interactive dense. But were visitors learning any more science than before? For many years educators and researchers have been discussing the complexities of communicating science and technology in informal settings and have questioned the effectiveness of interactive exhibits as an educational device. But just like the traditional museums, science centres were reluctant to change their style of display.

For more than 10 years staff at the Powerhouse Museum have used a different conceptual model for creating science and technology exhibitions. The exhibition development process starts with the needs of the visitor and our staff are willing to use any available display media to communicate content. There are several aspects to this model.

Define purpose and audience, then ideas and lastly display
Purpose (or aims, objectives, goals):
While writing the exhibition proposal and during the early stages of developing an exhibition Powerhouse museum staff define and redefine their purposes for producing the exhibition. Once approved, the purposes act as a guide for the development of all the exhibition content. Having clear and specific purposes for the exhibition helps all involved to know what they are trying to achieve and why.

Visiting an exhibition that lacks a clear set of aims is like listening to a speaker who doesn't have a clear idea of what he or she is supposed to talk about - you hear the words but the ideas, if any, are unconnected and you can't determine what the person is trying to communicate.

But what are some clear purposes for making an exhibition? This depends on who you want the exhibition to communicate to.

Purpose and audience:
Define your audience as carefully as your purpose. Then consider whether your purpose is appropriate for your audience, otherwise your exhibition is unlikely to achieve its objectives. I've questioned exhibition developers who state that they want the 'general

public' to appreciate their exhibition and I find they usually mean the public that they are familiar with, that is, people similar to themselves. The 'general public' includes just about everyone and it is impossible for one exhibition to please all these different types of visitors.

For example if you want people to learn a range of scientific principles by exploring your exhibition you have to first consider that 'people' learn in many different ways depending on their age, educational background, experience and so on. Then it's likely that most of this broadly defined audience may not want to learn about scientific principles as they think that have no need for the information and that the subject is boring. Many won't enter your exhibition or perhaps even won't voluntarily go to your institution. Therefore for most people it is an inappropriate purpose to expect them to want or be able to learn scientific principles in your exhibition.

At this point you may redefine your goals to say you want school students to be the target audience for your exhibition. You are concerned about statistics that indicate that students aren't doing well at learning science in school and you want your exhibition to become a educational resource in support of the school science curriculum. Your purpose is becoming more defined as you consider your audience. But you probably still haven't asked why students must learn science or at least, 'What is the science that students must learn?'. Your exhibition is likely to repeat the failure of the formal school science curriculum if the science it presents is the same as that taught, but not learned, in the schools. For exhibitions intended mainly for students then, at the very least, you must select content that they are likely to be interested in and presented in a way they will understand.

In short, it is an important but difficult task to clarify one or more particular purposes for an exhibition and it is equally complex to define and understand the audience. You have to consider the individual and institutional difficulties of learning science and technology, the reasons for learning it, how different people learn and what they want and need to learn. You must also consider the overall attitude of the people, media and government towards science and technology.

Ideas:

Your initial statement of purpose might be about what the visitor is intended to learn from the exhibition or how you want to change their attitude to the subject. You believe that your purpose is appropriate for the target audiences; these are the types of people you want to appreciate your exhibition based on their learning behaviours and backgrounds. Now you can consider which ideas to include in the exhibition. Ideas constitute the main content of a science and technology exhibition.

Ideas can be facts, concepts, interpretations of events or many other different things. Ideas are powerful. People spend a lot of time and use various ways to try to communicate their ideas to others. Ideas may be part of a narrative story-like structure, be captured in painting or poetry, or be plainly stated. For a non-scientific audience I suggest that ideas relating to science and technology be presented as part of the way of interpreting a common subject that your audience is already very interested in. For instance you can present many concepts about chemistry by interpreting popular everyday things like chocolate, fragrance or colour from a chemical perspective.

This way of presenting ideas in exhibitions seems alien to most curators and exhibition development staff in science museums and centres. They produce exhibitions full of objects with incomprehensible labels or galleries full of interactives which need staff nearby to explain to the visitor how to use and interpret the hand-ons but ideas-off exhibit. Ideas should drive the content development of an exhibition, not the preferred medium of display.

Of course not every idea is suitable for presentation in an exhibition. Some concepts are best explained in books, documentaries, demonstrations or other non-display format.

