HÖGSKOLAN
Dalarna

Master Thesis in Science Communication

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Citizens and Contemporary Science. Ways to Dialogue in Science Centre Contexts

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Contents

Abstract

The current paper presents a study conducted at At-Bristol Science Centre, UK. It is a front-end evaluation for the "Live Science Zone" at At-Bristol, which will be built during the autumn of 2004. It will provide a facility for programmed events and shows, non-programmed investigative activities and the choice of passive or active exploration of current scientific topics.

The main aim of the study is to determine characteristics of what kind of techniques to use in the Live Science Zone. The objectives are to explore what has already been done at At-Bristol, and what has been done at other science centres, and to identify successful devices.
The secondary aim is mapping what sorts of topics that visitors are actually interested in debating.

The methods used in the study are deep qualitative interviews with professionals working within the field of science communication in Europe and North America, and questionnaires answered by visitors to At-Bristol.

The results show that there are some gaps between the intentions of the professionals and the opinions of the visitors, in terms of opportunities and willingness for dialogue in science centre activities. The most popular issue was Future and the most popular device was Film.

Keywords

Science centre, science communication, visitor studies, contemporary science, current science, public understanding of science, public understanding of current research, dialogue model, Citizen Science, Live Science Zone, At-Bristol, interviews, questionnaires.

1. Introduction

In this chapter the background of At-Bristol Science Centre and its activities will be presented. The aim and objectives of this study will also be described. Furthermore, this chapter also contains previous studies made in science centres, and a theoretical background which explains the importance of science in general and contemporary science in particular, and science centres as a part of our society of today.

1.1. About At-Bristol

According to the At-Bristol Science website (2004), At-Bristol Science Centre is a place of discovery and surprise, a place where education, exploration and sheer delight go hand in hand with an unforgettable day out. It is an immense £97 million project, being the core of a £450 million urban rejuvenation scheme, covering 11 acres at the heart of Bristol's Harbourside area. The centre opened in July 2000 and it is situated in the city of Bristol in the southern part of the United Kingdom (UK).At-Bristol consists of 4 different parts, Explore-at-Bristol, Wildwalk-at-Bristol, the Orange Imaginarium and the IMAX® Theatre.

Explore-At-Bristol is the first of its kind - A true 21st century science centre combining the best of hands-on activities with the very latest multi-media techniques. In Explore-At-Bristol science is brought alive through stunning visuals and over 170 interactive experiences. Visits are opportunities for focusing on developing skills as much as concepts. The exhibitions encourage students to ask questions, observe what happens, look for patterns, predict events and communicate their findings. In Explore there are 4 themes; "Your Amazing Brain", "Move it", "Curiosity Zone" and "Get Connected".

Wildwalk-at-Bristol is the first of its kind in the world and offers a new balanced perspective on the natural world. Wildwalk lets you look at these small creatures and many other forms of life in a totally new way. From simple beginnings, to the complexity of life today, Wildwalk immerses you on a journey through a rich world of live plants and animals, with stunning images and sounds. Pupils are encouraged to observe, explore and investigate. They can come face-to-face with pond life, use a camera to watch a spider spinning its web, and walk through a tropical forest with free-flying birds and butterflies. Wildwalk consists of 5 themes; "Simple Beginnings", "Botanical House", "Animals on Land", "Living Planet" and "People and the Planet".

The Orange Imaginarium is a 100 seat planetarium where you can take a trip to the stars beneath an immersive domed screen. You can take a dazzling journey from the origins of the universe to the mysteries of time, as well as be taken on a tour of the starry night sky as seen from Bristol

The IMAX® Theatre-At-Bristol makes you part of the on-screen action. Images of unsurpassed beauty, clarity and impact, enhanced by state-of-the-art sound system are projected onto the

biggest cinema screen in the South West of the UK. The screen is a massive 21 metres wide and 15 metres tall and. Because the screen is so large, it fills your peripheral vision giving the impression that you are right in the middle of the action itself. The IMAX Theatre screens shows in both 3D and 2D.

At-Bristol's vision is to increase personal interest in science and the environment, technology, nature and the Arts through visualisations and simulations of the world around us. The centre provides open access to all combining hands-on experiences, exploration and education. At-Bristol Science centre emphasizes that it is committed to the pursuit of excellence, demonstrating best practice to promote a better understanding of how the world works, and by doing so, provides an informal and independent learning environment.

1.2. Acknowledgements

I would like to thank my supervisors Catherine Aldridge and Lars Broman for guidance, support and getting me on the right track when planning my investigation.

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1.3. Background: why and how was the project chosen?

Science and science-based technologies occupy a central place in our society of today. A public awareness of Science is therefore crucial for the maintenance of a democratic society. For this to become a reality, forums for dialogue between the general public and scientists working in a variety of fields must be attended to.

The public should have a chance to form their own opinions and to debate different issues of their concern. Science centres can be useful tools in this ever-ongoing process. With the use of different media within the science centre environment, a broader awareness of, and thereby hopefully also a deeper understanding of, contemporary science and scientific processes can be brought about. With this in mind, it would be of great interest and importance to investigate possible ways of action for science centres to create mechanisms for the public to engage in dialogue.

The project was chosen after consultations with the Director of Education at At-Bristol Science Centre, Catherine Aldridge.

1.3.1. The Citizen Science Program at At-Bristol

Citizen Science at At-Bristol is a program funded by the Wellcome Trust, as part of their "Engaging Science" grants programme. (At-Bristol, 2002) The project is running over 3 years. The main aim of Citizen Science aim is to engage young people and teachers in biomedical science issues. Citizen Science tries to encourage young people to get thinking and talking about these issues. Different approaches and activities have been tried out. The techniques found to be effective will be shared with teachers and science centre staff across the UK through a series of professional development days, related publications and web-based resources.

Through evaluations of previous science and society programmes run by At-Bristol, five processes have been identified. These five processes are at work during a successful activity. Firstly, young people have to discover the many different facets of an issue. What are the scientific facts? Who does the issue affect; how and why? What are the different stakeholders' views and opinions? What are the risks involved?
Secondly, there is a discuss process which seems to be important for making sense of the information obtained in the "discover" phase. Different ways of considering the issue are talked through. Thirdly, there is a decision process; what different voting tools can assist young people in making decisions about these issues? Fourthly, ways of increasing student's confidence in speaking, writing and otherwise express their opinions and concerns, once they have formulated their viewpoint, are to be found. Fifthly, after the actual activity, it is important to identify routes for progression. How can young people move on to the next stage, by finding out more information, engaging others in the debate or taking action if they believe change is necessary? (Aldridge, 2002)

1.3.2. The Live Science Zone Project

The Live Science Zone in the Explore building in At-Bristol Science Centre, will be built during the autumn of 2004. It will provide a new focus to science learning. It will consist of three areas; Live Science Studio, Meet the Expert and The Science Café. The Live Science Zone will provide a facility for programmed events and shows, non-programmed investigative activities and the choice of passive or active exploration of current scientific topics. It will both ask the visitor what they think about science and invite them to explore science through various interactions with people, products and processes.

The Live Science Zone will be a multi-faceted, multi-layered interpretation space. It will allow for a complex interplay between visitors, experts, contemporary, cutting edge scientific knowledge and the impacts science has on society.

The arena will have different modes. It can be used for live performances, and when it assumes its "default" mode the content will be delivered through a range of mediums to engage and interact with the visitor, continuing the debate.

With live interpretation as its main goal, the area will have layered interpretation delivery mechanisms ranging from scientific experts, education specialists, demonstrators and theatrical performances, to the latest technology systems. The vision for the arena is that it will be buzzing with constant activity, whether it is through human engagement between explainer and visitor, or between visitor and visitor or between large screen delivery of evocative imagery and information.

The Science Café part will be focused on the older visitor. It will offer opportunities to voice opinions through comment boards or electronic message systems. They will also be able to explore and research current science issues and science news on the internet. The Science Café will also have the use as an orientation area, providing the visitor with planning information for their visit.

Meet the Expert will be a presenter lead area, using informal discussions and small tabletop demonstrations by external participants. Presentations will involve materials provided by experts including science equipment, posters, images etc. The presenter will deliver small demonstrations, activities and competitions. The Meet the Expert area will also include prototype beta testing of new technologies, which may be either computer based or hands-on.

The Live Science Studio will be focused on presenter lead shows and workshops. The Studio will address different media and will include opportunities to explore audiovisual communication such as production of film and music, live web casts etc. The Studio will also occasionally be used as a theatre.

The Live Science Zone's purpose is to create a dynamic, changing environment for visitors. Every time they visit, they will see something new or different. The content will reflect science in the news, so flexibility will be the key. (Cathery & Aldridge, 2004)

1.4. Aim of the project

The main aim of the project is to determine characteristics of what kind of techniques to use in the “Live Science” areas in At-Bristol. The objective is to explore what has already been done at At-Bristol, and what has been done at other science centres. Another objective is to identify what kind of devices turned out to be successful or not.

The secondary aim is mapping what sorts of topics that visitors are actually interested in debating.

1.5. Previous knowledge, previous studies.

1.5.1. The Naked Science events at the Dana Centre, London

Naked Science was a pilot series of science dialogue events that took place over a period of 18 months between August 2003 and February 2004. *Naked Science* was financed by the Wellcome Trust and run by the Science Museum in London with the goal of bringing forward this knowledge into the Science Museum's new events space, the Dana Centre, which opened in November 2003 (Gammon, 2004).
Naked Science and the Dana Centre have a target audience of independent adults aged 18 – 45. It is this audience who have been the subject of extensive research through focus groups, interviews and questionnaires looking at the audience's attitudes, preconceptions, motivations and barriers to engagement in contemporary science dialogue. All 16 events were also individually evaluated as part of an iterative process that enabled the series to develop through an increasing understanding of the audience and events over the 18-month period. (ibid.).

Consultation with the audience showed that the ambition of engaging audiences in a dialogue on contemporary science issues will inevitably have to tackle the preconceptions and prejudices of this target audience. Most notably, the target audience overwhelmingly expressed a cynical attitude towards contemporary science and scientists. Whether from an arts or science background the audience felt this distrust about both the development of contemporary science and how this is articulated to the public. Many also felt a more personal feeling of powerlessness: *'contemporary science is progressing independently and nothing I can say or do will change that" (independent adult in consultation).* Clearly these emotional barriers affect if and how the audience engages with contemporary science issues (Gammon, 2004).

Knowing the potential difficulty of engaging the Dana Centre target audience in a dialogue about contemporary science issues, it becomes interesting to explore what positive factors about an event might encourage their engagement (ibid.).

Whilst the audience may fear the prospect of complicated content that excludes their involvement, it was discovered that our audience feel more able to approach a topic that is outside their field of expertise when the content is relevant to the audience members and concrete rather than abstract. For example, speakers should have direct experience of the issues concerned and a genuine interest in the particular topic. Outside the framework of events, it was apparent that the audience as a whole did not often engage in contemporary issues. When engagement occurred, it was always in an area strongly relevant to the individuals concerned (ibid.).

The process of evaluating dialogue events poses a number of problems to the researcher. How can something that lasts for a matter of hours only, and is not numerically quantifiable, be measured? What is a measure of dialogue, and how do you know if an event has truly been successful? In answer to these questions, Naked Science events evaluators used a combination of techniques at each event to ensure that the evaluation was robust and reflected on several different aspects at one event. For example, establishing the profile of the audience may give statistical information, whilst conducting a detailed observation allows for investigation of the quantity and quality of dialogue that is taking place (Gammon, 2004).

The development of a model that describes what an effective event *should* look like proved invaluable in describing the successes and failures of each event. The model was developed as an adaptation of Abraham Maslow's work on the self-actualisation of an individual in society, and describes 4 stages in a hierarchy that must be attained for an event to be entirely successful. If all of the stages are reached, at least in part, then there will be genuine dialogue with longer lasting implications for the participants at that event. At each level, a number of measurable factors determined the event's success. These factors were then used as the basis for evaluation of an event, resulting in a qualitative judgement about specific attributes that should be changed for future events (ibid.).

Establishing whether dialogue has occurred at a particular event, and to what extent, cannot rely solely on quantitative data. Whilst that will tell how many comments have been made, or even, how many comments were made by women and so on, it cannot be used as a sole measure of true dialogue. Dialogue at events has a complex definition, and accordingly the measure of dialogue requires a network of reference points and guides. For this purpose, indicators of dialogue were developed for the Naked Science events, to provide the evaluator with a qualitative guide to measuring dialogue at an event (Gammon, 2004).

The methods used to evaluate the Naked Science events were detailed observations, questionnaires, focus groups and accompanied surfs (ibid.).

The introduction of detailed observation allowed the Dana Centre to track dialogue and take note of any barriers to the audience's engagement whilst the events were taking place (ibid.).

Questionnaires provided qualitative information about the events, and were conducted with the audience and speakers to give the broadest picture. They enabled the evaluators to uncover a broad spectrum of information such as what participants wanted to change about an event, as well as more subtle information such as what prevented the participants from engaging. Questionnaires were conducted using email, the telephone and face-to-face techniques as appropriate to the situation (ibid.).

Focus groups allowed the Dana Centre to develop an understanding of the motivations, concerns and pre-conceptions of the target audience. The focus groups were conducted before events to make possible to establish the barriers and opportunities that are already in place for engaging this audience, and after events to investigate reactions to the events themselves (Gammon, 2004).

In addition to the events themselves, online material was evaluated using accompanied surfs with the target audience. Participants were asked to visit particular pages of the website and were observed as they navigated, or browsed for particular information. Any barriers to using the web pages could then be uncovered, and initial reactions could be observed (Gammon, 2004).

Parameters that were measured in order to assemble profiling statistics of the event audience were age, gender, and ethnicity. As for the events themselves, what was evaluated were what would engender successful dialogue, in terms of qualities of content, formats for events and possible barriers or opportunities to the audience's engagement at an event (ibid.).

According to Gammon (2004), previous experience has shown that controversy can often be an effective route into dialogue about a topic. For many people, conversation naturally occurs around controversial topics, therefore making it an appropriate focus for further discussion at an event. However, during focus group work, the Dana Centre target audience proved that they are not easily shocked or wooed by so-called controversy. Whilst this audience is quick to identify the use of 'shock tactics' in the media the ultimate affect of this approach risks being off-putting rather than engaging. Rather than focussing on a shock impact, true controversy in science dialogue events will emerge by exploration of the factors below.

a) Risk – implied to society as a whole, or on a more personal level
b) Timely and newsworthy – familiarity without being tedious
c) Ethical and moral issues – provokes the audience's sense of right and wrong
d) Personal and social relevance – fundamental for motivation to contribute in debate

The format of the event itself is critical in facilitating dialogue at an event. Through experimenting with different styles of events the Dana Centre was able to develop an understanding of the effectiveness of a range of formats for presenting content to the target audience (Gammon, 2004).
One technique that was used was Performance Based events, where performance was a stimulus for discussion, containing the performance in the first half with a separate discussion making up the second half of the event. The evaluation showed that by integrating performance into the structure of the event such as with forum theatre (where actors in character, invited experts and audience members are discussing together) successful dialogue can occur. As the performance progresses, participants are able to develop their ideas and engage in discussion with one another. Another technique that was used was Talk Show style events, where a facilitator had the crucial role of encouraging discussion from the audience. Invited 'experts' were mingled with audience members to break down the traditional panel debate format and encouraged an open exchange of opinions and information. In this way, the audience become the experts as much as those who have been invited (ibid.).

Gaming and competition have also proved themselves as motivating factors that will encourage participation during events. Introducing a structured game format enabled participants to work as teams discussing the content of the event (ibid.).
The Dana Centre also used a technique called "In Conversation" where the traditional panel debate format was broken down. By asking participants to discuss in small groups rather than as a large audience body proved to be highly successful. Speakers and audience were able to approach each other informally so that there could be genuine dialogue over a sustained period of time, but with no need for a chair to intervene (Gammon, 2004).

1.5.2. The Mine Games at Science World, Vancouver

In recent years there have been conflicts over the land and its resources in the province of British Columbia, Canada. By deciding to allow limited logging in an ecologically sensitive area of the Queen Charlotte Islands, the government made a decision that angered the environmentalists. By declaring the Tatshenshini River system a protected area, the government decision precluded the development of North America's largest copper deposit. Executives of the mining industry marched in the streets, claiming that the decision had been made on political, not scientific grounds (Bradburne & Wake, 1994).

Science centres were seen as able to provide an alternative to the street as a forum for debate about the effects of science and technology. The science centre was considered by most citizens as neutral territory, where science and technology is presented without political bias. It is a place where discussion and debate can be supported by exhibits with a strong factual content. The science centre also has trained staff that can create programmes that can be used to guide discussion and debate among its visitors (ibid.).

A new gallery was developed in 1992 for Science World, a large science centre located in downtown Vancouver. This gallery was meant to be dealing with the issues of the land conflict in British Columbia. The exhibition developers had two clear alternatives to tackling the subject. On the one hand, the earth sciences could be treated as they have been in traditional science centres. Visitors would learn about geological time, the development of rocks, faulting and continental drift. As in many other science centres, geological themes could then be linked to newsworthy geological events that captured the public's interest - volcanoes and earthquakes. By treating the earth sciences as a subset of geophysics, a traditional path would be followed: separating scientific fact from social issues. (Bradburne & Wake, 1994)

The other alternative was clearly more challenging. Instead of an exhibition on the earth sciences, an idea was to look at how the geological sciences are applied in a political and economic context: in short, an exhibition on mining. This exhibition, entitled Mine Games, would deal with the issues surrounding the mining industry in our province, issues that have been increasingly the subject of heated debate in the press, on television, in parliament, and in the streets. With a mining exhibition, a debate about the future of the province could be initiated, teaching visitors to evaluate scientific positions arrayed in support of any number of competing positions. An exhibition on mining would call into question the role the science centre should play in the life of the community, suggesting that the role of the science centre is to prepare visitors to participate in the social and political life of their community (Bradburne & Wake, 1994).

According to Bradburne and Wake (1994), the chosen alternative was the mining exhibition. Unlike most science centre exhibitions the Mine Games exhibition had three unusual goals that made it different from other science and technology exhibitions. These three features are:

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

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

2. Using game strategies as a means of ensuring coherence.
In most science and technology exhibitions, exhibits are designed as stand-alone elements, each one demonstrating an isolated scientific principle or phenomenon, each one meant to work best with a single visitor. It had already been observed that these exhibits often failed to capture the interest or attention of a teenaged audience. It has already been noted that teenagers were captivated by games and game playing - chess, Risk, Battleships, and Nintendo - and that was the target audience for the Mine Games exhibition. Young people are capable of much more intellectual activity than most of our science centres provide. Secondly, teenagers are attracted to the competitive aspects of gaming. They don't mind engaging in complex thought, as exemplified by the chess, which demands memory, strategic thinking, and problem solving ability. Hence, the entire *Mine Games* exhibition was designed as a series of games.

From a design perspective, the games were developed to look like common board game that children have at home - chess or Monopoly. From an intellectual perspective, each of the games was made up of several hands-on activities linked to a computer game. The activities were deliberately made difficult, so that it could take more than an hour to solve all of the clues.

The visitor had to play all of the hands-on activities, solve all of the clues, in order to be able to play the computer game. The computer game began with a quiz, designed as a job application, and unless the information was mastered, you did not get the job. The visitor begins the Mine Games exhibition by picking up a clipboard with 'game plans' describing each of the exhibit areas. The visitor keeps track of the outcomes of hands-on challenges on the game plan, and uses these answers while playing the computer games. Significantly, by making the game plans an integral part of the exhibition experience, the visitor is free to explore the exhibition in whatever order she wants, marking the results on her game plan as she completes the exhibits. In this way the exhibits can sustain the narrative of Grizzly, their results cumulative, but the entire experience non-linear.

3. Minds-on science.
The commitment to hands-on and minds-on science lead the exhibition planners to develop exhibit approaches that encouraged visitors not only to learn science, but also to learn to think in a scientific way. Hence, a twofold strategy was developed. It was decided that throughout the exhibition the visitors would be asked to put themselves in the shoes of working scientists. Four exhibit areas were developed, one where you work as a geologist, one area where you work as a biologist, one where you work as a mining engineer and finally one area where you play the role of a metallurgical engineer.

Secondly, it was decided that in each area a series of hands-on exhibits would be developed, that were linked by a single problem. In the environmental area, for example, the visitors were told: "You are a biologist and your job to find out if there is any place in the Grizzly Valley where you could put 100 million tons of mine waste - safely." All the exhibits in this area were related to solving this problem, but it was determined that the solutions would not be neat or easy.

The games
According to Bradburne and Wake (1994), the "Mine Games" exhibition consisted of different game themes within the exhibition: High Stakes, Wild Things, Blast It!, BoulderDash!, Helter Smelter and Hotseat!.

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

The game Wild Things challenges visitors to develop an environmental plan that will accommodate the tailings that will be produced by the mine. These tailings may cause some environmental complications. Acidic water and dissolved solids may be carried into the local water supply, destroying fish habitats. The visitors are challenged to dispose of these huge quantities of tailings in an environmentally safe manner. The player discovers that there are sites that could be used for disposing of the tailings, each of which has important vegetation, wildlife or other environmental concerns. Visitors are asked to make a decision among a series of options, each of which has drawbacks (ibid.).

The game Blast It! is based on the premise that the visitor is a mining engineer for a mining company. The goal is to re-open the old mine tunnels and reach the high grade ore deep underground. The visitor must understand the use of the rock bolts to keep the loose rock from falling in and blocking mine tunnels. In the pillar game, visitors determine the minimum number of ore columns required to keep the mine from collapsing. Finally the visitor must devise a ventilation plan which to ensure that air reaches all the parts of the mineshaft. This game provides an opportunity for open-ended exploration. Unlike many science centre exhibits, which give the visitor the same response every time, the Blast It! exhibits allow visitors to experiment with more subtle engineering phenomena such as tolerances and limits (Bradburne & Wake, 1994)

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

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

Hotseat! is the exhibition's electronically-supported, multi-media interactive theatre - a forum for public debate on the role of mining in the province. When the designing of the Mine Games exhibition began, two starting points for the interactive theatre was taken. First, systems which limited the audience's answers to yes or no questions were rejected. Second, new ways to empower the visitor, to recognise their competence and to encourage their participation, in order that they can regain control, in some measure, of the information they are being asked to absorb, were sought after. Interactive theatre is one means of reaffirming the visitors' control over information. The central goal of Hotseat! is to show visitors how their knowledge of science and technology can be brought to bear on complex social issues such as the planning of a new mine. The game is co-operative and not competitive - the goal is to reach a consensus (Bradburne & Wake, 1994).

Experiences learned

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

Second, science is not an activity conducted outside society, on a distant island far from real human concerns. Science is a social practice, and a practice used to justify technical means to social and political ends. As a consequence, exhibitions on science should reveal the relationship between social and scientific issues, and how science can supply technical answers to social problems only when the issues are formulated and resolved socially and politically. Visitors seemed to have no trouble accepting the fiction on which the Mine Games exhibition was based - and of recognising its relevance to very real issues in the province's life - jobs, the environment, native rights. They seemed prepared to accept the challenge of putting scientific issues into the context of a wider discussion of possible futures for the town of Grizzly - and for the province of British Columbia (Bradburne & Wake, 1994).

Finally, science museums are not merely extensions of the school, nor are they only showcases for the proven results of past scientific investigation. It is places where new competences are passed on, and new understandings evolved. Armed with competence, information and understanding, the science centre visitor can thereby play a greater role in society, and in some measure be said to be a better citizen. The Mine Games exhibition puts the visitor in the centre of social debate on science and technology - the visitors seem ready, willing, and able, to take that responsibility. In putting an emphasis on the complex relationship between scientific argument and social debate, the Mine Games exhibition puts the science centre at the heart of the democratic process, and creates a new role for the science centre in the coming decades (ibid.).

1.5.3. Feedback on the Wildwalk Live Science Zone at At-Bristol Science Centre

A survey was conducted at At-Bristol Science Centre in May 2004, where floor staff, so called explainers, were asked to share their thoughts and give feedback on the current "Live Science Zone" in Wildwalk. 12 explainers contributed to the survey. The explainers were consulted in order to form a picture of what has worked well and less well in this area. The survey was carried out with the aim of getting some ideas to use in the development of the Explore Live Science Zone (Penny, 2004).

What has worked well in the Wildwalk Live Science Zone is that there is a chance for parents, children and staff to interact and learn and share knowledge. The space is flexible with a layout that is accessible for various target groups such as disabled, small children and the elderly. The visitors seem to find the "Live Science Zone" relaxing with an opportunity to investigate items themselves – a midway break. There are good technology links, cameras and big screens. There is also a chance to look at various themed exhibits in more depth and also get some hands-on experience (ibid.).

What have worked less well in the Live Science Zone is that the lighting is insufficient and needs to be more variable. Noise from neighbouring exhibitions must be reduced. Something that also could be improved is signage (ibid.).

The explainers were also asked to leave some suggestions that would make the Explore Live Science Zone exciting and engaging for the visitors. What was mentioned was that there should be a variety of things going on over a period of time. The explainers also were of the opinion that there should be a lot of hands-on activities. There should also be an opportunity to take material home. The surroundings should be appealing and colourful (Penny, 2004).

1.6. Theoretical background.

1.6.1. Science finds its way to the public

The tradition of popular lectures can be traced back to the seventeenth-century public lectures and demonstrations of physics and chemistry experiments (Fehlhammer, 1997). The prophet of public funding of science was Francis Bacon. He expressed the idea that science would contribute many practical benefits to society in general. In his fictional work "New Atlantis" written in 1624, Bacon envisioned a utopian society that supported systematic scientific research to unlock the secrets of nature and systematic applications of this knowledge to produce practical benefits. (Derry, 1999)

By the middle of the 18th century, there was a broad interest in natural curiosities amongst a public audience that would not otherwise have had access to the private cabinets of princes or royal societies. The evolution of cabinets into museums was part of the long winding road of widening the audience for nature (p32, Stewart, 2004).
The public museum, acquired its modern form during the late 18th and early 19th centuries. According to Bennett (1995), the process of its formation was as complex as it was protracted, involving, most obviously and immediately, a transformation of the practices of earlier collecting institutions and the creative adaptation of aspects of other institutions – the international exhibition and the department store, for example, which developed alongside the museum.

However, the museum's formation – whether understood as a developmental process or as an achieved form – cannot be adequately understood unless viewed in the light of a more general set of developments through which culture, in coming to be thought of as useful for governing, was fashioned as a vehicle for the exercise of new forms of power. The museum provided its visitors with a set of resources through which they might actively insert themselves within a particular vision of history by fashioning themselves to contribute to its development (ibid.).

According to MacDonald (2002) 19th century museums were regarded as exemplars of analytical techniques and as useful for scientific research, but also as important sites for the legitimisation of scientific results. Visibility to "the public" came to be crucial as evidence of transparency and objectivity. Museums of science became important spaces for this public presentation and therefore validation of objectivity and science.
During the 20th century, science increasingly became bureaucratised and professionalized. The validation of science became a more specialised process carried out largely outside the public domain. As museums no longer had the same role as validators of scientific process, a new task emerged. This was to inform the public about science, a task that, as science came to be regarded

as increasingly complex and mysterious, was seen to require not just "showing and telling", but more extensive processes of "interpretation". (ibid)

Karl Popper (1989), stresses that truth is manifest. Truth may perhaps be veiled, but it may reveal itself. And if it does not reveal itself, it may be revealed by us. Removing the veil may not be easy, but once the naked truth stands revealed before our eyes, we have the power to see it, to distinguish it from falsehood, and to know that it is truth. The birth of modern science and technology was inspired by this optimistic epistemology whose main spokesmen were Bacon and Descartes. They taught that there was no need for any man to appeal to authority in matters of truth because each man carried the sources of knowledge in himself; either in his power of sense-perception which he may use for the careful observation of nature, or in his power of intellectual intuition which he may use to distinguish truth from falsehood by refusing to accept any idea which is not clearly and distinctly perceived by the intellect.

As stated by Bloom (1992), museums and science centres can inspire visitors to ask questions, to pursue new-found interests on their own. This may well have more long-term impact than the nuggets of information an exhibit can convey. U.K. House of Lords definition (2000) of a science centre is that it is distinguished from a science museum by having exhibits and activities but no collections. However, according to Quin (1997), mutual characteristics are that they have real objects on display, and real processes with which visitors may interact.

The first science centre is generally said to be the Exploratorium, which opened in San Francisco in 1969. Those which emerged in Britain in the 1980s (the Exploratory in Bristol 1987, Eureka! in Halifax 1987, Techniquest in Cardiff 1988) followed the same general pattern of collection-free interactive hands-on galleries. In their aim to show general scientific principles, and in their exclusion of any kind of context, these science centres became very popular and were an encouraging development for museums of science and industry in that they seemed to indicate a popular interest in science. (Macdonald, 2002)

At the Ontario Science Centre in Canada, an effort is made to "convey the excitement felt by scientists as they break through to new discovery". Techniquest in Cardiff seeks to ensure that "visitors are positively encouraged to use all their senses to explore the fascinating world of science for themselves". At At-Bristol,"the exhibitions and events provides stimulating starting points, raising questions, promoting creativity and encouraging citizenship". According to Allan (2002), science centres such as these ones unashamedly dispense with the norms of the museum by striving to develop "participatory" strategies that inspire fresh ways of thinking about science and technology. Moreover, they open up new possibilities for social inclusion and lifelong learning.

1.6.2. Science and Society – and the Dialogue between them

A common element in all forms of science considered as a social activity, is communication, Derry (1999) declares. A discovery or theory doesn't become incorporated into science until it is communicated to the scientific world. Science and technology gives us power but not wisdom. Any tool can be used for good or for ill, and only we, as individuals and as a society, can choose (ibid). However, in an evolving global society, decisions can no longer be handed down from the top. Traditional hierarchical structures are being modified. Many more players demand a role. (Bloom, 1992)

The very close interdependence of science and society first came to be generally recognized only in the second half of the 20th century. Before 1950, science was generally regarded as a thing apart. But now, in an age of nuclear power, nanotechnology, and the NASDAQ, it is not difficult to understand that science is a critically important part of economical and social development. (Durant, 2004)

According to Sismondo (2004) scientific facts and technological artefacts can have substantial impacts on the material and social world – that is the source of much of the interest in them. As such, we can say that science and technology contribute to the construction of many environments.

Science also shapes policy. Governmental actions are increasingly accountable to scientific evidence. Almost no action can be undertaken unless some chain can be made that is supported by a study, whether it is in areas of health, economy, environment or defence. Scientific studies, then, have at least some effect on public policies, which have at least some effect on the shapes of the material and social world. Science, as well as technology, then, contributes to the construction of our environments (ibid.).

Many policy decisions do have a science dimension. Decision are made at various levels – from local to national – about waste disposal, energy policy, genetic engineering, emissions of carbon dioxide, and so on. These are of broad social interest and involve a science dimension, so called socio-scientific issues. The democratic argument for promoting public understanding of science focuses on the understandings needed to participate in the debates surrounding such issues and in the decision-making process itself. (Driver et al, 1996)

Science does not exist in a social and cultural "vacuum". Most obviously, the technological products of scientific understanding have a major effect on our daily lives. The influence of science, however, is not simply material; scientific knowledge and methods of enquiry colour our view of the world and of ourselves. We become particularly aware of the impact of science and technology on our lives when there is dispute about a specific issue, such as the purity of water supplies, the disposal of nuclear waste, the consequences of carbon dioxide emissions in the atmosphere, or the use of knowledge of the human genome (ibid).

Sjöberg (2000) stresses the importance of remembering that science is driven forward by people that do not distinguish much from other people. These scientists must be seen both as individuals and as citizens of a society. They take part in what can be called a research society, which is in itself part of a larger society. To understand the true soul of science, we must have some knowledge of society in general, the research society and of the scientist as an individual.

According to Sismondo (2004), the scientific illiterate are presumably less likely to support spending on science, and presumably more likely to support measures that constrain research. In addition, given the centrality of science and technology to the modern world, scientific illiteracy is a moral problem, leaving people incapable of understanding the world around them and incapable of acting rationally in that world. Therefore, many people feel that we need more "public understanding of science" and this phrase has come to stand for a movement to teach the public more science.

Sjöberg (2000) divide "scientific literacy" into three dimensions:

- The products of science, its thoughts, ideas, laws and theories.
- The processes of science, its methods and procedures.
- Science as a social institution, the foundation of economical and technological developments, and the basis for norms, ideals and ideologies.

Traditionally, school education of science has to a large extent been targeted towards science as a product.

According to Macdonald (2002) the ultimate ambition of public understanding of science programmes is often expressed in terms of enabling the public to participate more fully as citizens. In order to do so, it is regarded as vital that the public has a better understanding of science because it is assuming an ever-greater importance in the contemporary world. So making "science accessible" is seen as the route to providing "understanding" and this, in turn, as a way of enabling the public to make rational choices. Although "making accessible" might mean various things, it is often equated with making science "fun", "enjoyable", and "user-friendly". However, if citizens are to be able to evaluate science and make informed choices they need to be able to understand its potential benefits *and* risks; they need to notice its presence in their everyday lives *and* its distant and global effects which may be far less visible to them.

A study was made in 2000 by the Office of Science and Technology (OST) and the Wellcome Trust, entitled *"Science and the Public: A Review of Science Communication and Public Attitudes to Science in Britain"*. The survey found that the majority of the British population are "amazed" by the achievements of science. This is largely because they can see the benefits for themselves. However, concerns were raised over the use of science and the ability of society to control science. There was also a concern about what might go on "behind closed doors" in research institutions. But in general, scientists are respected by the British population, and are seen as making a valuable contribution to society. (OST & Wellcome Trust, 2000)

The key finding of the study has been the identification of attitudinal groups within Britain. 6 attitudinal groups were identified. *Confident Believers* are interested in science because of the benefits it brings, and have faith in the regulatory system and believe that they can influence

Government. *Technophiles* are pro-science and well-educated in science but sceptical of politicians. *Supporters* tend to be amazed by science and technology, and feel self-confident enough to cope with rapid change. They also believe that the Government has got things under control. The *Concerned* have a realistic and positive attitude to life but are sceptical of those in authority. The people of the *Not Sure* group are neither "anti-science" nor "pro-science", because of a feeling that the benefits of science are not always apparent in their daily lives. The *Not for Me* group are not particularly interested in political and topical issues or in science (ibid.).

There is a general feeling that people are somewhat alienated from the political process. In general, people who are younger, better educated, on higher incomes and in higher social grades are more positive about taking on new challenges, taking control of society an trusting those in positions of authority. (OST & Wellcome Trust, 2000) However, it is important to reach as wide a proportion of the general public as possible. Individual organisations may wish to target their activities at a particular grouping, but it is important that there should be collaboration between organisations to ensure that there is satisfactory overall coverage (ibid.)

One conclusion of the OST and Wellcome Trust study is that there is a lack of a framework within which people can access information about new science, access and judge the information and its implications. By coordinating activities, organizations with different perspectives and objectives can begin to address certain clusters with different provisions for science communication, providing a framework for a national debate. As it is, there is a skew towards more activities that provides facts about science compared with activities that highlight the ethical and policy issues raised by science. There is also a tendency for activities to be "provider driven" rather than "consumer driven". Few events are designed with the aim of actively engaging and broadening the audience. Success tends to be measured by numbers attending and quality of the experience, rather than by the impact or effect of the activity, especially in the long term (ibid.).

The Wellcome Trust and the OST believe that an "engagement model" of science communication – a two-way dialogue between specialists and non-specialists – is more appropriate than the "deficit model", which just gives people more information about science. (2000) Despite a general agreement among science communicators that the top-down model of "teaching people science" (known as the deficit model) is inappropriate, there are still many communicators who operate in this mode (ibid). While stimulating and informing an inclusive debate involves the dissemination of scientific information, it also requires the identification of "hooks" which link in with people's everyday lives and concerns – so that their attention is attracted and information retained. This will allow people to develop an awareness of the role of science in their everyday lives, and provide them with the information and confidence to contribute to national debates about science policy (ibid.).

1.6.3. Contemporary Science

> The beauty, the joy, and the frustration of science; is that it is an endless frontier because it builds in information that is gathered constantly. Then, more experiments are done and more information is gathered. You have another opportunity to pull from the accumulated and integrated knowledge, a basic principle, a fundamental concept, but that only gives you ideas for the next iteration. Science is an endless frontier, and I do believe that the human condition can be so described as well. (p77, Colwell, 2003)

The very term "contemporary" entered the English language at the same time as the foundation of England's first public museums in the mid seventeenth century (Schaffer, 1997). Contemporary science could, according to Quin (1997), be defined as science which appears in the mass-media spotlight and so, however briefly, touches people's everyday lives. It is, by definition, framed by culture. Its context has social, economic, political and historical dimensions.

Scientific results often lead to new technologies, profoundly affecting human society in ways that can be either useful of destructive. Even in the absences of new technologies, new science can sometimes have unforeseen effects on cultural issues well beyond the scope of science itself. Increasing knowledge alone can affect the way we think about our values (Derry, 1999). Durant (2004) distinguishes between what he calls "finished" and "unfinished" science. Finished science represents the body of scientific knowledge that scientists take for granted as they go about their work, and unfinished science represents the work itself. Notoriously, finished science dominates the lives of most science teachers and students, whereas by contrast unfinished science dominates the thoughts and activities of working scientists. Clearly, the boundaries between finished and unfinished science are not fixed. It is commonplace among exponents of science and scientific method that all scientific findings – however apparently "finished" – are open in principle to challenge and revision. What is taken for granted by the scientific community at one time can come to be regarded by the same community as in need of radical revision.

Popper (1989) stresses that you may get something of scientific interest if you say; "Here are the theories which some scientists hold today. These theories demand that such and such things should be observable under such and such conditions. Let us see whether they are observable." In other words, if you select your observations with an eye on scientific problems and the general situation of science as it appears at the moment, then you may well be able to make a contribution to science.
Among the real dangers to the process of science is not the likelihood of its being completed, but such things as lack of imagination (sometimes a consequence of lack of real interest) or a misplaced faith in formalization and precision or authorization in one or another of its many forms (ibid.).

An understanding of contemporary science is of great importance. This would involve knowing about the institutional framework and processes of science, its organization into disciplines, sub-disciplines, research groups and so on, its method of funding, its system of recognition and reward. (Driver et al, 1996) However, according to Schaffer (1997) it is often complained that a problem of showing contemporary sciences is that it is hard to see what makes them visitors' contemporaries, what features of everyday life and labour are to be matched up with this or that gleaming new device. We surely also thus have to ask which aspects of any culture are relevantly contemporary to the sciences of the time and ask, too, about the mediations between these bits of culture.

1.6.4. Science Centres and Contemporary Science

Widespread scientific literacy, numeracy and technical competence are essential to our economy. These skills are also important to the individual in that they seem to increase confidence and the feeling of being in control of everyday life. Science is a very significant cultural activity and a supreme example of human creativity. Science centres and museums have a particularly important role to play in improving the understanding of the cultural significance of science. They are uniquely equipped to put science into a historical perspective and to display the achievements. (p97, Brookes, 1992)

According to U.K. House of Lords (2000) museums and science centres alike are seized of the need to respond more rapidly to newly emerging issues involving science, and all agree that formal exhibitions, with their long lead-times, is a difficult medium for doing so. The presentation of unfinished science (Durant, 2004) obliges museums to engage with their visitors in new ways. No longer can a museum or science centre pretend to "have all the answers" and no longer, either, can it presume that the role of the visitor is simply to look, to listen, and to learn. When the science is unfinished, the story must be open-ended, and the true import of what is being dealt with must remain open to question. Mayfield (2004) argues that we are moving into an era when visitors are co-authors of content, not merely the passive recipients of expert knowledge. Several museums and science centres have begun to move in this direction; producing exhibitions and programs that plainly value the visitors' input and make their opinions part of the show.