Display:
Developers of science and technology exhibitions should be communicators. Instead they are usually curators, who are primarily *collectors* of objects, or former scientists or science teachers, who have come from a *hands-on* working or teaching laboratory environment. These people spent years learning the concepts associated with their objects and interactives. Then they forget how difficult it was to grasp the interwoven ideas and overlook the intrinsic complexity of their displays. Only those visitors with the same background and way of thinking can extract the specified information from viewing or interacting with these mono-media displays. The lay visitor has no means to decipher the information coded into these exhibits.

The choice of display media used to communicate an idea should be determined by selecting the medium that best can communicate the idea to the chosen audience. Exhibition developers who do not understand how a display medium is used by visitors often select an inappropriate medium to carry information. This could be an interactive suitable for use by one person at a time but which all visitors must use to obtain the introductory ideas of the exhibition. Most visitors would pass by an occupied interactive and therefore not get necessary information.

Developers may also favour a particular display technology because of fashion. For instance, from the late 1970s through the 1980s some museum exhibitions were filled with video monitors showing audiovisual information as the main means of communicating to the visitor. Visitors might as well have stayed home to see the exhibition content as a documentary on television. Another fashion for many years has been to have galleries full of interactives. These exhibitions often look like playgrounds scattered with colourful activities and encourage playground behaviour in visitors. Many people have a series of playful 'doing' experiences with the interactives but learn little if anything.

The theatre of multiple media exhibitions
Once the exhibition development team is freed from the constraints of using a particular display media its members have the freedom to explore more of the potential of communicating in a three dimensional exhibition setting. The multiple media approach presumes that a greater range of individual learning styles can be accommodated in an exhibition by using a variety of carefully selected display media.

The process of presenting live theatre is a good model to inspire and guide the development of an exhibition. Both theatre and exhibitions can integrate various media to tell a story or communicate information in an anecdotal way. The actors in a play present a narrative story from a three dimensional stage setting to a seated audience. In an

exhibition the visiting audience walks among the various three dimensional displays. Despite the lack of a linearly presented script information can be placed in meaningful contexts and it is possible, although challenging, to present a form of narrative.

In an exhibition each display element may communicate a different aspect of the story. An example is shown in a display grouping from the museum's science exhibition called *Experimentations*:

- O*bjects* manifest reality - someone spent time and money to make or use the artefacts for various reasons. Prized objects may be the material cultural evidence of a significant event or were used by a famous person. Some objects have a magical attraction for those who know something about what it represents. Or they may just look unusual which will stimulate people's curiosity.
- Carefully selected *graphics* replace a thousand words in depicting where or how an object was used, setting an ambience or illustrating a detail. Conversely an inappropriate graphic requires a thousand words to explain what it is supposed to represent.
- *Interactives* bring to life an artefact in a showcase or an associated phenomenon. It may show how an object was used, how it feels, how it was made or any manner of fact, concept, experience or sensation.
- *Audiovisuals* provide more detail for the interested visitor and provide a depth or breadth of information for the exhibition. But audiovisuals shouldn't be relied on to provide the basic information about the display; the visitor may encounter the audiovisual in the middle of the program and lose patience and walk away. Or as so often happens, the video is out of order and the visitor gets no information at all.
- And the *label* tells the story - the three dimensional displays should engage the visitors' curiosity so that they seek out the label to answer questions raised in their minds by the display. Brief carefully written, well designed and legible labels can provide an enjoyable reading and learning experience. They can give simple information or raise complex issues and relate to other displays.

These elements can be mixed together to create a harmonious whole and an illustrated narrative. They become the means to tell a multifaceted informative story.

Thinking about the audience

The *Experimentations* exhibition also illustrates another agenda. The exhibition was intended to appeal to people who would say they didn't like science. They might think that science was ugly (as opposed to art which was beautiful), that it didn't have anything to do with their lives, that scientists were all middle aged men wearing lab coats and that science was boring. Therefore *Experimentations* was developed to be highly aesthetic, to display many everyday things and place phenomena in familiar settings, to show a range of people involved in experimenting and to be enjoyable. It's content was intended to be comprehensible and appealing to people with poor science literacy; whether they had never learned it, were in the process of learning it now or who forgot, by chance or intention, much of their school taught science. The exhibition was developed to reach these and many other people. In general I view the potential audiences in the following way:

The audience model: When selecting and structuring exhibition content I consider what will attract and involve visitors who are *uninformed* or disinterested in the overall

subject. At the same time I seek ways to maintain the interest of those who are *informed* or even *specialists* in the material.

- I view **uninformed** people as those *who don't know what they don't know* about a given subject. For most subjects this is the largest group and the most difficult to reach. The challenge is to make them aware that a subject exists and has an effect on their lives and that they can chose to learn more about it. An even greater challenge is to entice and excite the uninformed while still holding the interest of those more knowledgeable about the subject.
- The **informed** are those *who know what they don't know* and actively make choices about when to expand their level of knowledge of the subject. Most exhibition developers count many of the informed among their friends and have this group in mind as the target audience of their exhibitions.
- The **specialists** *know*. They are likely to have a greater familiarity and detailed knowledge of the subject than the exhibition developer. The developer may be part of or seek to become a peer of this academic group. This group is fewest in number but often the most influential. Individuals may have the attention of politicians, members of boards and the media and have no hesitation in championing their particular subject area.

The goal is to identify and communicate the fundamentals of a subject which are relevant to the *uninformed*, have enough variety to intrigue the *informed* and reinterpret the content with freshness and humour to surprise and entertain the *specialists*. Actually humour, originality and quirkiness works for all the groups.

Another important way of increasing interest in science and technology is to place the subject in a broader cultural context. This is unlike the way the subject is usually taught in schools. Schools usually teach science with little reference to other subjects. It is rarely shown that most human and natural activities can be viewed from a scientific perspective. Other school subject curricula, such as history, language studies, religion, art, politics, philosophy and mathematics are treated in the same isolated way. Science centre exhibitions usually reinforce the notion of the separation of science from society. One way you can encourage visitors to see that science is indeed a part of their live is to exhibit everyday subjects and interpret them from a scientific viewpoint.

Since most voluntary visitors to museums go to enjoy themselves the educational experience on offer should be enjoyable. Some exhibition and program developers feel that if something is entertaining it has little didactic value. Admittedly, form should not swamp function nor should the medium forget the message. But a lightness of style, the telling of a story and a sense of performance are powerful ways to communicate a message. And this feeling can be achieved in exhibition displays.

As an example I'll discuss how this model was used to develop our exhibition about chemistry.

Chemical attractions: start with the news
A persistent tone of media coverage about a large and varied industry can influence the public to vilify or praise an associated science and technology subject. For instance, many people hold chemistry with the same suspicion reserved for the chemical industry which has had ample negative media attention about various controversial practices. In many minds the wealth, health and lifestyle benefits made possible by this industry are outweighed by concerns about real and perceived risks.

Therefore when I started developing an exhibition about chemistry I deemed it critical to address likely prevailing public attitudes about the subject. For the exhibition to have a chance of communicating some of the science of chemistry I thought the public needed to see displays that addressed their interests and their concerns. Yet the content had to understandable to people who might not understand basic chemical concepts such as what is an element (or an atom) or a molecule. The content also was to be gender inclusive. My task was therefore three-fold: to determine how to communicate a range of chemical concepts, select content that showed important uses of chemistry and find ways to interpret some of the environmental concerns related to the making and use of chemicals. I gained agreement from the primary exhibition sponsor, The Royal Australian Chemical Institute of NSW, to pursue this path.

Choosing a direction
The few chemistry exhibitions I've seen in other museums are arranged around chemical concepts, much as one would find in an introductory textbook. This formal didactic approach to chemistry is reinforced by interactives that, at the push of a button, mix chemicals to make an electric charge, a change of colour, a bang or a whiff. While important as effects of chemical reactions, these phenomena are viewed by the lay visitor as perhaps mildly curious but isolated from any context. In contrast I wanted to present everyday experiences that could be interpreted from a chemistry perspective using a relaxed anecdotal style. I also wanted to devise interactives that required little maintenance. If materials were to be consumed they had to be easily and cheaply replaced at not too frequent intervals. If waste had to be made it was to be minimal in amount, non-toxic, easily and automatically disposable. All the displays had to be safe for visitors. And yet the interactives had to be easy to use, informative, to the point, appealing, entertaining and illuminating.