With science changing so rapidly and with so many quick response media ready to cover news at a moment's notice, it is commonly argued that museums are not best placed to present current scientific research, says Farmelo (2004). The argument goes that they should concentrate on what they arguably do best: programs about well-established science, including unique historical artefacts and lots of hands-on exhibits. Yet over the past decade, museum visitors have demonstrated an appetite for contemporary science programming in natural history museums and other types of museums. It is plain that we are now in an era in which these institutions are becoming less focused on the past, more responsive to the present, and more willing to look to the future. However, according to Bennett (2000) there is no evidence that public confidence in science has risen over the period of rapid growth of science centres. If they were meant, as they surely were, to help restore the public faith in scientific progress, and to make science a more a more attractive option to students and graduates, they have not succeeded. And it is by no means clear, Mayfield declares (p112, 2004), that an emphasis on contemporary research in its broadest sense is going to bring in the new audiences we would all like to attract.

Another critic of the science centre movement is James Bradburne, who argues that new science centres continue to be planned based on the traditional pattern of clusters of hands-on displays about science and scientific principles (the most popular display topic is physics), and existing science centres still develop installations based on the assumption that physical interaction is a

good thing, in and of itself. In Bradburne's view (1998), these traditional approaches to interactive displays share three signal weaknesses; they focus almost exclusively on principles and phenomena rather than processes, they misrepresent the nature of scientific activity, and they show science out of context—science defined 'top-down' by scientists, rather than as experienced by visitors. Even when an institution tries to put science and technology into a social context, it is science and technology that is the point—not the society. This view is something that Per-Edvin Persson (2000) reacts strongly upon. He find Bradburne's arguments being incorrect, since science centres often arrange lectures and debates, produce material on the internet, are partners in joint ventures to produce film and audiovisuals, arrange summer camps etc. In Persson's view, many of these products are there to provide a deeper understanding of processes and contexts. Furthermore, science centres do show an increasing attention to processes and society also in their exhibitions.

Bradburne compares science centres with dinosaurs on their way to extinction. In its modern form, the science centre is a creature of Second-World-War American society. Spurred by the Soviet Union's conquest of space with Sputnik, stimulated by the race to put a man on the moon, and alarmed by increasing public scepticism about the benefits of such scientific blessings as pesticides, nuclear power and genetically altered food, government and industry have supported the science centre as a means of informing the public about science and technology. Like the dinosaur, the science centre fitted into an ecological niche—fed by government and industry in the lush tropical climate of the Cold War. Of course it was assumed that, once understood, science and technology, and the interests that directed them, would be seen in a favourable light. (p121, Bradburne, 1998) However, now at the threshold of the 21st century, with the Soviet threat collapsed and the Cold War behind us, the traditional mission of the science centre is no longer relevant. New challenges face society, and understanding science and technology, in and of itself, does not seem to hold out the key to meeting these challenges (ibid.). However, while there is a need to provide more context and background, and to pay attention to the surrounding society, the main product of a science centre is still to highlight phenomena and scientific principles (Persson, 2000).There are phenomena that remain fairly constant, and where the basic concepts are changing slowly. There is still a public interest in these basic phenomena, and some visitors come to science centres to refresh their knowledge about these basic concepts.

According to Bradburne (1998) an institution can only survive if it provides, at a competitive price, a product or service unavailable elsewhere. There has to be 'experiences'—for example the opportunity to study an artefact, or a demonstration, or making a dam in running water—which cannot be replaced by new media. The power of a live demonstration cannot be replaced by a talking head on a screen, whatever the inherent interest of the subject. However, hands-on interaction is not always enough to sustain engagement and the science centre is no longer the only mechanism to offer informal learning opportunities. It must now compete for the attention of its visitors with other informal learning resources—notably CD-ROMs, video games and television—which are often far less expensive, and better still, available at home on the Internet. But according to Persson (2000), science centres has an advantage that the different kinds of electronic media cannot compete with; people come to science centres because it is a social event.

In Bradburne's (1998) view, another impediment for the success of science centres is the fact that institutions such as science centres are expensive to create as capital projects, expensive to maintain with a professional staff, and, given the high costs of exhibit development, expensive to change. Lacking a permanent collection of unique artefacts with which to attract repeat visitors, the science centre is at risk when it cannot change quickly enough to meet the demands of its users. The science centre is in Bradburne's opinion faltering because, on the one hand, unlike the museum, it offers little that is truly local (nearly everything which can be found in one science centre can be found in almost every other one, or on the Internet) and on the other, the historic mission of the science centre no longer addresses the needs of the world we are in the process of creating. Persson (2000) stresses that it is hardly important to visitors if the same phenomena is highlighted in the same way at another science centre as in their local science centre. The main reason they go to a science centre locally is that it provide an opportunity to do experiments and to experience science at work – to see or experience the "real thing" in much the same way as you go to a museum to see the "real object".

So how should a science centre as a platform for learning and discovery behave to gain long-term success in the society of today? Bradburne argues that the new learning platforms must stress the acquisition of new skills, not just information. These skills are largely shared by art, science and technology alike—creativity, collaboration, abstraction, thinking in terms of systems. The common ground provided by putting the accent on skills has the effect of making less important the distinctions formerly made according to content—science, ethnology, history, fine arts. Of course information is still indispensable, but it must be linked to the skills of finding, using and appropriating that information. (p132, Bradburne, 1998) The new learning platforms must draw lessons from the library, not only the theme park, and thereby provide experiences which satisfy the full range of interests and expectations. The new learning platform must establish its base in the community, work with its local community to expand that base, and encourage repeat visits, real or virtual (ibid). And according to Farmelo (p6, 2004) , if science museums really want to present current science, they have no choice but to collaborate much more effectively with other institutions that are "content-rich" in contemporary science.

A new learning platform must place its emphasis on what is unique to its specific locality, and on what cannot be found or done somewhere else. It must set a premium on local culture, local practices, and local experience. It must be firmly rooted in its local conditions, and use them to build a community commitment to the institution (p133, Bradburne, 1998). Most science museums and science centres could do much more to seize opportunities to focus on local engineering projects and science research being done in their area by local universities and companies. In this way, a museum could aspire to be the "science hub" of their community; the place where scientists can meet informally with local people while museums provide the communication skills necessary for mutual reward. (p115, Mayfield, 2004)

The public that visits museums is not, in general, looking to learn any specific information. Family visitors say they want a pleasant, entertaining afternoon together. Individual communities want to see celebrations of science and technology related to their own culture and history. There is however one overriding demand: to explain how the subject directly relates to the visitor's own life, and what the visitor already knows and is interested in (p44, Friedman, 2000). Hence, knowledge comes to be regarded not so much as a body of accumulated truths, but as a matter of information from which consumers choose that which they want or need: it is turned into a matter

of "pick and mix" (p188, Macdonald, 2002). This knowledge is somewhat limited by the fact that it is localized to matters of individual choice; as such it is not capable of being transferable to other persons and fields. There are many exhibits whose aim is not to provide a kind of generalisable knowledge that can be taken away and applied elsewhere, but which relates to individual experience and subjectivity (ibid.). Thus, the more relevant subjects become to visitors' own lives, the more of an "expert" the visitor becomes in the subject, and the more confident they will be to contribute themselves (Mazda, 2004). Furthermore, as Sjöberg (2000) stresses, learning is not only a purely intellectual and cognitive process. Another side of learning that is just as important is that learning is an emotive or affective process. You only learn the things that you actually are interested in learning.

Quin argues (p81f, 1997) that when viewing science as a part of culture and the public as citizens with whom to enter into dialogue, we should no longer avoid controversial issues but, rather, be prepared to give up objectivity and admit to having a viewpoint. We must also exploit the communication media best suited to such meeting places and such forms of dialogue. Mazda (2004) argues that the public, who rarely have any cause to be involved firsthand in research, are often made aware of scientific research only when it is expressed in terms of controversy. Controversy is a useful way for museums to introduce social issues and raise visitors' awareness of the political, economic, and environmental angles to current scientific debates. Ignoring controversy would inaccurately represent issues in contemporary science and technology, as it would imply that there is no room for future changes of direction.

At a moment of controversy or conflict, people with incomplete knowledge or information will choose to trust the institutions in their community that have created bonds through previous interaction and open dialogue. The goal of any Public Understanding of research (PUR) activities, Lewenstein and Bonney (2004) argues, should be to create opportunities for experts and lay audiences to learn from each other – partly so that lay audiences can learn the science but also very much so that researchers will understand the public's concerns about their work and may even take those concerns into account as they direct their research projects.

When science and society cross swords, it is often over the question of risk. Risk, as it is widely understood, has at least two dimensions: the chance of something happening; and the seriousness of the consequences if it does. It is often the case with new phenomena or theories that scientists are uncertain about both these things, and also uncertain about the chains of cause and effect supposedly at work (p34, U.K. House of Lords, 2000). According to Mayfield (2004), many of the most popular themes in topical research will be the ones that audiences find controversial. What museums have to do is to find ways of enabling their users to engage in controversy that give them more than they could derive from other media. One of the key challenges is to provide programs that have a life beyond their duration rather than to organize events that are simply "talking shops". However, according to Durant (2004) this should not be too difficult, because partiality, provisionally, and controversy are frequently the stuff of high drama. So-called "unfinished" science presents multiple opportunities to science communicators of all kinds – including exhibitors – precisely because the need to engage with the research process puts "the thrill of the chase" itself under the spotlight.

But it is not surprising that visitors almost always view an exhibition on controversy to be biased. If the topic is truly controversial, visitors will colour their perception of the exhibition by their

personal views. But perhaps in some instances we can afford to be more courageous in the way that we tackle controversy. Rather than attempting to be neutral or attempting to be perceived by visitors as being neutral, we should clearly take one point of view, sometimes in a challenging and provocative way. (p141, Mazda, 2004)

Mazda (2004) has experienced that dialogue and debate are especially useful in dealing with controversy. Issues surrounding controversy are often abstract and complex and are difficult to cover using traditional exhibition media, such as interactives or object-based display. Museums must, Ucko (p216, 2004) argues, present current research in ways that differ from, complement, and expand on other information sources. Providing "added value" is especially important in the content realm since the Web offers many sites geared toward translating new scientific developments for general audiences. There are many ways of providing this "added value". Some museums have, according to Einsiedel & Einsiedel (2004), brought groups of people to the field on expeditions and field studies. These are considered interactive to the extent that learners learn on-site and participate in the research activity. Friedman (2000) suggests random access and layered audio tours, live tours, theatrical presentations on the exhibition floor to be useful methods. They all allow more complex, multiple verbal perspectives to be offered and multiple agendas to be addressed. Furthermore, many exhibit developers hold that what counts is not what intended by a design, or even what an exhibition presents, but only what the visitors actually takes away from the experience. If taking that literally; taking materials home from a museum visit can be not only a valuable vehicle for continued interest in the science content but, even more so, a sign of interest in experimentation, Storksdieck and Falk reason (2004).

Another way for the public to understand research in science is to observe scientists as they conduct research in the museum itself. (Einsiedel & Einsiedel, 2004) However, if a scientist is to be a content source, it must be on the basis of the importance of her work, potential audience interest in the topic, and a willingness to participate. Furthermore, if the scientist is to play a more visible role, other requirements become paramount. Scientific expertise may not translate into communication skills to lay audiences without training – or at all. (Ucko, 2004)

Einsiedel & Einsiedel is also talking about an engagement continuum (p74ff, 2004), along which a museum's activities can be located. To which degree is the activity interactive or passive? On the interactive side of the continuum, the public understanding of research occurs in a social, economic, political, and environmental context of society. In this context, the learners are regarded as experts in their own right, adults whose experiences, perceptions, beliefs, and concerns are valued and recognized as another valid way of knowing. The passive side of the continuum can be suggestive of the traditional role of museums where content – whether it was artefacts, historical, artistic, or scientific knowledge – was presented without representations of context. Activities on the interactive side of the engagement continuum are learner centred, collaborative, and inquiry based. Inquiry learning involves understanding knowledge in the context of authentic and personally relevant problems and meaningful tasks. The public's understanding of research can be enhanced through workshops and conferences, as those forums tend to be more interactive. Participants often have opportunities to engage in dialogue with one another as well as with the researchers and workshop facilitators.

2. Methods

This chapter will describe the methods used when conducting this study. The methods used are deep-qualitative interviews and questionnaires. In addition to that, to get a proper background for the thesis, literature about science centres, museology and contemporary science has also been studied.

2.1. Validity and Reliability

According to Hein (1998) Validity refers to the extent to which information gathered is about the phenomena in question, that is whether the information gathered on a survey actually reflects respondents' views on the subject.

Reliability refers to the repeatability of a measurement or data collection method, that is whether a comparable result would be reached if the same activity is carried out. (ibid.)

2.2. Front-end evaluation

According to Kelman (1995), evaluation has traditionally not received much attention in museum, science centre and gallery education in Britain, partly because of the difficulty of defining the outcomes of a programme and partly because of the resources in time and money required to do the work properly.
The purpose of evaluation is to inform current and future planning and to judge the effects of activities. Unlike research it is not concerned with developing theory or testing hypotheses. An important function of evaluation is to help define areas where new learning can be built on existing knowledge and skills. This is done by front end analysis. Front end analysis should also ideally involve pilot testing of the programme before deciding on the final form of the learning experiences (ibid.). Front-end studies, which focus on visitors' interests and understandings, can be seen as the beginning of a continuing conversation among museum staff and advisors, visitors, and the subject matter. (http://www.astc.org/resource/visitors/index.htm)

According to Collins (2004), all research accumulated before the actual building of a final exhibition is considered front-end. This includes focus groups, staff interviews, observational studies on extent similar type exhibits, topical surveys and prototyping.
When planning the construction of the Live Science Zone, an area of the science centre that will be dedicated to contemporary science issues, At-Bristol wanted to know what experiences professionals who are working within the field of science communication had.

Furthermore, At-Bristol wanted to know what contemporary science issues the visitors to At-Bristol were interested in, and what techniques they would like the science centre to use when addressing these issues.

2.2.1. Deep qualitative interviews

Kvale stresses that to use the interview as a research method is nothing strange; an interview is a dialogue with a structure and a special purpose. (1997) In an interview dialogue, the researcher is listening to what the human in focus is telling about her world, what kind of opinions and remarks she expresses with her own words. The researcher gets to know the interviewee's own view upon her own working situation (ibid.).

The qualitative interview is of a non-standardized character. This means that the researcher has to develop and follow up on what can be appropriate for the situation and for the main aim of the investigation study. (Starrin & Renck, 1996)
Most kinds of qualitative interviews require some form of interview guide, which is distinguished from a structured standardised question sheet. The researcher should retrieve information on all the themes mentioned in the interview guide, but how it is done and in which order is unimportant (ibid.).

According to António Barbosa da Silva (1996), a deep qualitative interview requires that the researcher has enough empathy that she can imagine the world view of the interviewed person, so that an authentic dialogue – in attitude as well as verbally – can be created, through which important and relevant information can evolve.
Furthermore, the researcher needs good background knowledge in the specific issue in focus, to be able to ask the right questions. This knowledge is an important part of the reference frame that is required for an authentic interview dialogue as well as interpretation of the information that is found (ibid.).

The aim of qualitative interviews is to discover and identify not known or uncertainly known phenomena, characteristics or connotations. It is therefore a method for investigation, to understand the form and/or qualities of something (Starrin & Renck, 1996).

19 deep qualitative interviews were carried out with professionals within the field of science communication. These professionals work in Austria, Canada, Denmark, Finland, The Netherlands, Sweden, United Kingdom and USA.

The interviewed professionals are not a full scale sample, but a selection of the expertise working within the field of science communication in general, and with science centres in particular. The professionals were chosen after reading current literature on the issue of public understanding of science, attending seminars on the issue, searching the web site of ECSITE, the European cooperation organisation of science centres and museums. Consultations with Catherine Aldridge, At-Bristol Science Centre was also made. A complete list of the professionals that took part in this study can be found in the Appendices.

The interviews were conducted between 19th of May 2004 and 23rd of June 2004. The interviews took place either through a meeting, or over telephone when required due to geographical distances between the two parties. The interviews lasted on average 35-40 minutes.

2.2.2. Questionnaires

The questionnaire was conducted in order to get information and opinions from the visitors on what contemporary science issues they would like At-Bristol to address and which techniques they would like At-Bristol to use when addressing these issues. Questions were drafted and approved by At-Bristol and the local supervisors before they were administered.
The questionnaire was given out to visitors in the Explore building of At-Bristol Science Centre, between 10th of June and 24th of June 2004. 79 questionnaires were retrieved.
The questionnaire contained mostly multiple choice questions, but also gave the visitors the opportunity to give own suggestions.

3. Results

In this chapter, I will present the most important and relevant findings from my study. The investigations that were made consisted of two parts; interviews with professionals working within the science communication field, and questionnaires answered by visitors to At-Bristol Science Centre.

3.1. Interviews with professionals

The aim of the interviews was to investigate the opinions on and experiences with working with contemporary science issues in science centre environments. The interviews consisted on mainly three different elements. The major themes involved were: dialogue, devices, and audiences. Within these themes a number of questions were asked.

3.1.1. Dialogue

The importance of contemporary issues in science centres

The professionals were asked whether they thought issues regarding contemporary science should be addressed in science centres, in which they all agreed. However, the reasons for this varied.

The majority of the professionals said that contemporary science issues are of great importance to address because of the guidance it would give for the public, not only particularly in science issues, but in order for them to be able to make more informed choices in issues that have a direct relevance or indirect influence on their lives.

> *Although not everybody will grow up to be a future scientist, everybody will need to have…everybody will be a citizen in society, which will be increasingly technological….*

> *A society which is increasingly underpinned by science…and everybody needs to be able to vote intelligently, make intelligently personal decisions on a day-to-day basis. And the conclusion is we need to have a science literate population.*

By addressing contemporary issues in a science centre environment, background information can be provided in order to achieve a sufficient level of scientific literacy amongst the public. The scientific community also have a responsibility to keep the citizens informed about new developments and the current agenda of science. The universities research is funded by the public, therefore the citizens has a right to know what their tax money is being spent on. In addition to that, it is of good value for the scientists to hear what people have to say about research; by engaging in discussion and dialogue the work of scientists could be considerably enhanced. As for the citizens, they have to have been enabled to understand science as a process. And understanding science as a process is to understand that it is actually about dialogue.

There is also the aspect of putting science within its historical context and to emphasize the process and developments. In the science centre where one of the professionals in this study currently works, research was done with the visitors of the centre. The visitors' research very clearly indicated that the centre was expected by the audience to cover the past, the present, as well as the future of science. Another interviewee phrased it like this:

> *If you don't present anything about contemporary science then you give people the wrong impression of what science is like. You leave people with the impression that all of the significant developments of science are in the past. And that is simply a matter of describing what we know, whereas really, science is an ongoing process of exploration, of discovery.*

Another professional stress that science is ever evolving, and if only science that is "finished" is presented, then people are not really being told about the whole enterprise of what science is. Furthermore, it is of great importance to eliminate misunderstanding and disillusions that science should be equal to the truth. Scientific knowledge is based on temporary conclusions, which could be revised whenever new knowledge is added. When encouraging a dialogue on contemporary science issues in science centres, the process of scientific investigation could be better understood by the public.

The dialogue model

What constitutes dialogue? Is there a special model for what dialogue is? These questions were raised during the interviews. Not all participants thought that there was a dialogue model at the moment; others thought the phrase it self has become somewhat of a cliché. However, everyone thought that there was a lot still to be done to achieve a dialogue model that would work in reality.

> *Dialogue is a very broad term, and I don't think that it has been fixed yet.*

The dialogue model, in contrast to the deficit model, could be seen as an attempt to find an alternative way of characterizing the relationship between science and the public. In the deficit model, the essence of this relationship is that scientists have the knowledge, whilst citizens are ignorant. A one-way communication from the former to the latter is occurring. But with the dialogue model, a two-way communication is encouraged, where it isn't just the scientists that bring their expertise, but where the citizens also contribute with their general knowledge and a range of other interests and concerns, that are relevant for the outcome. When engaging in dialogue, the two parties could arrive at a better mutual understanding.

> *The dialogue is a way to shorten the distance between the citizens and scientists. There are at least two groups involved, citizens and scientists, in scientific research and in society as a whole in general, which are quite distant from each other. And the dialogue is a way to understand each other and to find common links between these two groups, which maybe at first sight are not so obvious.*

Dialogue could also be about finding effective ways for visitors to express their opinion about particular issues.

> *Anything that encourage people to want to talk about a subject, anything that is thought-provoking, anything that is a bit controversial or anything that asks of their opinions. And things that let them see what other opinions are…*

For this to happen, good quality, reliable, well-balanced information is required. The dialogue model is a way which the public could hold to account the politicians, the scientists, the campaigners, and the other stakeholders in the issue.
With the dialogue model we move into

> *…a model where it is very much more of a level playing field, Where the public dictate the agenda much more than they used to. They can never dictate it completely, but very often they are not aware of or have any idea of what the issues are. I would say that the word dialogue is about giving the public much more say, putting them on a much more even footing, and putting the scientists in a listening mode, much more than they were before.*

There have been phases in the history of science communication within science centres, where the communication has been on a top-down basis. Today with the dialogue model centres are trying to make the communication less patronizing. The elements of the scientist or facilitator being the expert are taken away. They can still be a resource, but are present to spur conversation

rather than to tell people something. Hence, the motivation of the communication is different in the dialogue model.The dialogue model could be interpreted in many different ways. Some interviewees stressed that the dialogue model is really context-dependent. You have to take under consideration who your intended audience is, that would be engaged in this dialogue.

> *Well, for it to be a dialogue, you have to have a sense of who is discussing what with whom, and the means to discuss, so the dialogue model…. What would that mean? Is it a dialogue if you have a lecture by a scientist and questions afterwards? It seems to me that the dialogue model would involve science centres addressing seriously matters and try to form relations between science and the scientists, policy makers and the ones who visits science centres.*

It is also a matter of listening to what is of interest to the visitors, not simply giving them what we think they need. This could be used as a sort of formative evaluation when planning an exhibition.

> *And while planning an exhibition, you are gathering data not only from the experts with whom you are doing the exhibition, but also what the visitors are expecting from the topic.*

It is important to remember that there could be a number of different perspectives when having a dialogue. An issue could be tossed and turned, and things could be seen from many different angles. Furthermore, as the dialogue model as a concept is not yet fixed there are some challenges in finding out the way to work with dialogue in science centres.

> *Well, we are trying to find out, but we don't know yet. That is why we are trying to use as many different techniques as possible, to engage all the different people that come here. We know that people showup with completely different set of baggage with them. Things they know, things they don't know, places they've been… We are trying to suit all those different sorts of people.*

Advantages with a strengthened dialogue

If to strengthen a dialogue between science and society, what could the advantages be? The interviewees could fine several answers to this, but the majority thought that a better mutual understanding between scientists and citizens was one of the most important benefits that an increased dialogue can bring.

> *As well as giving the public access to scientists, which they don't tend to have…. And to give scientists access to the public, which is equally important.*

> *It is easier to get acceptance for research, that resources are given to research, if people understand what it is that scientists do.*

> *For the scientists to understand what kind of questions people have, what it is that people find strange, what it is that people are wondering about.*

Another powerful argument for strengthening a dialogue is that it is good for democratic reasons. The people should through dialogue be given the background knowledge so that they can make informed decisions about what is going on politically.

> *It is this notion about transforming people from being just consumers…. In order to be a full citizen, you need to have an appreciation about what is important in your society. An educated citizenry wants a better understanding of science and its processes….*

> *To build capacity for rational thinking, for critical thinking. Not just about science actually… more of an… as an approach to life… They will be able to go and vote with rational arguments….*

A dialogue could also help prevent people's knowledge base from getting distorted People tend to pick up only small bits of information. They are remembering bits and not the whole picture. An increased dialogue could, as well as bridging the gap between scientists and citizens, get people to find out things directly from the scientists rather than just believe what they watch or read in the news. The more people get involved in a longer term ongoing dialogue, the less likely they are to have the wrong perceptions of things.

Another reason for looking at encouraging a dialogue about contemporary science issues on a long-term perspective is how much it would probably economically benefit our future societies.

> *If we have this dialogue, and we reach the younger generation, then I think that on the long term, our societies will be wealthier. Because science, and research in science, is giving more wealth today than any other sector.*

To sustain a dialogue is also very much a matter of trust. If people lose trust in science, they also lose the willingness to engage in science and they will withdraw their support in it. They have to have the opportunities to be engaged as both witnesses and participants. To build up their confidence and interest, there has to be trust.

> *The public loves the products of science-based technology, but they are suspicious and worried about some aspects, of science. It is a question of linking those two things up.*

Issues to address

When addressing contemporary science issues in science centres, are there any questions that should be particularly in focus? The professionals had many thoughts on this.

The majority of the interviewees thought that what issues that should be addressed could not be said in a normative way. It is very much context-dependent, and varies from one science centre to another. Factors that influence what issues that should be presented are what the centre has done previously, or is planning to do in the future. If the institution has a mission they should act according to their mission.

> *I think that those issues are extremely local; I don't think that there are overarching issues. They are extremely local, they are related to the news, they are of people concerns and they are related to the community.*

Science centres can be seen as having some sort of responsibility towards the citizens. Hence, what should be addressed in science centres should be according to the demands of the audiences. However, in some cases the public don't know what their demands are. There are issues that people don't know about, because they have not yet been published. So part of the work for a science centre is also to introduce the public to the new developments in science.

> *I think that the emphasis should be on State of the Art, new developments that have an effect on daily lives.*

What is seen as very important is to present an overview of what the scientific community is doing. In this way, the public have a chance to get more background knowledge in what their tax money is really being spent on, and what developments that might be occurring.

A keyword that some of the interviewees mentioned, was meaningfulness. Science centres should consider topics that are relevant and thought provoking to their audiences.

> *…make it meaningful for citizens, meaningful so that they when they leave the dialogue; the exhibition, the theatre, the event or whatever form this dialogue takes, they leave with a change in their way of thinking about it, or a conformation of their ideas, but that there at least is a process going on in both groups, both scientists and citizens.*

The fields of issues that were specifically mentioned were biotechnology, information technology, nanotechnology, environmental issues. These issues are seen to be the ones that have the greatest importance for our future. Specific topics could be the sorts of issues that often come up in the news, like bio terrorism, cloning or IVF.

Issues to avoid

Are their any contemporary science issues that should not be addressed in science centres or that might be considered as being taboo? The interviewees all believed that you in principal should not avoid any issues. Many of the interviewees said that if an issue is said to be somewhat taboo or more difficult than other issues, then there are even more reasons to encourage an open dialogue about it.

> *Why is it taboo? What it is about our society that says that this cannot be discussed? Maybe it is then very important that we do break down these barriers and let it out and open.*

To avoid certain issues could lead to distrust amongst the public towards not only science centres, but towards the scientific body as a whole. People can get sceptical and they might start to think that there are some hidden reasons why science centres, scientists and politicians are not talking about it. It could be about the risks, possibilities or threats that may come along with new developments.

> *If you are trying to withhold that information from the public, eventually it is going to come out. So I think that it is better to talk about it in beforehand, and to inform people in the right way.*

A science centre could also be seen as being bias, if they choose not to cover certain issues. There are however some aspects that a science centre might have to take under consideration. One is to think about the context and the environment in which the dialogue is taking place, in terms of what is appropriate for your audience, and what type of audience you would like to be engaged in the dialogue.

Another issue to consider is that there might be issues that are difficult because of that it might offend sensible persons, or that they are not very decent. Some issues might also be hard to treat because they are very emotive or very controversial, for various reasons. The use of animals as experimental subjects in scientific research is a good example of an issue that causes strong feelings amongst some groups. Other issues that are probably equally difficult to address in science centres are issues which raise fierce religious or ethnic feelings. A science centre might then be faced with the risk of having people who are willing to use direct action and even violence to pursue their arguments. This could seriously damage the reputation of the science centre and might even be directly dangerous.

The most challenging issue

The professionals were also asked what issue they saw as being the most challenging issue to address in a science centre. The majority of the professionals thought that this is very much depending on the context. The factors that could influence how challenging it would be to address a particular issue is that different audiences would have different challenges, and all have topics that challenge them differently.

To describe the process of science and how it is administrated is seen as a very important but also very difficult issue, in which no science centre has yet succeeded, according the some of the interviewees. The efforts that are being made mostly end up with showing the results of science instead of the process of science.

> *The public's understanding about how science is done is not very good. And I often find that some of the scientists' understanding of how science is done, the process, is not particularly strong. And that becomes challenging, because that is the fundamental….. The essential of being able to have rich discussions, around other aspects.*

It is also of great importance to bear in mind that when someone has a pretty good understanding of how science is done, then their perception on and openness to a lot of issues changes. It is also difficult to address that science is a human activity, and that it therefore has inbuilt frailties.

Quite a lot of contemporary scientific research is extremely complex, mathematically and technically. And there may be some issues, that although they are scientifically important, and even significant in public, that the relevant issues are so arcane, so obscure, that it is very hard to know how to make them accessible to people. The challenge in that is to make these issues interesting and to make people want to engage in a debate around it. Because of the complexity of some issues, more background information may be required than is normally the case, in order to be able to make rational comments.
Another aspect is that contemporary science issues tend to be very fast-moving, and therefore are difficult to display, since the material easily goes out of date.

> *By its nature, contemporary science moves. So you need to find ways of displaying which allows you to go back, to add, to amend, to update.*

Within contemporary science scientists do not always yet have an agreed opinion. That could also bring challenges to the efforts a science centre is making to address contemporary science in a way that is not to confusing for the audience.

> *You can't give a unified picture. You can give a best guess and you can give probabilities and stuff, but it is not concrete.*

One constraint that could make presentations challenging is time. In the context of a museum or a science centre, standing in front of a video or a presentation for 10 minutes or so, could be seen as a long time. People will not necessarily arrive at the beginning and there is a risk that they leave before the end. So if something seems very long, they sort of skip it, either from boredom or from peer pressure.

Other aspects that are challenging are how to make an issue interesting and meaningful for the intended audience.

> *I think that everything that has a direct or obvious interest is easier than things that don't. The things that you don't necessarily feel the effects of are always harder I think, if you cannot make a human angle on a story, then it makes it harder.*

Issues that are more conceptual and do not involve things that people can see and touch tend to be harder to address.

Specific issues that were mentioned as being very challenging were pain and torture, animal experimentation, climate change, biotechnology, human health, space exploration, high-particle physics, information technology, genetics.

A balance of facts, ethics and policy

When dealing with contemporary science, there are often questions of ethical and political nature involved. The professionals were asked how they would balance these three aspects alongside scientific facts and evidence, when planning an exhibition or an event in a science centre. In this question, the opinions of the interviewees differed.

The majority of the professionals believed that the three aspects facts, ethics and policy should all be covered, but that it also depends on the context and on what particular issue you are dealing with. One particular issue may need that one of the aspects is more in focus than the others.

> *I think it is more about looking on those three sectors, and see which one provides the best way of capturing people's interest in the subject.*

This can depend on the difficulty of the issue, or what audience you are trying to reach. The main concern is to get the audience interested and engaged in the issue in the first place. The balance has to be more of what interest people and what the uses are, and the implications.

> *The difficulty is to get over the basic science. If you are putting up your agenda in a way that all you are talking about is dry facts of science, the public would be switched off. So that is one of the challenges, how do you set up the issue in such a way that it is aiming at the public?*

However, the majority of the professionals also thought that facts were the foundation to build on.

> *Curiosity and need for information needs to be satisfied first, before the lay audience would really engage into a debate about things apart from the actual subject.*

In order to be able to discuss ethical issues and policy, there is always a need for some background information.

> *They don't have to be experts, but they have to have a reliable source where they can find the relevant facts and information. There is nothing worse than discussing ethical issues or future outcomes of a technology without having the right information.*

But the three aspects tend to get all tangled up together, and may be difficult to split. In a way that could also be seen as a strength, as it could help when trying to explain the complexity of contemporary science. Contemporary science is built up from all three aspects, and they all need to be addressed.

> *I think the way to do it is to create an environment in which people can discuss things openly. Within that, the different issues are involved, for instance: What constitutes evidence in science, and when do we start to declare things as facts? How can you declare that something is not true? As you declare that something is true or not true, to what extent is that relevant to a social debate?*

One interviewee said that in the centre where he currently works, the different aspects are usually split up. The main reason for this is time. During the days, the events they run are quite short, approximately only 30 minutes. Therefore only facts and evidence are dealt with during the day-time events. But in the evening, events with a different format are run, which are usually longer, which gives time for a deepened debate involving ethical issues and policy. People then have the opportunity to discuss it further and argue it out.

> *With all of this, you have a talking shop, people may share their opinions. And here, our staff only acts as moderators. So everybody has a chance to have their say. And we try to come to a conclusion in the end. Sometimes we don't get to a conclusion, but that is not relevant. What is relevant is that people has a chance to discuss it.*

Some interviewees believed that there would be differences in how the three aspects would be balanced depending on if the issue is address in an exhibition or an event.

> I *think that the only way of getting the ethical issues and messages in consideration in an exhibition type of media is that they must be brought together; you cannot speak about ethics and policy alone. Then it becomes all to abstract.*

However, it may be difficult to present ethics and policy in an exhibition without a very large amount of text. Facts and evidence are easier to make attractive with hands-on exhibits, lots of images etc., which might be more difficult when addressing something of an abstract nature. Some interviewees believed that an event is a better forum for the ethical aspects and the politics.

> *For issues and policy you really do need people, otherwise it would be a very boring exhibition. So I would then be quite pragmatic and not put ethics in an exhibition. It is likely to be stronger on facts and evidence. But if it is an event, where you've got facilitators then you've got the right tools to look more carefully at ethics and policy.*

Open questions in contemporary science

Contemporary science is of a changing nature; hence it will always include questions that are open-ended. The professionals were asked how they would deal with this aspect when presenting contemporary science in science centres. All interviewees thought that it is a very important issue to address. It could also be an effective way to show the connections current science has with the science of the past and the science of the future.

> *I quite like going back in history, and sort of looking at what we knew at different times, and how these then got to be closed and inverted kind of questions, but then opened up again when something else happened. That would be an exhibition kind of doing it. When you are doing discussions, it is probably… having people there that are doing the science would help, because they could say: - Well, 10 years ago, my PhD field didn't exist or wasn't something we knew about. In 10 years time we would probably have answered these questions, maybe…. We would have found a whole lot of others, but we don't know what they are going to be.*

Some of the interviewees thought that the unknown could scare people, and that it for that reason is very important to be extremely precise about what is known, well-known and proven.

> *There is a progress going on, and we are just at a certain time of that progress. There are different lines of research; some aspects are unknown, why? It is very different from saying that this is going on now, and everything can happen.*

Other interviewees on the other hand, see the open question aspect of contemporary science as the essence of what scientific research, enquiry and progress is all about.

> *In a sense, that is the point. I mean, science is about…. Science itself, the practice of science, is a large open question. Some edges of science tend to solidify into canonical knowledge. But essentially science is about open questions, and the reopening of questions, if new evidence starts to suggest other answers.*

However, one of the ironies of science is that science teaching tends to concentrate on what science knows, but scientist researching tends to concentrate on what people don't know. Scientists themselves are not interested in what they already know. They are much more interested in what they don't know.

> *One of the most important things that can be communicated to public is that science is always revisiting things and we are coming up with new explanations, using better techniques and new approaches. And that an awful lot of what is written in the text books is wrong.*

That could seem strange to people, because what is taught in schools tend to be a series of facts. In order to avoid this uncertainty, it is of great importance not only to talk about specific bits of science, but about the scientific process, both strengths and weaknesses. Because of what is being taught in schools, many people demand of science that they will get a particular answer, they just want the answers to things.

> *I think that it is very important that the discussions with scientists do stress that the scientists do have information, but that information is very often quite provisional.*

This is a problem that we will soon overcome, is the belief of some of the other professionals. The public get more and more aware of the world around them and that science as a part of that world is ever changing. A good way of getting people to realise that is to relate it to ordinary everyday things.

> *People are becoming more aware of that things are continuingly changing, and that is a bit different from whether or not there are right answers. I think that people expect science to have some facts and some answers, but that doesn't mean that they don't appreciate the fact that things are moving on. And that more things will be available in the future. And to sort of reconcile those two related but slightly different ideas to each other.*

One way of addressing the "open questions" issue could involve having games where different outcomes and different people's opinions could be seen. That can encourage people to think about what the possibilities could be, what it would result in, and how they would life their lives as a result of that.

Another way is to focus on science as a process, and letting scientists share their diaries, with their daily observations and what processes they have to go through while working. This can also help to brake down some of the barriers and the mystique around science.

The capturing of people's opinions

The professionals were asked how they would try to capture people's opinions in a science centre. The majority of the interviewees thought that there are various ways to do that, some methods more efficient than others.

What has to be taken under consideration though is whether the collected opinions should actually be used for evaluation purposes, or if the main aim is to let the audience air their views. Another aspect that needs some reflection is what sorts of opinions you are trying to capture and what you are intending to do with the results. The majority of the professionals believed that there is great value in letting the visitors share their opinions.

> *We provide opportunities for people to look at people's opinions, what general people thought, thoughts of different experts, and then add their own to those.*

Letting people have their own opinion engages them in the issue, and involves them in a wider debate. Many people are to a larger extent interested in what other ordinary people think, than they are interested in what scientists and experts think. However, it is important to ensure that scientists, policy formers and others of influence are kept posted on people's views, in order to make the visitors contribute to democracy.

There are both high-tech methods and low-tech methods that can be used when trying to capture people's opinions. Among the more technically advanced methods are opinion polls systems used during events, video recordings of the events, broadcasting on the internet, online forums, interactive exhibits and mobile phones. Opinion capturing methods that do not require any advanced technical devices are notice boards, interviews, focus groups, questionnaires, card games, discussions, drawings and role play.

One interviewee stressed the importance of following the whole process of how a person may change his or her opinion in certain issues.

> *It is not enough to just ask in the end; did you change your mind or not? It is important to know what happened in between. If people haven't changed their minds, it is not that they haven't changed by definition; they can stay with their ideas and understand better why they feel in a particular way about a subject. How strong are the opinions, and why do they have those opinions? Maybe that is because of ethical or religious concerns rather than scientific ones. That is fine, but it is important to understand why you have those certain ideas and opinions.*

There could be certain risks with some methods of capturing people's opinions. One risk is statistical validity. Some of the professionals believed that there at times could be almost too easy to capture opinions, mainly through the use of interactive exhibits where people could enter their opinions on various issues into an opinion bank. With these exhibits there are no guaranties that the opinions that are valid, because there is no control over who inputs answers to questions. There is nothing to stop the same visitor answering the same question several times and scoring as several individuals. The results then become statistically unrepresentative. It is not even clear that the average results are accurate for the population that they claim to report.

> *I think that you have to take that more as passing thoughts that people have, and not actually use it for some sort of research. I have seen examples where people have been drawing the wrong conclusions from the wrong sort of information. I think that there should be an opportunity for people to share their opinion, but those comments shouldn't be researched on.*

Another risk is the possibility of people airing obscenities, sexist or racist comments onto notice boards, online forums and other forms of opportunities to give an opinion in a written format.

Censoring of views

If you let the public share their views, should those views be censored in some ways? The majority of the interviewees believed that opinions given by audience should not be censored. However, it quite often requires some sort of moderation. The problem with letting people freely express their opinions is that it tends to result in a lot of material that does not have anything to do with the issue that is on the agenda. This can range from innocent statements to serious obscenities or political propaganda.

> *If you were going to publish the results of your exhibition, event, debate etc., you would have to go through the different opinions and the different views that people expressed and sort of get an overall picture. In order to convey an overall picture, think that you would have to pick out different quotes from different people with different opinions. So it could be that you also present then the opinion of an extremist. But I don't think that you should censor it, and sort of try and hide the fact that somebody might feel that way.*

Some of the professionals believe that the events are easier to moderate than written material, because in a live event you could deal with the problem at the same time as it occurs.

> *It would be quite interesting to see, from a facilitator's point of view, if you are unconsciously censoring people or whether other participants are censoring people, and whether or not it is a good thing.*

The facilitator of an event could slightly steer the discussion back to the right track, if it is at the edge of what is being appropriate. All facilitators need to be trained in moderation.

> *When you are running some kind of dialogue event you need to have well trained and very capable people who… when it's appropriate… or at least they know when it is appropriate, challenge people on their opinion in a friendly way, not in a bristle kind of way.*

What should be taken away are comments that are not decent, that incite people to racial attack or hatred or violence. A science centre has legal and ethical responsibilities as a public institution and should therefore not allow hate crimes and hateful language. Personal riots against others should be prevented from being displayed to the public as well. A good idea would be to develop a policy with set rules that suits the individual science centre, in order to follow the laws of the country and also to make the setting an appropriate place for the intended audience.