At this point I had identified the challenge and determined the overall approach. The difficult next part was to find the required magic subjects. These topics had to be familiar to most people yet have an underlying chemical complexity which could be revealed simply and compellingly. They also had to work together to create a welcoming informal learning environment suitable for a varied lay audience. The ultimate aim of the exhibition was for visitors to leave the display thinking that everything is made of chemicals and that there is no difference between natural and manufactured chemicals.

Choosing the content
One of the good things about the diversity of subjects the Powerhouse Museum deals with (decorative arts, social history and science and technology) is that this attracts people with a diversity of interests. Most visitors wander around sampling every exhibition and spending time in ones that they find most appealing. Happily, *Chemical attractions,* as the chemistry exhibition is called, has become a strange attractor for visitors. They wander in and get caught up with the displays.

1. Chocolate

And why not? One of the subjects is the chemistry of chocolate, the world's most popular flavour. Some of the sensory appeal of chocolate comes from its complex chemical and physical behaviour. It also has an interesting history, is familiar to most people and has a mythology of perceptions associated with it. In a perverse way it is an advantage that many people think of chocolate as a slightly naughty, forbidden, luxury food as this attracts them to explore some of the facts about a food that gives them guilty pleasures.

The showcased content sweeps through the history of chocolate and alludes to some of its association with luxury, shows the path from cocao pod to cocoa liquor and other related topics. It looks at the undesirable chemical effects of fat and sugar bloom, which affect the appearance of chocolate, and relates them to crystallisation, solution and evaporation. With the temptation and stimulation caused by the contents of the showcase we would be cruel if we didn't give the visitor a taste of the subject. The interactive to do just that had to be pretty special. And we're fortunate that another sponsor of the exhibition, World's Finest Chocolates Australia, supplies the various chocolate chips for the device we created.

An instant queue forms in front of this interactive as soon as a school group enters the exhibition. And despite the entire experience taking 9 minutes, the kids patiently wait their turn. That's the power of chocolate!

But for us to deliver on the promise of a flavourful experience, we had to create a hygienic way of storing and delivering different types of chocolate, limit the amount of chocolate given to each visitor, make a reliable delivery system and address concerns about visitor reaction to possibly unpleasant bitter tastes (eg spitting out a sample of raw cocoa mass). It was worth the effort as this has become the most popular interactive in the museum.

2. Fragrance

Fragrance was another appealing subject for the exhibition. Fragrances and its relative, flavours, are used in a wide range of products that find their way into every home in many countries. Perfume may be the highly visible, high profile part of the market but the functional fragrances and food flavour enhancers make up the vast bulk of manufacture and sales. The latter are in many everyday products. Just read the fine print on the ingredients labels.

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This is another subject about which people have strong feelings and a variety of misconceptions. The chemical complexity of the products is matched by the chemical mystery of the workings of our sense of smell and the origins of all our body aromas. Dealing with the personal effects of smelling and smelly provided very compelling and humorous showcase content. Two interactives bring the all too familiar to life: one shows how the shape of a molecule can determine its aroma (as demonstrated by smelling the difference between a left and right handed molecule, carvone); the other shows how one chemical can mask the bad smell of another (an effect used in some air fresheners).

Others showcases explore the making of fragrances for fine perfumes and functional products. In one related interactive visitors enjoy the smell of a complex perfume and then separately inhale the completely different aromas of its main components, which are called 'notes' by the perfumer. Another smell experience challenges people to identify the natural lemon essence from three synthetic chemicals used to give lemony scents to various functional products. Or visitors can delight in a four course meal, or at least the surprisingly accurate synthetic smell of one.

The labels from the perfume showcase are noteworthy for the brevity of text used to mentions the significant chemical component of a fragrance, the name of the perfume, the designer, perfume house, date of creation and the perfume style. This is intended to address the basic questions of the informed and perhaps even appeal to the specialist.