> *My tendency is to be as open as you possibly can. But if you got a family space for example, you cannot put anything there, but then you also have to make that policy clear and somebody has to make a judgement on that.*

Comments that are irrelevant to the subject in focus could also be omitted, since they are quite useless to save when they does not add anything to the debate.

3.1.2. Devices

Devices and techniques to use

Contemporary science could be addressed with the help of a range of different devices and techniques. The professionals were asked what they believed would be the best suited technique to present contemporary science issues in a science centre. The majority of the interviewees thought that this was a difficult question to answer, as what is the most suitable technique very much would depend on the context of the science centre, and what specific issue that was going to be addressed. Another important aspect to consider is what audience the science centre has.

> *It depends on how old people are, that are coming to your museum. It depends on what their background is, not just from an educational point of view, but also from a cultural point of view. So I don't think that there are rules for what you can do, and certain do's and don'ts.*

The effectiveness of every initiative as well as the sustainability from an institutional point of view has to be carefully judged, in order for the science centre to survive economically. However, the interviewees had many suggestions on what could be used, which they experienced had worked effectively in some cases.

Some of the professionals stressed the importance of having as many varieties of presentation techniques available as possible. Not everybody learns in the same way.

> *For a museum open to the public, it is also a part of the game to have several different meanings, and then people would choose the best one for them.*

> *You have to think of that everyone comes to the science centre with a different agenda... You might have to have a few different things that will appeal to different people; it varies what they want out of their visit.*

Even an individual visitor could get tired if there is only one type of exhibits available. It would be boring. To successfully catch the attraction and interest of a visitor, you have to change the pace and the format a number of times throughout the centre, as many different modes as you have a budget for.

Some science centres focus mainly on different kinds of devices within an exhibition, whereas others try to develop new event formats. Many try to offer as many different ways to engage in science as possible, whether it may be exhibits or events.

In an exhibition it is of great importance that there are opportunities for the visitors to explore the issues through more than one of their senses. Something that is really complex could effectively

be presented with the help of 3D visualisations, backed up by a voiceover. There could also be interactive software and interactive mechanical exhibits.

There should be opportunities for visitors to share their opinions as well as to play. What is important is that the addressed issues are constantly updated or changed. Expensive fixed physical exhibits that soon go out of date should be avoided. A very good way of drawing people's attention into contemporary science is to use the news. Not science stories within the news, but actually the news. There are often opportunities to build science stories, away from news stories.

Some of the interviewees believe that the exhibition media should be the heart of a science centres activities. However, other activities and techniques should be connected to the exhibition to add to the attraction and learning opportunities.

> *When we are talking about a science centre, of course the core of the activity lies in an exhibition. But then you should also focus on a subject via other media. First of all, you should have a website, and the website should be very, very closely linked to the exhibition. Some of the exhibits could actually be visited and tried and experimented with via the website. You should also make school material of the subject. So when a school class comes to visit the exhibition, then the teacher and the pupil would already have had the chance to prepare their visit. And during the visit they could also use the school material, and after the visit they could also use it when discussing what they experienced at the science centre. And the website, the school material, and the exhibition must be very closely linked.*

One effective way to make the outcome from a science centre visit last even longer is to provide tables with books, and also to provide internet access. There could be a special folder with websites where you can find more information on the particular subject in focus.

Another connection with the internet could be web-based simulation games, which could also be played in the science centre. The setting of the games should be that you have to play a certain role where you have to take certain decisions and consider the consequences of your choices. The impact of particular decisions over time could also be shown.

When having events there a range of different formats that could be used. Most science centres try to move away from the standard lecture format, to much more informal sessions.
The majority of the professionals believe in bringing scientists and other persons with a deep expertise into the centre, but instead of letting the expert hold a lecture, there are opportunities for the visitors to be involved in discussions with real experts, in order to get a deeper understanding or a changed opinion on the issue in focus. The scientists could bring in real objects or equipment that they use, as catalysts for a debate.

> *The idea would be to have a facility without big amounts of expensive exhibitory. But with some very well chosen display techniques, particularly electronic display techniques. And to be able to bring different objects, artefacts, even table top demonstrations into that place, and have them presented; by scientists themselves, by our own floor staff, as a basis for discussion or debate or whatever.*

The science centre can at the same time be linked with persons at other places in the world via a video conference system, which could also enter the debate or being asked as expertise. The event could also be broadcasted on the internet. The centre could also have a weekly short spot at a cable television channel. This could all be very useful for the outreach in sparsely populated areas.

Another useful technique to use during events is electronic voting as part of the debate, where particular questions are put up before and after the speakers, and people are given the opportunity to express their opinion, most effectively anonymously. People can suggest additional questions and they are added in live, and then people can vote on those questions too. People can also use text messaging in the same manner. Options can be presented as well as feedback.

Theatre could also be a meaningful way to engage the audience. Actors could perform a short drama presentation about a particular issue. The actors will then run it again, but now in subsequent times, so that the audience can shout out and stop the actors at particular points, and suggest alternative things that the actors could do. This format provides a lot of flexibility and can be a good stimulus.

In a big audience people could easily feel intimidated by the size of the group, and therefore they may not dare to share their view. This problem could be helped by breaking up the audience into small groups and effectively run a simultaneous round of focus groups, where the speakers go from group from group. The speaker is allowed a couple of minutes to state an opinion and then the group discuss that particular opinion. Another format to prevent people from being reserved is to have a normal-sized audience, but where the speakers sit in and amongst the audience. There will be a facilitator upfront, but the experts are placed amongst the audience to break down the perception of it being a panel of experts.

One interviewee had experienced that workshops in combination with performance type events really engaged the visitors. The participants produce objects, music, drama pieces, art etc. during the workshop, which are shown in the following performance event. This had worked very well, and got the visitors involved throughout the whole activity.

Another interviewee had experiences from working with science festivals, and believed that it could be fruitful to make some kind of hybrid between a science festival and a science centre. The festival could for example run annually in the science centre and each year focus on a particular aspect of contemporary science. It might also very well take up on the regional cutting edge science that is being done in your particular city.

Working with experts and the selection of them

To have scientists and other people with expertise in science centres could be of good help when running events or when doing research for new exhibitions. Letting the scientists and visitors engage in dialogue with each other could be very fruitful in order to achieve a mutual understanding between the two groups. However, it is not always that a science centre's cooperation with scientists works as smoothly as one might hope. The professionals were asked what issues should be taken under consideration when working with scientists in a science centre, and also how they would select which scientists to cooperate with.

> *You have to select people that you know would be entertaining and would captivate people and make them want to learn more.*

All the interviewees believe that the most important characteristic for a scientist to have, when participating in events, is to be a good communicator. It doesn't matter how much knowledge the person has if he or she cannot communicate it in an interesting, energetic and meaningful way. If there is a dull performance, the audience are not motivated to listen.

> *We want speakers that either knows how to communicate with the public already, or are willing to work with us ahead of time to sort of improve their communication skills. That is a service to them, but also to our audience.*

> *If someone is very passionate, whatever it is that they are working on, if they can convey that in a dialogue with the public… That really helps making it accessible, and boost up the interest on the part of the people in general.*

A problem is that not all scientists are interested in a dialogue with the public. Some scientists do not see why they should be communicating with the public because they can not see what relation the public could possibly have to their work.

> *Many don't have the interest of talking to the public, and they also don't have the desire to convey their understanding, or their research, to the public. It is not there for them. And they may not have the skills to communicate with them either.*

In other cases the scientists could be frightened by the public. They are terrified of being asked questions that they cannot answer, or that people are being hostile to their field of expertise. Some scientists seem to feel that people are interfering, and some feel very nervous about being on stage. In these cases, training and support should be given by the science centre, so that the scientist can speak to people in a non-threatening way. However, scientists tend to be rather self-selecting when it comes to engaging with the public.

> *People that come forward to you, they already have some pre-existing feeling that they might be alright with this. It is rare to meet someone that is incredibly shy and has a stutter and clearly wouldn't survive on a public platform. They just don't turn up for these kinds of things. So there is a self-selection going on, which I think is sensible.*

Some professionals see it as hard to get the scientists they want the most to come, as some scientists are very busy with research work and lecturing, and are therefore hard to schedule. Other interviewees have partnerships where they cooperate with the local or regional research institutions and universities, which provide them with suitable guest speakers. The experts could also be used as a knowledge base and can be consulted during the planning of new exhibitions.

In some cases, there is sort of prestige for scientists to cooperate with science centres and museums, as these kinds of institutions usually have a respected role in the community.

> *We are approached by a lot of people; we don't have to go looking for so many. So we can select people based on the most interesting approaches.*

It is of great importance that the cooperation between the science centre and the scientist work well even on a social level. But after a while, a group or network of people is often built up, where you know that they work really well and are cooperative.

> *We select, whenever possible, people that we like, to begin with, so that we can work up a nice working relationship with them. We like people who are friendly, open and honest. We try and avoid people that think that the world ended with their opinion.*

It is also important that the science centre try to change the traditional picture that the public have of scientist. When children are told to draw a scientist they draw an elderly man in a lab coat, with thick glasses and messy hair. But the scientist of today might as well be a young girl with long blond hair, looking absolutely fabulous, being really cool. It is of importance to think about what kind of role the scientist as a person play, and to show the audience that a scientist could be someone like them.

> *I think that if you have an expert in your science centre, then he must be an expert that is a good promoter, a good communicator… I think that is very important, because the scientists are role models for the younger generations. It will show that a scientist is not a Professor Frankenstein…*

The majority of the professionals stressed the importance of a thorough planning process before letting a scientist participate in an event.

> *I think that the expert or the scientist needs to be involved in the planning, right from the beginning of any event. There is no way you could just call them and say; OK, go ahead and speak about your field. You need to be involved from the very beginning.*

The scientists must, first of all, be interviewed by the science centre, to see that they can really talk to ordinary people. Then they are given some training. They need to be briefed on how the audience are likely to be, and clearly explain that this is not going to be like a lecture, rather something quite different from most of the things they have done previously. What also needs to be explained is that it is not necessary for their audience, whatever the audience, to know everything about their subject. They are going to have to in some way to come across, create ways where they can connect what they do with people's everyday experience. What they also need to think about is what language level to use.

It could be very useful to get them to imagine that they are speaking to someone they know, who they know have no scientific information or scientific knowledge, like their grandmother.

A dedicated area or integration

The professionals were asked whether they believed that a science centre should dedicate a specific area of their exhibit halls to contemporary science issues, or if these issues should rather be integrated into the other exhibitions in the centre.

The vast majority thought that contemporary issues should be integrated into the other exhibitions in the centre. In cases of doubt, all interviewees believed that it could work either way. Nobody was for a dedicated area without having some parts integrated as well.

I think both can work. It is probably a good idea if you can, to have an opportunity to update any science based exhibition, with topical developments, new material. But I think there is a virtue to have a bit of the place to be about what is going on today. A news place or whatever you want to call it. I think that have a function for people too. Especially if it is based around programs, around presenters doing stuff, it can be a real focus for activity.

Furthermore, advantages with a dedicated area could be that it may be easier to keep this particular area very updated, than if it these issues were spread all over the science centre. The dedicated area could be suitable for debates or more contemplative activities that are difficult to host in a normal exhibition hall, which tends to be rather noisy.

There are cases where a dedicated area attracts people who want to look closer on different issues, you can clear out different environments, a small forum etc. …

Some of the interviewees however felt that how contemporary issues could be dealt with very much depends on the organisation and its goals, the venue as a whole, and of course its audience. One way of getting around the costs involved in building a specific area is through staff facilitation.

We got a very large crew of dynamic, well-educated floor staff, who are very well trained in both how to work with the public, but also in getting them an understanding of the science that they are getting across of. They may be in an exhibit hall that is relatively old, but they already know some current science, and are sharing that with the public and do live presentations, and just interact in instructions and conversations.

The most common reason for integration is that it is of great importance to make connections between contemporary science and the history of science. It also becomes more part of the overall experience of the science centre visit. One of the professional's experiences from doing audience research was that most people expect subjects to cover past, present and future. To some extent, separating these three aspects from each other is an artificial distinction.

The majority of the professionals felt that integration is a must, because otherwise a strange situation would occur, where the public do not get the understanding of science as a process, and put in a context.

> *It is really based on a long research tradition, which is based on that you are based on someone's shoulders. To make the contemporary science understandable for the audiences, or even for experts, is that you show on which facts this contemporary science is based on.*

It would also create strange concepts, that contemporary science is open and in development, whilst the rest is closed and finished, which is not true.

> *You will come to the situation where you have current science, and the rest is, what? Old science? It could confuse some people.*

The linking of older science with newer science could help the public realise that the older science was once controversial, and what is controversial now may be accepted in the future.

The design of a dedicated area

The professionals were asked whether there were anything special that needed to be taken under consideration when designing an area where contemporary science issue are meant to be addressed. They could not say any particular design that would be the most suitable, as you also have to reflect on how the area will fit into the context of the science centre as a whole.

> *I guess all exhibitions, depending on the content and the context have to have a specific design that suit their environment, the audience that you attend to reach, and the messages that you are trying to give.*

However, there are some aspects that are particularly important to consider in order to attract and engage visitors. Many interviewees stressed the importance of the area being visually attracting, as well as durable and well built to sustain the pressures from eager visitors.

Flexibility is also a key word. The place should encourage to dialogue, hence it is good to create a place with a cosy atmosphere, where people would feel comfortable and at ease, but still stimulated.

> *It should have a lot of different spaces, for different moods. Some spaces could be load and noisy and you feel like you are at a party and other spaces could be calm and relaxing…..*

It is important that the space can be used by as many different people as possible so it needs to be convenient at times to all those people. The majority of the interviewees thought that the place should have both big open spaces suitable for large groups, and somewhat private corners for one or just a few individuals.

> *The whole atmosphere should be one of "make yourself comfortable, this is your living room".*

You also need to have good acoustics and good adjustable lighting and not exhibits that disturb too much.

> *So there is no huge body-on experience in there that are very dynamic and involving, because that attracts from everything else. And that would wind up in that the design would overwhelm the message. There has to be a mirage, a very strong mirage, between content and design.*

3.1.3. Audiences

Hard-to-reach groups

The professionals were asked whether they though there are some target groups that are more difficult to reach than other groups. The vast majority thought that teenagers and young adults were the groups that are most difficult to reach out to. The professionals believed that the reasons for teenagers not to visit science centres was mainly social pressures around science, or cultural pressures against getting engaged with science. They may also have been somewhat turned off science at school, so that they do not think that science is cool.

Science centres tend to reach families, and school children. Some of the interviewees mention the unspoken rule of visitors coming at least three times in their lives, as a child, with their children and later on with their grandchildren. Some professionals feel that one has to realise that going to science centres and museums are not something that everyone has to do all the time, in all phases of life. There may be periods in peoples' lives where there are other things that are more important. Maybe not too much effort should be put in getting those people to visit, but instead concentrate on the groups that actually are eager to visit.

When it comes to what social groups that are the most difficult to reach it is people with low income and poor education. They often come from lower social classes or from ethnic minorities.

> *There is certainly a question of costs, when people have driven to centre and paid the entrance fee, so there are already some people that are excluded on the basis of how much it costs. Particularly if you think how much it would cost to take a whole family. There will also be people who would think that all that technology stuff is all too difficult and it is not something that people like us are engaged in, and you could probably find a large cross-over between those two groups.*

Another target group that some of the professionals believed were difficult to reach were scientists. They may be very interested in their particular field, but it can be a big challenge to get them interested in other fields.

> *I think that we could find a huge market, if we target towards the ones that are sort of already interested in science, and give them something a little edgier to work with, rather than just aiming for a public that might not know anything about science.*

One way of trying to reach certain groups are to do outreach activities. For various reasons, people can have difficulties to come to the science centre. Staff from the centre can then instead travel to the particular target group. With new emerging technologies, there are also possibilities to link up with other places and have video conferences. The activities could also be broadcasted on the internet. In this way, audiences outside the centre's actual area could also be reached. All this also creates excellent marketing opportunities.

The narrow path or Broadway

The professionals were asked whether they thought a science centre should focus on one or a few target groups in particular, or if a science centre should try to reach an audience that is as broad as possible. The majority of the professionals thought that is really dependent on in what context the particular science centre is; in terms of budget, size of the centre, other existing institutions in the same city, the demographics of your region. The science centre also has to reflect on what their mission is; they have to make up their mind on which groups they are really targeting.

> *You have of course to focus to some extent, and certain activities will appeal more to specific groups than others. But in terms of focusing more on one group more than the other, I don't know. I think that it is very important to define them very well, but then try to focus on as many as you can.*

However, the vast majority thought that the best strategy is probably to try to reach an audience that is as broad as possible.
Some of the interviewees believe that if you are focusing too much on particular target groups that could be seen as a mischief for other groups, by excluding them. Audience that already come may start feeling excluded and they stop visit.

> *If you trying to reach as many people as possible, then there comes the danger that you become nothing to no one. You cannot reach everybody, and that is something that you have to accept. But equally, I think that you should make a conscious effort to define who you are going to try and reach. It may be a small and limited group, so that is probably not a good idea from a business point of view. So, I think you have to admit where your limitations lie. You cannot be all things to all people, I think it would be unrealistic to try and do that.*

But science centres have to at least try to cater for everyone. As the majority of visitors to science centres are families and school groups, the main focus ought to be set on them, but there should always be something to offer more specific audiences as well.

> *I think that you have to have a key market that your exhibitions are aimed towards. And I think that you are really missing out if you focus something toward certain age groups. It is good to have activities for all ages. And for all different Key Stages, for school children, for family groups and for interested adults. I think that you really have to do activities for all different sorts of groups. So that you can really get everybody interested.*

You also have to enable access for disabled people and help those with special needs. Maybe there is not possibilities to access everything, but they should be able to access the majority of things. There has to be a range of different exhibitions and activities that are interesting and accessible for both those with a special interest, special need, and for the broad public. Doing something that suits everyone, all the time, is virtually impossible. However, a serious effort should be made to try and have as broad a spectrum of activities as possible. Different projects can be run simultaneously, where in each project the focus lie on a particular community or group of people.

Some of the professionals stressed that one of the beautiful things with science centres is that is a meeting point cross generations. All communication in a science centre needs not to be delivered by the science centre.

> *It is wonderful to focus on many, because there is a lot that people learn from themselves. So if you look for instance on intergenerational dialogue, between older people and younger people, there are indeed fantastic things that people learn from each other. Teenagers could explain modern technology to older people who are not very familiar with that, and so on. There are examples of programs and exhibitions that try to involve the visitors by encourage them to share their own knowledge about a subject. And the people know a lot about it. So you have to reverse that idea of that science centres inform people and allow people to know more of so and so…. There is a lot of things that people know, that the science centre should be able to take out of them, and then distribute this knowledge to other people. That is also something that I want to see more of in science centres, possibilities for visitors to contribute with their own knowledge.*

The question of targeting also has to reflect what happens in society. A science centre should be able to cater for targeting specific groups' interests when there is a big debate evolving nationally.

> *I would suggest that it is much easier for them to look at the entities for them as an institution, look at issues that interest their particular audiences. But it may be in the society, or their maybe local opportunities or national opportunities that they can look at, pressing more national things. That then raises the question how do you take on an issue, and what audiences do you address? I would say that, if you take mad cow disease as an example, the question is: do you work with your standard audiences or do you try to move outside? I think the short answer is that it is much easier to work with your standard audience. But to go outside, you need a lot of extra funds to do that. That should be the aspiration, I think. It is the tension between the science centre as a popular fun place, and as a research and dialogue institution. That model is very different. If you were to run a science centre and you went only on the dialogue model, you would rapidly go bankrupt.*

The organisation and administration of a science centre

The professionals were asked whether they had found any challenges with practical issues, for the reason of trying to address contemporary science issues in science centres. The majority had experienced problems.

One problem is that contemporary science issues requires a lot of staff, both with constantly updating exhibits and to act as facilitators at events. Furthermore, the personnel of science centres are not as in touch with science as they used to be when they were scientists, if they were scientists. It is a big question of cost to find out what is going on, and in what direction science is going to head next. Contemporary science is very unpredictable, so there is a need to build in the ability to change things rapidly to keep it up-to-date.

> *You have to a get-out plan for: what happens if….? You can't possibly ever second-guess where research is going or going to end up.*

Another important aspect of keeping things up-to-date is to avoid recurrence. You have to consider new angles to approach contemporary science from, look at what possibilities your specific institution can make this issue a bit different from how all other science centres would address it.

> *If you visit science centres all over the world, you will see that the exhibits are quite similar to each other, no matter where you go. That could be a bit boring. I think that it would be very exciting to work more on a regional basis, to look at what kind of technological developments that have been made in the area, and how one can create exhibits out of old and new inventions, in a way that makes it fun. Maybe the child will understand where his or her aunt works, and what she does there.*

A way to keep down the costs for research could be to share the required information, in some sort of news wire service. This could save resources in terms of material costs as well as staff wages.

> *Newspapers have long since abandoned the idea that they would individually research and produce all the news that they report. News services, international wire services have been used by these papers for a long time. So they login to international sources of news, which they can acquire and present or represent to their readers. Now, there are no reasons why science museums and science centres shouldn't do this. We need to start sharing resources in the collecting and the editing of topical interesting accessible material about contemporary science. And spreading it out so that people can access it, different science centres can access it and use it for their own purposes.*

To address contemporary science often also requires a lot of technical devices, such as video cameras, electronic opinion poll systems, broadcasting material, sound equipment etc., which is very expensive.

To present contemporary science in science centres could also bring challenges in terms of thinking of what is appropriate for the audience. That is something that can bring practical issues as well. You have to reflect on what use people have with engaging with science. The science centre has to investigate into what the visitors actually want to know, to be able to present subjects according to those wishes. But working in this way often becomes quite expensive.

> *It is a lot of money per head, depending on how many people that you are going to reach, so as an organisation you have to fight the budget, balance that and that visitor numbers, raise the revenue. You have to accept the fact that there is something that you do just to bring in the numbers, and that there are some things you do to reach out to the right people. Some things are more expensive. I think that you have to accept that, and you got to find a happy balance between the two.*

Some people do not want to be confronted with certain issues and some people do not want to think about them. Others do not know how to have their say; they are not used to being asked on their opinion. If the science centre wants to introduce them to something that might be a difficult concept, and if it is controversial, it is going to make them feel uncomfortable. So you have to consider ways to make the visitors to feel at ease.

> *The challenge with having current science is that it is very hard to take something that is done in science and present it in a way that is appealing to the public on the floor, and understandable. So one of the things you have to do is update the mode of how you are going to present that, and how often you have to do that, and we are still struggling with that. We are still trying to determine what the best way is of getting these ideas and information out to the public. So what is the format, how do we present it?*

Outreach programmes are a kind of activity that there is often a very small budget for, at the same time as the activities tend to be rather expensive. A few of the interviewees were quite critical against outreach programmes, as they thought that there are many other players, other than science centres, that are doing outreach activities much better. A science centre should instead focus on being experts on doing science exhibitions and events within the science centre. In addition to that they should also have a well developed web site in connection to their centre.

Some of the professionals believed that there are not any recognised, good methods for addressing contemporary science in science centres yet. A lot more research has to be done before these issues could be addressed in ways that are completely satisfying. There is therefore a lot of experimentation involved, and a science centre has to expect to have some failures in some cases, and learn to tackle those. In addition to that, it is not yet obvious how to market contemporary science to the audience. Generally when people are going out for the day or out for the afternoon, they want to have a nice time, and they do not want to in advance expect that they are going to be depressed or faced with controversial issues, so it has to be marketed carefully.

Cooperation between science centres

The professionals were asked how they thought science centres could cooperate, and whether there are any differences in the cooperation between science centres on a local, national and international level.

On a local level, the collaboration could consist of building up a knowledge base, so that expertise in different areas is developed at different places. If knowledge in a particular field is needed, the other centres know what centre to get help from. The majority of the professionals thought that organisations have to realise their limitations, and that one should not try to do everything by yourself. Science centres can also share exhibits and share ideas and resources on outreach. Another thing could be that a few science centres get together and have common training days for their staff, and then split the costs between them. Hence, cooperation could mean that you reduce your costs in many different ways.

> *On a local basis, you have different issues that you can share with one another, like funding and whatever. And also I think that on a local basis it is absolutely necessary to cooperate, it doesn't make sense if you have two similar organisations and then you basically are planning the same exhibitions and the same events. That will take away audiences from both of them. They should try to cooperate and plan together.*

When it comes to national initiatives, the science centres can arrange seminars for professionals, in order for them to discuss new ideas and ways of development. They can share experiences, learning, but also information, through partnerships. Even on this level it is important to have a common knowledge base.

> *If people are focusing on different regions with similar demographics, there are probably ideas that could be shared and successfully assimilated.*

One of the interviewees had an idea that there could be some sort of shared ticket, so that people can visit all science centres that are members in a network, if visitors are on holiday somewhere they can visit the science centre in that area for a reduced rate.
There could also be cooperation nationwide using video conference systems, when having events at many sites at the same time.

At a European level, there is a network for science and technology centres, called ECSITE. One of their projects is to develop travelling exhibitions. They also arrange a conference annually, where representatives from science centres all over Europe are gathered to exchange ideas and methods. Internationally, there are conferences as well, but arranged every second year.

Some of the professionals did not think that the cooperation between science centres on an international level would differ much from cooperation within a country or on a local level. They believe that science is somewhat of a universal phenomenon.

> *There are good ideas all over the world, and what is going on in Brazil might be brilliant for Britain, and there are probably some outreach program ideas that might be adapted. You have to look at the central messages and methods rather than the details of the delivery. There might be things to learn.*

> *I think that nationally, there is sort of more of an academic role. Well, the public changes depending on where you are in the world, the sort of definition of what it means to be public. But the fundamental nature of science doesn't change… The fundamental nature of communication problems doesn't change. Even if it is in different languages, there are still some things that hold true. What are people interested in, what do they want to know, and I think that internationally, if we can work as a field and kind of figure out the overriding principles, that would be great. But certainly every country and every science centre is going to have a different way of adapt that.*

However, as most of the interviewees thought international cooperation is something to strive for, there are many differences in the way different nations present science in science centres. Hence, there are a lot of issues to take under consideration when cooperating internationally. The educational systems are so different, which also show in science centre exhibitions and programmes. Some things that are developed in one country may not automatically transfer comfortably into another country. However, it can give you new ideas and inspiration to develop something in the same style.

> *There are organisational differences, and then there are also differences in terms of voice and style and audience.*

Other constraints to an international cooperation are different languages, time and space. The majority of the interviewees felt that practically, it is probably relatively easier to cooperate locally and nationally. However, there are a lot to learn from other cultures' initiatives, experiences and methods. It is therefore important to visit conferences, to share, learn and become updated on what is going on in the field.

International collaborations also allow science centres to exploit, to try new techniques and issues that they otherwise could not have done.

> *Most of the collaborations work also on a long term; it is not only specific programmes and exhibitions that need to be developed. It is on a long term that you have to time to meet other people, visit other institutions etc. That could result in very valuable results. It also allow museums and science centres to pursue some specific goals and experiments that they would like to do, which would only be able to develop on a long term basis. For instance the BIONET project, several institutions developed various programs, from exhibitions, lessons, theatre, to events with the press and the public and so on. So if the museums were alone, they probably wouldn't be able to do it….*

Autonomy

The professionals were asked how important it is that a science centre has got autonomy, that it is not being governed by other instances like government or business. All of the professionals saw autonomy as very important. If a science centre is seen as being in somebody's pockets, it will lose its credibility.

One interviewee found when doing visitors research at his centre that autonomy is important for the integrity of the voice, in terms of what the brand of the science centre is. If the brand is perceived as that it has integrity, then there is also a trust amongst the visitors.

> *We are not seen as an agent of implementation of government policy, and that is a good thing…. That allows us to be honest brokers, and be to honest. And if we are perceived like that and if we behave in that way it is a very good thing, because the public trust is something that is hard to win and easy to lose. And we want to make sure that we maintain that.*

Some of the professionals believe that science centres can never achieve complete autonomy. A science centre is always going to be governed by something. If it is totally independent financially, the money is completely generated from visitors. But if the visitors stop coming, then the centre will be in danger. However, hardly anyone can be self-financing completely. The safest way to go for a science centre is to have multiple income streams. In that way they can compensate one for the other, when they run out. There has to be a balance between public, not profit and profit money. This will also mean that the interests keep in other in check, so one of the agendas does not become the only agenda.

> *You have to make sure that the key is to keep multiple income streams; so some from revenue, some from product development, some from the government, some from grants, some from foundations etc.*

Having autonomy is also very much about what is being communicated. A science centre has to be as objective as possible, since it is working for the public. If the centre is being funded from someone, it is vitally important that the funder do not have any demands on the communication. When seeking sponsorship, it has to be made clear that the science centre will hold the content under control and decide what goes into the exhibition.

> *We will seek advice from the sponsors, because quite often they have expertise that is quite useful for us. But ultimately, we have control over what the content is. We would always argue with the sponsors that that is to their benefit. Because if they pay for to be seen in an exhibition which is seen to be biased, they actually do more damage to themselves. Actually, what we have seen in a number of exhibitions is that visitors respond much more positively to whoever it is who is funding the exhibition, if they see that it tries to present various sides of an argument.*

An idea that some of the professionals had thought about is to have a content service, similar to the kind of news wire services that newspaper use to get material from. This reduces cost for individual science centres and increases the range of choices of what a science centre can do. The information can either be taken as it is, or be modified to suit local circumstances. In addition to the service this can bring in terms of saving resources, it also adds to the perceived view of the individual science centre as being independent.

3.2. Questionnaires with visitors

79 visitors to At-Bristol Science Centre took part in the study, 45 women and 34 men. They were asked on their interest in certain contemporary science issues. They were also surveyed on what techniques or devices they would like to use when addressed by contemporary science issues. In addition to the issues and techniques specifically mentioned in the questionnaire, visitors also had the opportunity to write suggestions on particular issues that they were specifically interested in, that was not in the stated list.

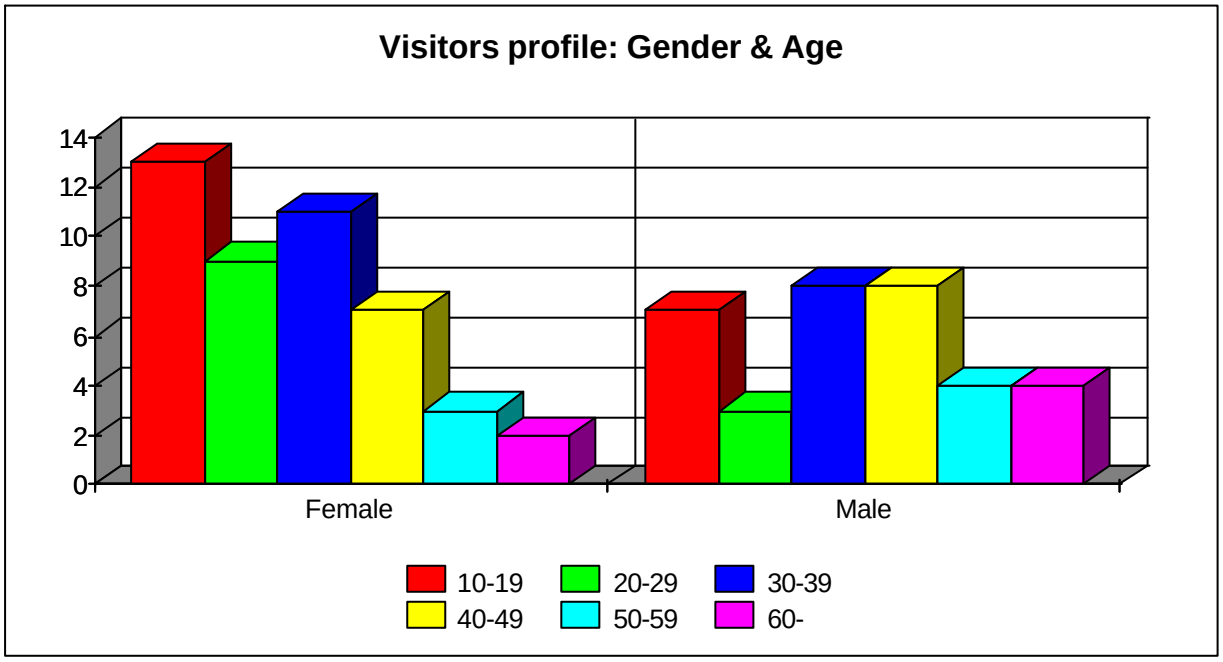

Diagram 3.1 Gender and age of visitors participating in questionnaire.

3.2.1. Issues of interest

The participants had the opportunity to share their level of interest in different contemporary science issues. The issues in focus were:

- Artificial Intelligence
- Climate change
- DNA & Genetics Research
- Drugs & Alcohol
- Ethics in Science
- Energy
- Future
- GMO
- Human Fertility Testing
- Infectious Diseases
- Mental Illness
- Space Exploration
- Sports
- Technology
- Telecommunication
- Travel & Transport

The alternatives given were Very interested, Interested, Indifferent and Not interested, to indicate what level of interest visitors have in a certain issue.

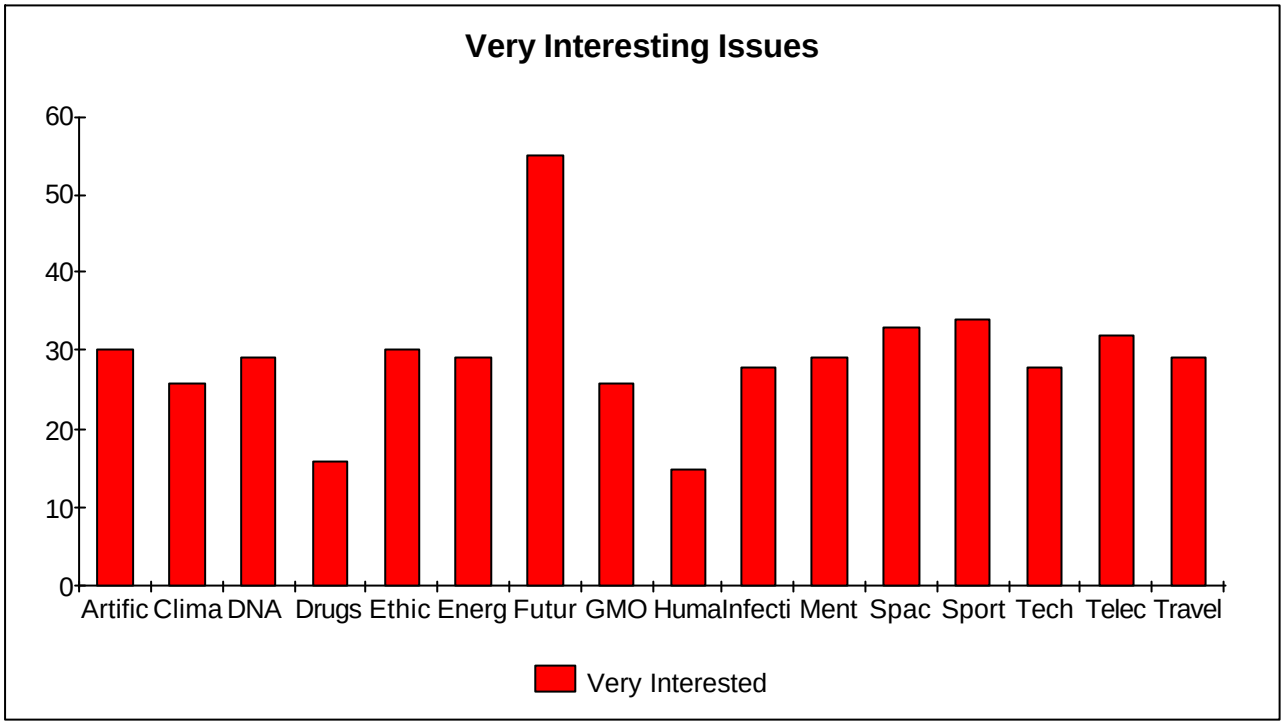

Diagram 3.2. Number of visitors answering Very Interesting.

The outstandingly most popular issue was Future. 55 persons said they were Very Interested in knowing more about the Future, which equals to 69 % of the sample. The issue least rated as Very Interesting was Human Fertility Testing, with 15 persons, or 18.9 % of the sample.

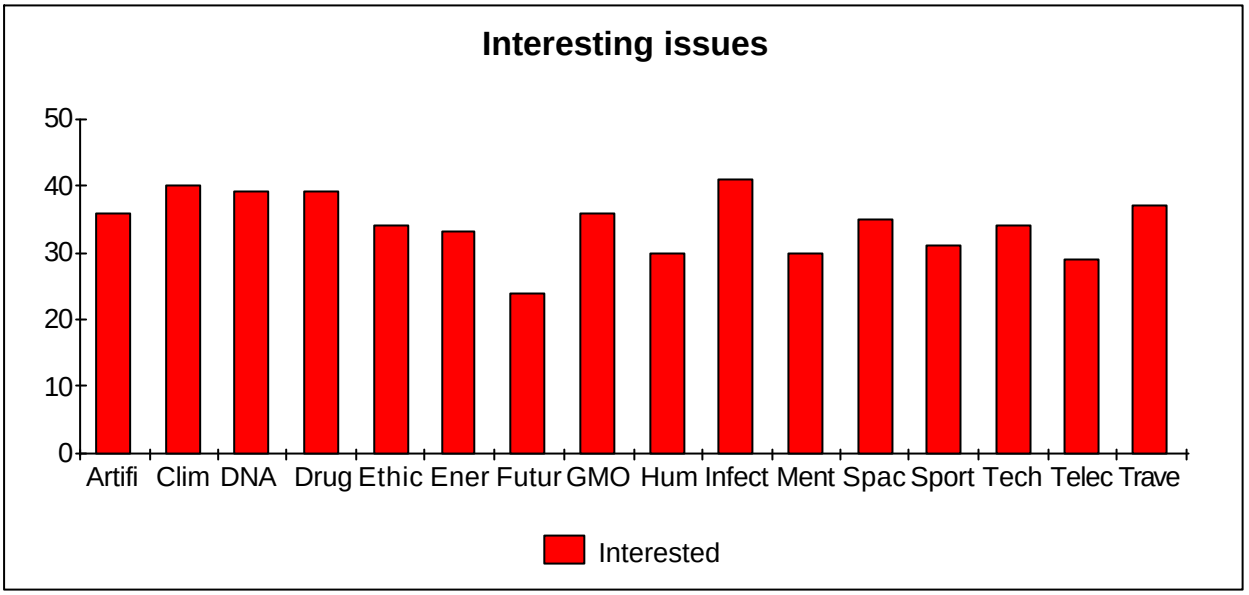

Diagram 3.3. Number of visitors answering Interesting.

When it comes to Interesting issues, the issue that gained most support was Infectious Diseases, chosen by 41 persons, 51 % of the sample. Close after that followed Climate Change with 40 persons or 50%, DNA & Genetics research and Drugs & Alcohol, both with 39 persons, or 49% of the sample. The issue that the least number of people rated as Interesting was Future. However, Future was the most popular issue, in terms of people rating it as Very Interesting.