3. Colour and ultraviolet light

Perhaps an easy way to get someone's attention is to use colour and movement. What's not so easy is interpreting the chemistry of what's happening to make colours. Luckily there are many artefacts available to help visualise some of the concepts. We display chemists' equipment used to identify chemicals by analysing the characteristic colours they absorb or emit. Next to these are a pool chlorine test kit, litmus paper and a home pregnancy test to show everyday chemical analysis by observing a colour change. Further along are bottles of powdered dyes and some naturally and synthetically coloured decorative arts objects. For the environmental side we look at the use and dangers of ultraviolet light and the chemicals that are associated with it. A showcase features CFCs and halons which were once viewed as wonder chemicals but now are being phased out of production and use because they destroy ozone in the upper atmosphere, the UV screen for the earth. We rely on three interactive exhibits to add the movement to the colour to help demonstrate the points raised by the showcased content.

For fans of fireworks the main interactive is a computer aided design and virtual manufacturing dream. It has become a major attraction and talking point for the exhibition and is especially welcomed by chemistry teachers and their students. Although it is the most technically and interpretively complex interactive in the exhibition it is very easy to use. Simple controls coupled to voice and screen based information help the visitor select from a wide range of possible choices. When they have completed their virtual firework they are rewarded with a dramatic large screen video projection of the results of their efforts.

The visitor operates the interactive from in front of the 'laboratory bench' showcase. This is a glass covered counter with an opalescent perspex bottom. A variety of 30 chemicals and materials used to make the various components of 6 different kinds of fireworks are displayed. 30 lamps are located below the perspex sheet, one positioned under each chemical or material.

A monochrome LCD monitor is located in the centre of the laboratory bench. The screen displays text and diagrams about the main components of each type of fireworks. There is also information about the characteristics of individual chemicals which the visitor selects for their pyrotechnic creation. Visitors rotate a selector knob to make individual chemicals or materials light up and have relevant information appear on the screen. The visitor presses a yellow button to finalise their selection and to move onto the next set of chemical or material choices.

A proximity sensor detects the presence of a visitor. A narrator invites the visitor to press a button to make their own fireworks. The narrator then guides the visitor through their various selections, providing brief introductions to each group of materials needed for their particular type of firework. More detailed information and diagrams appear on the LCD screen for each group of materials and individual items. Each time the visitor turns the selector knob one item within a group is illuminated and the narrator names the item.

When all the components of a particular type of firework have been selected a video sequence commences. This shows how a pyrotechnic worker actually makes each component of that firework and then assembles the various parts. Finally the finished product is taken outside to a field after dark, placed in position and the fuse is lit. Whether the result is a visual spectacular or a fizzer the narrator and the LCD screen provide a chemical explanation about what has occurred.

There is more to the exhibition but the examples given should provide a sense of the possibilities of using the model of theatre, audience and multiple media to intrigue and stimulate a wide range of people.

But is it a chemical attraction?

Has this exhibition succeeded in achieving its aims? It certainly seems popular with visitors who encounter it as a new section in our large science exhibition called *Experimentations*. We have done visitor counts in *Experimentations* before and after *Chemical attractions* opened and find that numbers have increased by 10%. We have had praise from the sponsors of the exhibition. Visiting science centre workers want a duplicate of the fireworks interactive. After the usual running in period we have been able to maintain the displays at a satisfactory level. But beyond this I can't say whether visitors are leaving the exhibition with more awareness of chemistry than when they entered. They seem to be having such a good time I haven't had the heart to interrupt them to ask.

Where to from here?

The multiple media style of display offers a diversity of experiences to capture and hold the attention of people of different ages, interests and educational needs. Ensuring the display is a credible exhibition and not a promotional exposition will reduce the visitors' wariness about one-sided presentations that uncritically support a subject. Old challenges still loom: how to attract people to the venue who don't like your subject; can one venue make all types of people feel welcome and if so will different types of people mix well in your venue, eg people of different levels of education, income and familiarity with cultural institutions? And the virtual challenge: how do you transform the multiple media exhibition experience into a virtual museum experience for the internet?

The way in choosing the subject will remain important. Present content that can get past the audience's defences. Such displays can be surprisingly interesting and painlessly educational. They may use 'bribes', eg chocolate, to encourage visitors to listen to information, or be about subjects that are slightly taboo but all people are interested in or effected by, eg. body odour. But perhaps most importantly present science and technology subjects in a broader cultural context. This may be the way to make the subjects more top of mind and valued than presenting it in isolation from people's familiar experiences.