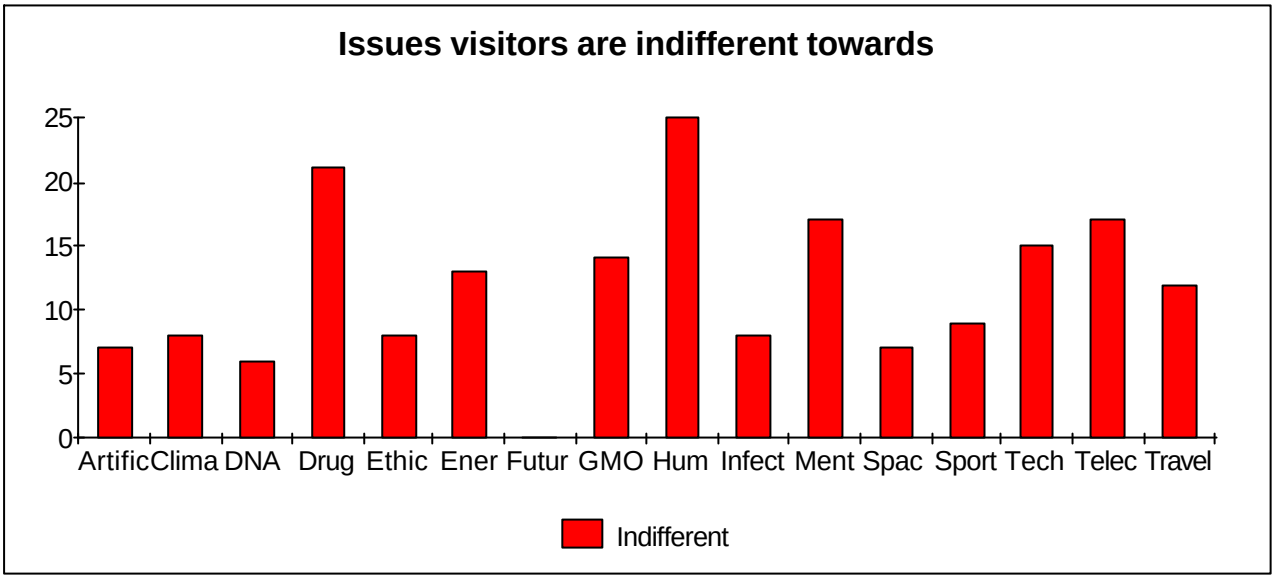

Diagram 3.4. Number of visitors answering Indifferent.

When it comes to issues that people said that they were indifferent towards, the most common answer is Human Fertility Testing, with 25 persons rating it as indifferent, or 31 %. In second place came Drugs & Alcohol, with 21 persons or 26 % saying that it was indifferent to them. However, the issue of Drugs and Alcohol also rated rather among the highest number of people stating that they were interested in the issue.

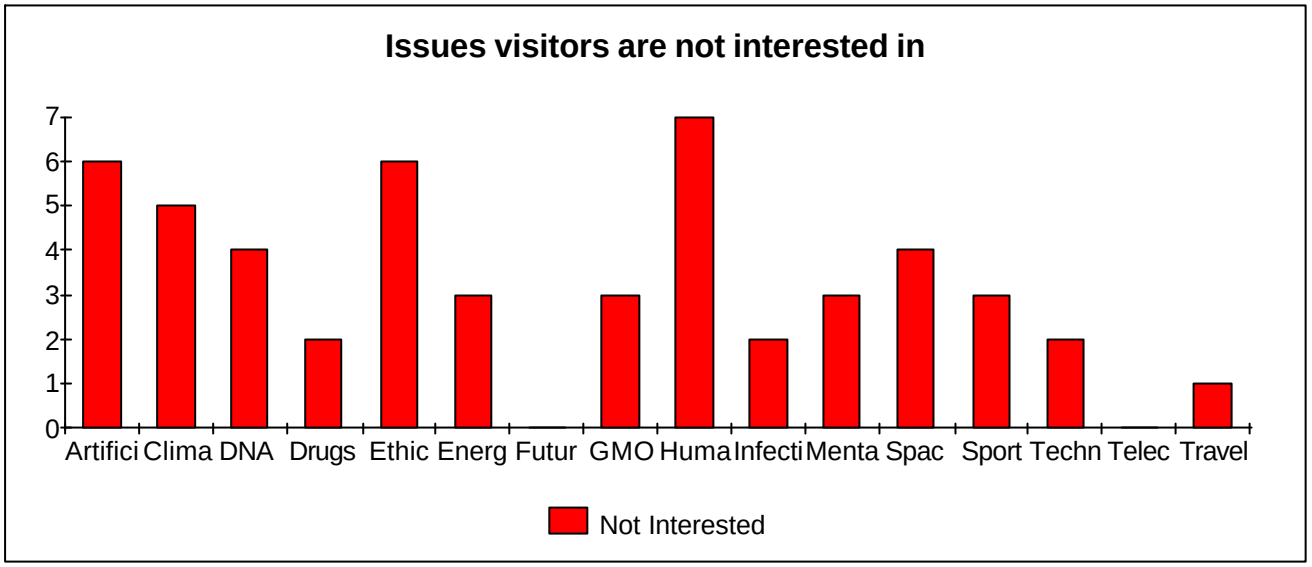

Diagram 3.5. Number of visitors answering Not Interested.

Issues that people answered that they are not interested in were most often Human Fertility Testing, with 7 people rating it as Not Interesting, which equals to 8.8%. The second least liked issues were Artificial intelligence and Ethics.

Interest level of particular issues

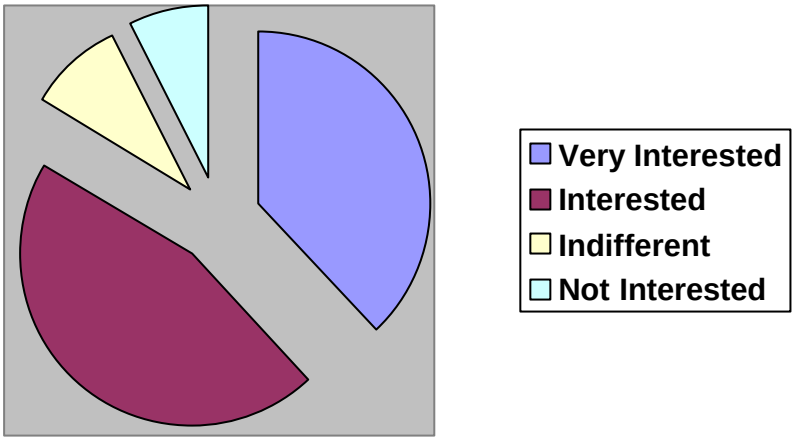

Diagram 3.6 Percentages of Interest level in Artificial Intelligence.

Artificial Intelligence was rated as Very Interesting by 38 %, Interesting by 45.6 %, 8.9 % said they were Indifferent towards the issue, and 7.6 % were Not Interested.

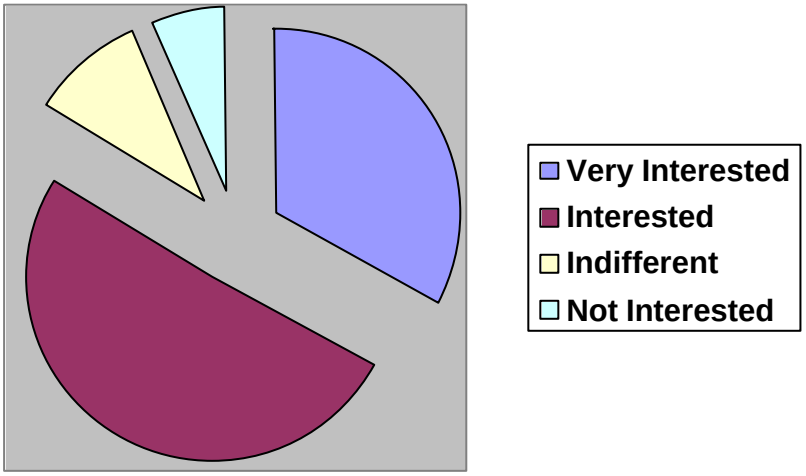

Diagram 3.7 Percentages of Interest level in Climate Change.

On the issue Climate Change 32.9 % said they were Very Interested, 50.6 % said they were Interested, 10.1 % were Indifferent and 6.3 % were Not Interested in the issue.

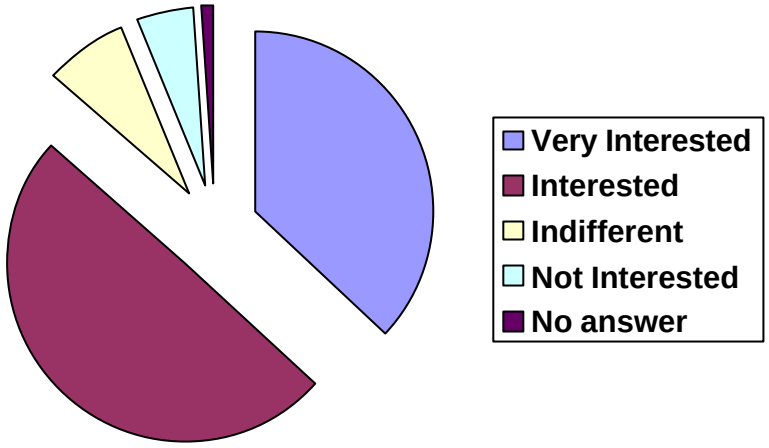

Diagram 3.8 Percentages of Interest level in DNA & Genetics research.

DNA & Genetics Researchwas rated as Very Interesting by 36.7 % and Interesting by 49.3 %. 7.6 % said they were Indifferent towards the issue, while 5 % responded that they were Not Interested. 1.1 % preferred not to give any answer.

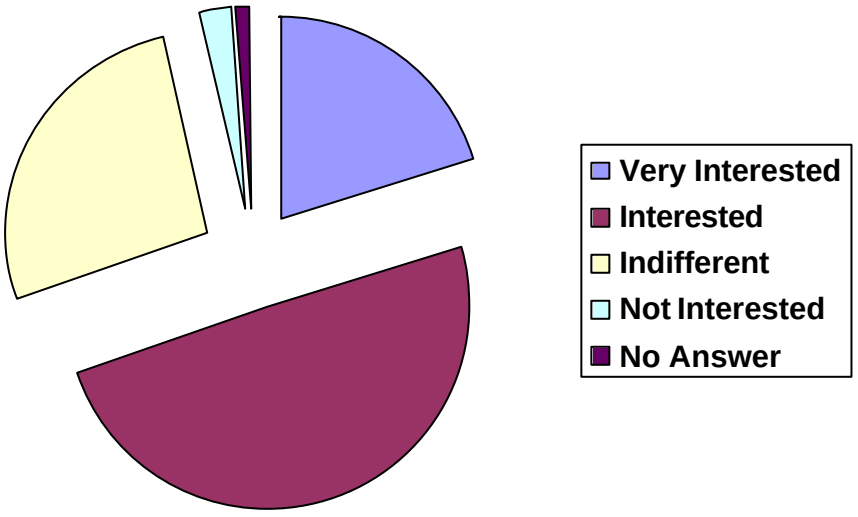

Diagram 3.9. Percentages of Interest level in Drugs & Alcohol.

On the issue Drugs & Alcohol 20.2 said that they were Very Interested, 49.3 % were Interested, 26.6 % were Indifferent, 2.5 % were Not Interested, and 1.1 % gave no answer.

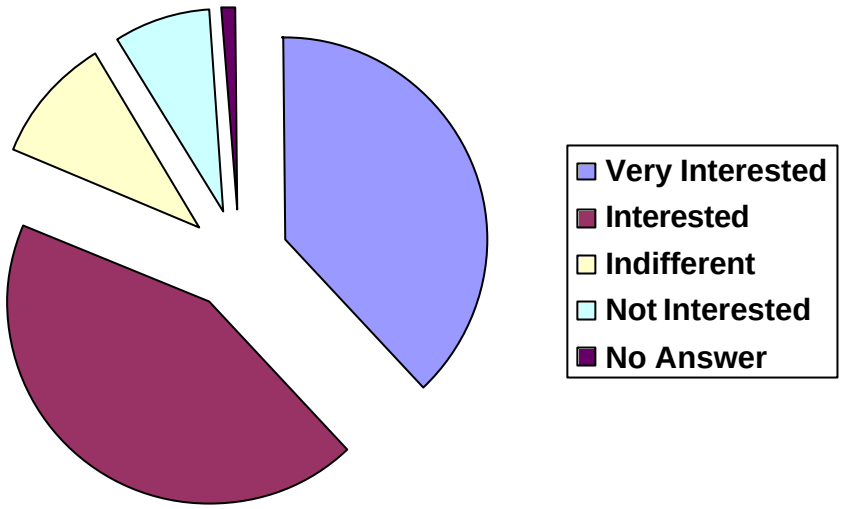

Diagram 3.10.Percentages of Interest level in Ethics in Science.

Ethics in Science was rated as Very Interesting by 38 % of the sample, while 43 % rated it as Interesting. 10.1 % were Indifferent, 7.6 were Not Interested and 1.1 % gave no answer.

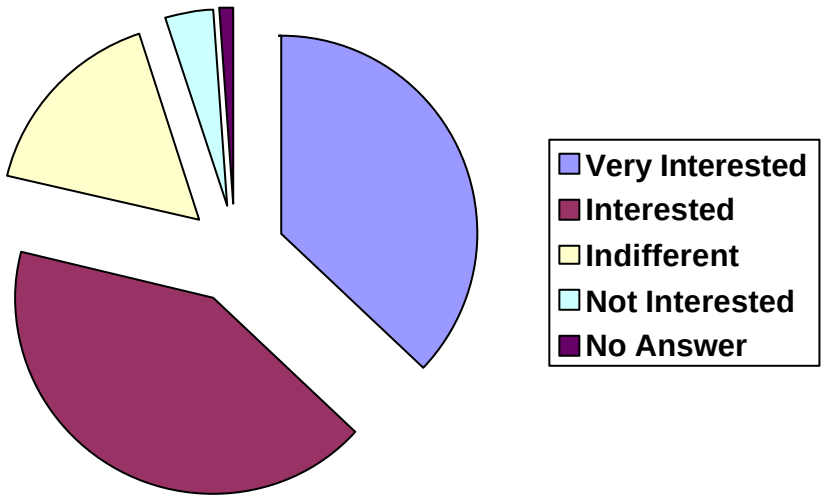

Diagram 3.11. Percentages of Interest level in Energy.

Energy was Very Interesting to 36.7 %, Interesting to 41.2 %, 16.4 % were Indifferent, while 3.8 % were Not Interested. No answer was given by 1.1 % of the sample.

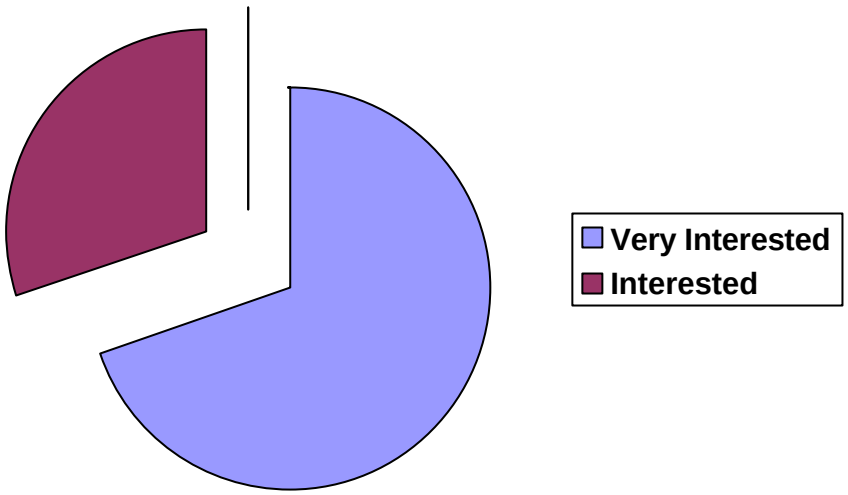

Diagram 3.12. Percentages of Interest level in Future.

On the issue Future 69.6 % said they were Very Interested, while 30.4 % said that they were Interested.

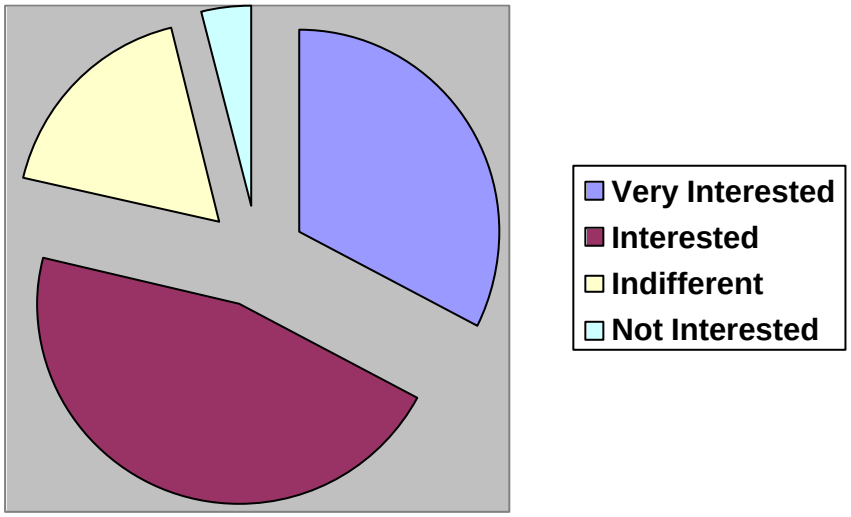

Diagram 3.13. Percentages of Interest level in GMO.

GMO was rated as Very Interesting by 32.9 %, Interesting by 45.6 %, 17.7 % were Indifferent, while 3.8 % said they were Not Interested.

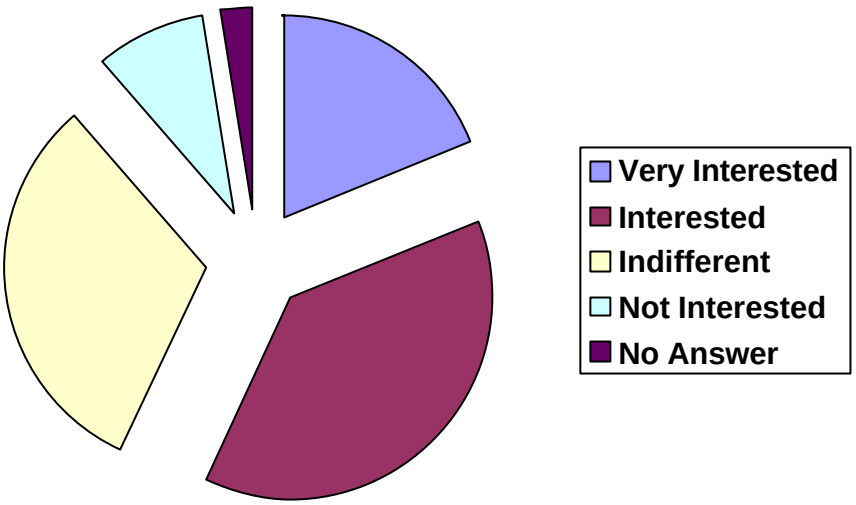

Diagram 3.14. Percentages of Interest level in Human Fertility Testing.

On the issue Human Fertility Testing 19 % were Very Interested while 38 % were Interested. 31.6 % were Indifferent, while 8.9 % were Not Interested. No answer was given by 2.5 % of the sample.

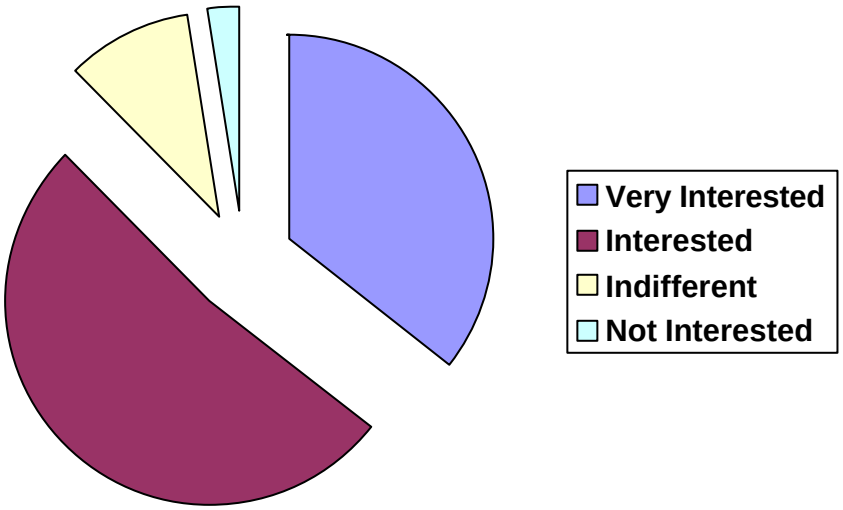

Diagram 3.15. Percentages of Interest level in Infectious Diseases.

Infectious Diseases was a Very Interesting issue to 35.4 % of the sample, while 51.9 % thought it was Interesting. 10.1 % were Indifferent towards the issue, while 2.5 % were Not Interested.

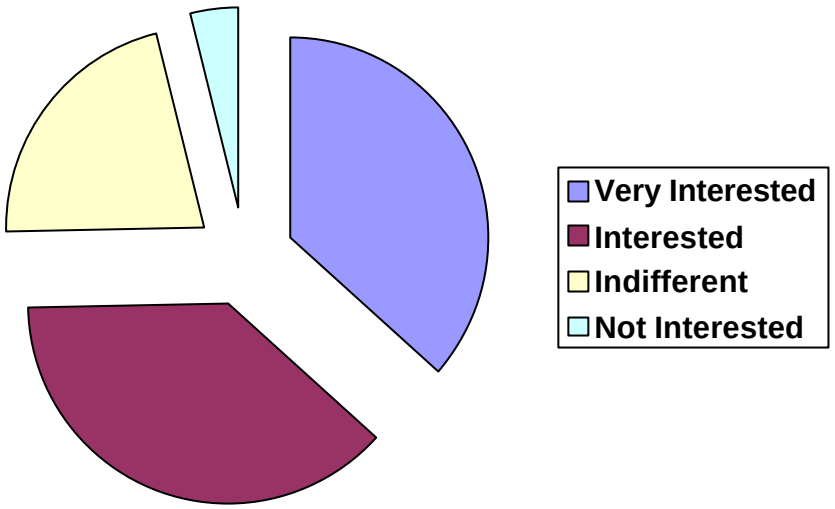

Diagram 3.16. Percentages of Interest level in Mental Illness.

36.7% of the sample were Very Interested in Mental Illness, while 38 % were Interested. 21.5% were Indifferent and 3.8% were Not Interested.

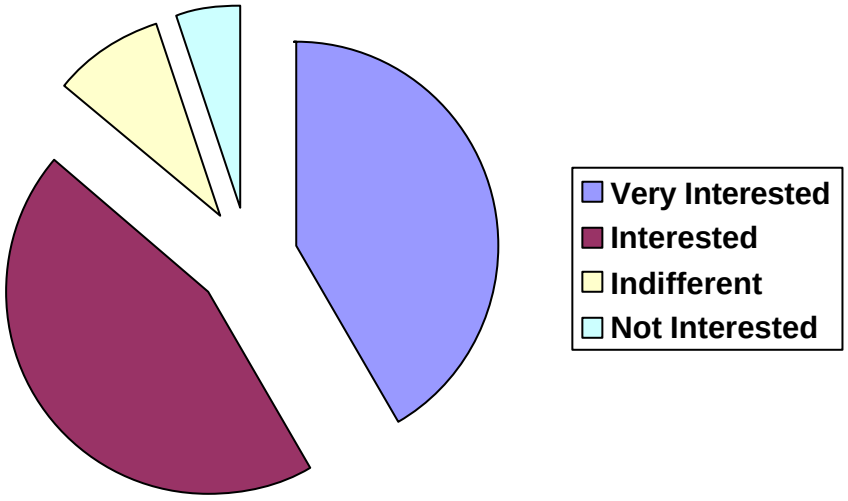

Diagram 3.17. Percentages of Interest level in Space Exploration.

Space Exploration was Very Interesting to 41.8%, and 44.3% were Interested. 8.9 % were Indifferent while 5.1 % were Not Interested.

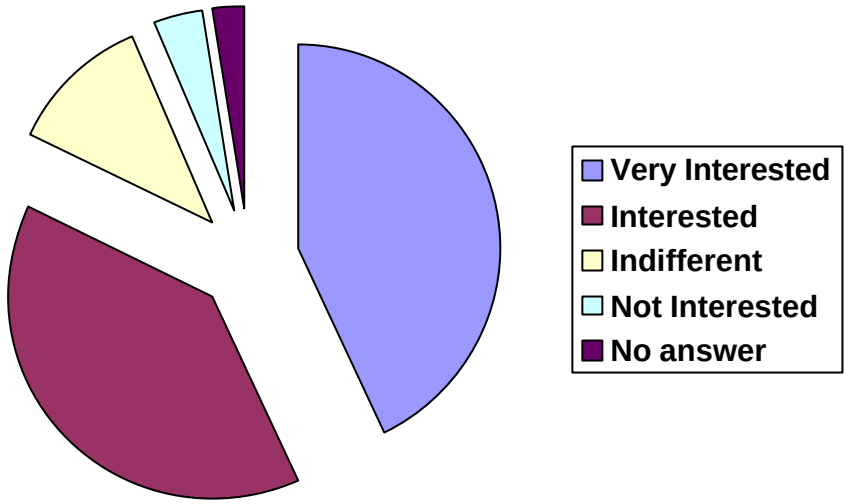

Diagram 3.18. Percentages of Interest level in Sports.

On the issue Sports 43 % were Very Interested and 39.2 % were Interested. 11.4 % were Indifferent, while 3.8 % were Not Interested. 2.5 % preferred to give no answer.

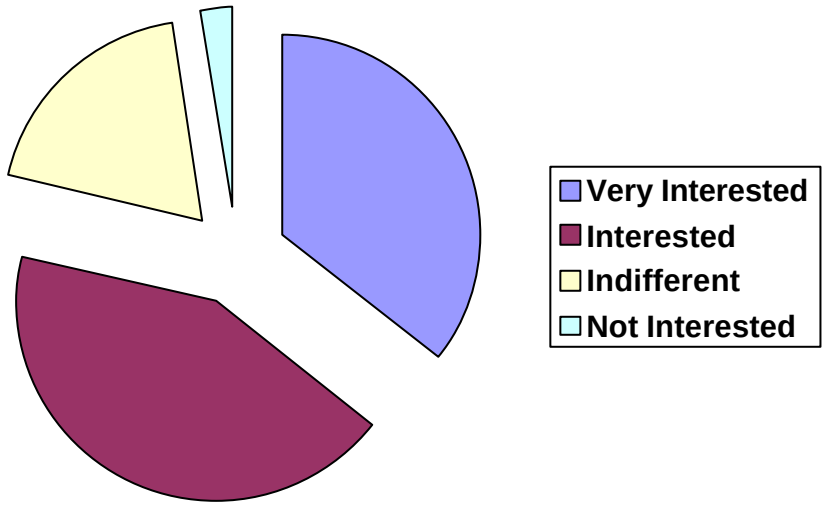

Diagram 3.19. Percentages of Interest level in Technology.

35.4 % were Very Interested in Technology and 43 % were Interested. 19 % were Indifferent, while 2.5 % were Not Interested.

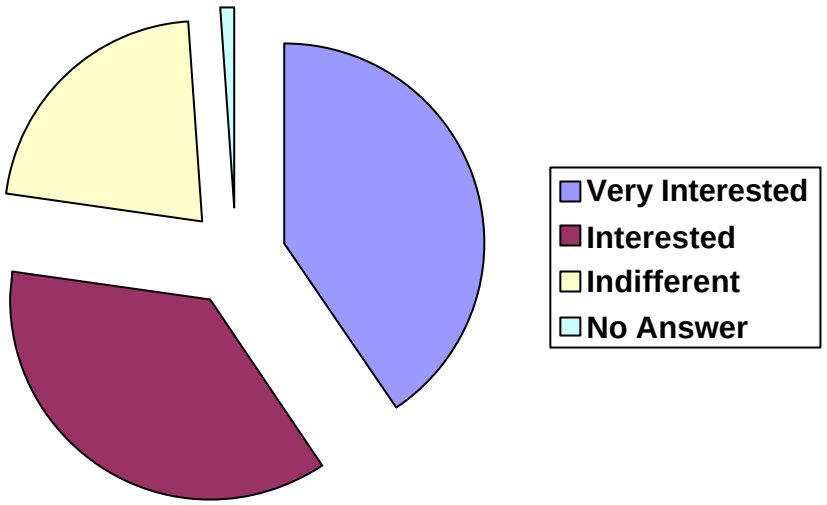

Diagram 3.20. Percentages of Interest level in Telecommunication.

Telecommunication was a Very Interesting issue to 40.5 % of the sample, while 36.7 % saw it as Interesting. 21.5 were Indifferent towards Telecommunication. 1.1 % gave no answer.

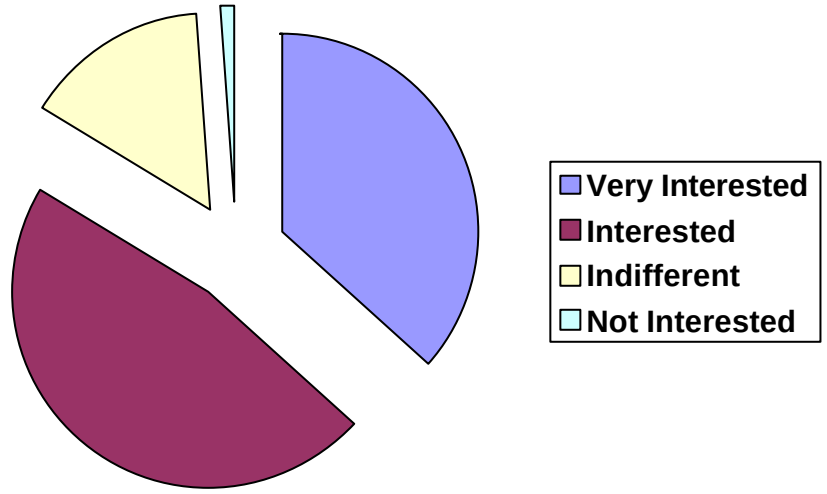

Diagram 3.21 Percentages of Interest level in Travel & Transport.

36.7 % were Very Interested in Travel & Transport, while 46.8 % were Interested. 15.2 % were Indifferent towards the issue, while 1.1 % were Not Interested.

3.2.2. Devices and techniques of interest

The visitors had the opportunity to share their interest in what devices and techniques to be used when addressing contemporary science issues in At-Bristol. The options were:

- Objects
- Graphic panels
- Opinion Banks
- Computer Games
- Internet
- Radio
- Film
- Newspapers
- Lab Experiments
- Drama
- Meet the Expert
- Workshops
- Debates
- Talk show style - debates
- Citizen Juries
- Audience Voting
- Seminars

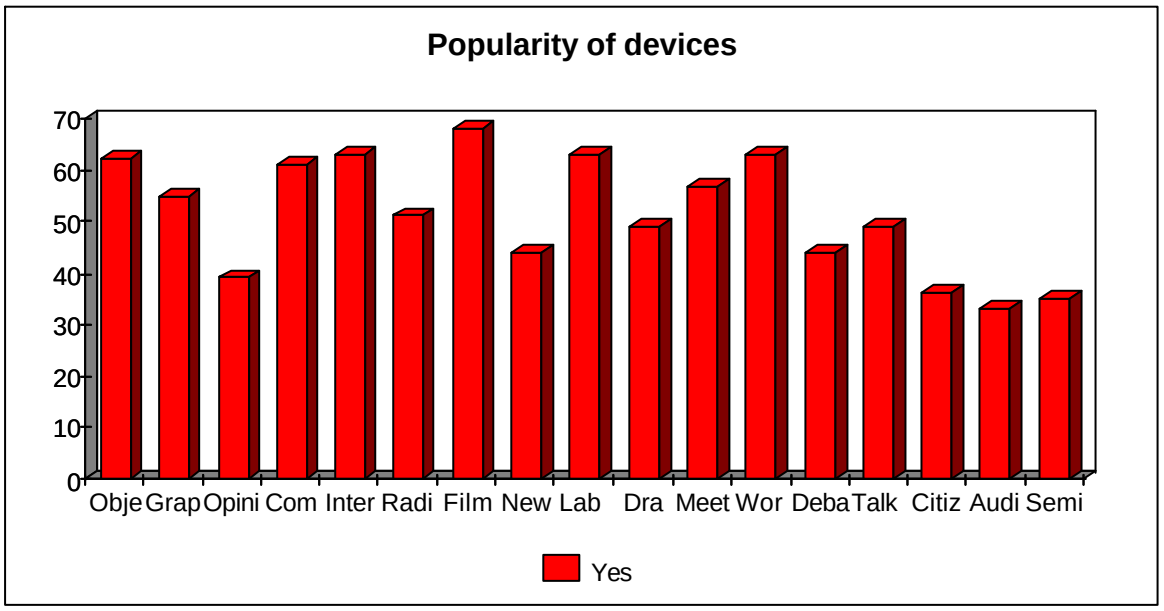

Diagram 3.22. Number of visitors that want to use different devices.

The technique that was most popular was Film, 68 persons said they wanted this technique to be used for presentations of contemporary science, which equals to 86 % of the sample. The second most liked techniques were Lab Experiments and Workshops, favoured by 63 persons each, equally to 80% of the survey sample.

The devices that the least people were positive towards were Audience Voting with 33 persons saying yes, equal to 41 % and Seminars with 35 persons saying yes, equal to 44.3 % of the sample.

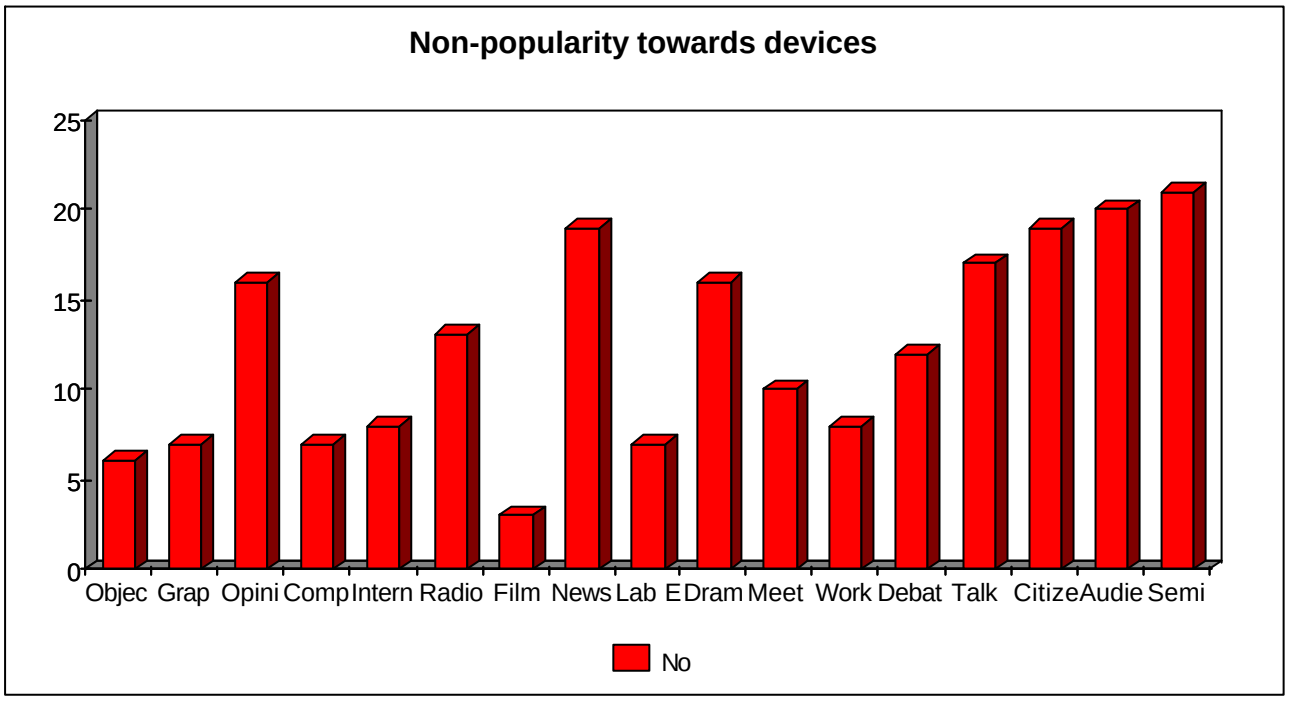

Diagram 3.23. Number of visitors that do not want to use different devices.

The technique that the visitors were most negative towards was seminars, 21 people which equals to 26.6 % of the visitors, said that they would not like this technique to be used in a science centre. The second least liked device was Audience Voting with 20 people or 25.3 %.

The techniques that people were least negative towards was Film with 3 persons responding no, equal to 3.8 %, and Objects, where 6 persons said no, equal to 7.6 % of the sample.

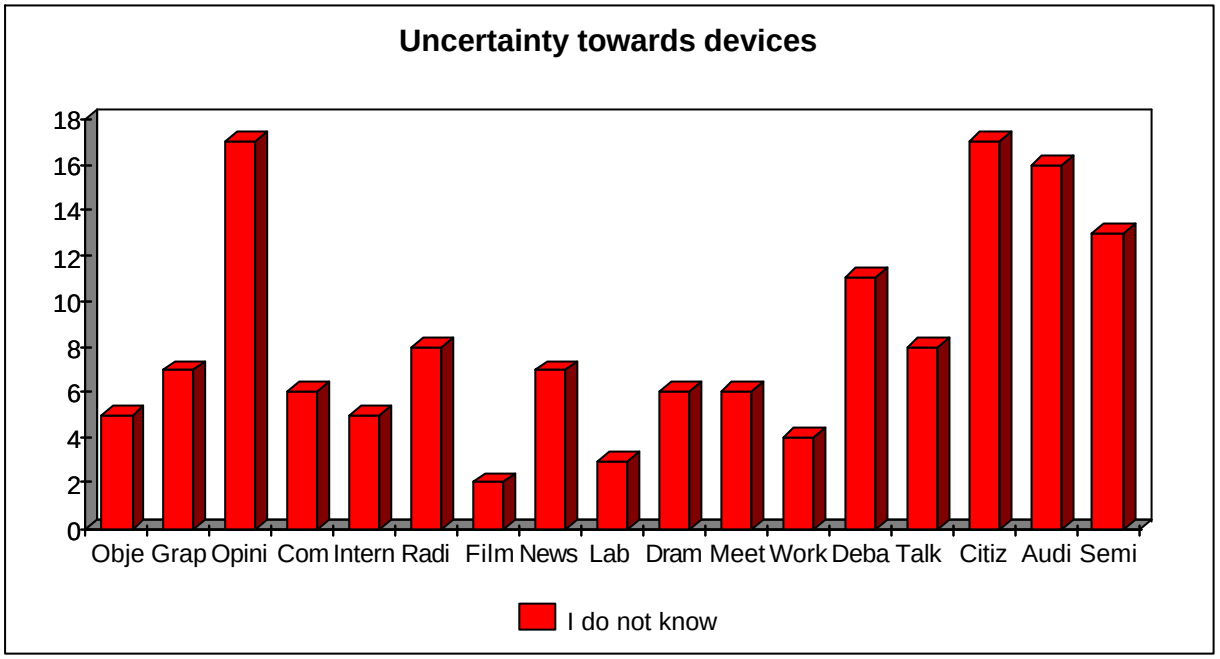

Diagram 3.24. Number of visitors that are not sure if they want to use different devices.

The devices that the visitors said they did not know their opinion about were most often Opinion banks and Citizen Juries, both with 17 persons saying I do not know, which equals to 21.5 of the sample.

The technique that there were the least uncertainty about was Film, with 2 persons not being sure, which equals to 2.5 %. The device with the second least uncertainty around it was Lab Experiments, with 3 persons responding I do not know. That equals to 3.8 %.

4. Conclusions and Discussion

This chapter consists of conclusions based on the results found in this study and their connection to literature, as well as a discussion on whether the aim and objectives were complied in a satisfactory way.

According to Allan (2002), science centres are striving to develop "participatory" strategies that inspire fresh ways of thinking about science and technology. Macdonald (2002), argues that the ultimate ambition of public understanding of science programmes is often expressed in terms of enabling the public to participate more fully as citizens. In order to do so, it is regarded as vital that the public has a better understanding of science because it is assuming an ever-greater importance in the contemporary world. So making "science accessible" is seen as the route to providing "understanding" and this, in turn, as a way of enabling the public to make rational choices. Although "making accessible" might mean various things, it is often equated with making science "fun", "enjoyable", and "user-friendly". However, if citizens are to be able to evaluate science and make informed choices they need to be able to understand its potential benefits *and* risks; they need to notice its presence in their everyday lives *and* its distant and global effects which may be far less visible to them. Furthermore, Driver et al (1996) stress that science does not exist in a social and cultural vacuum. The technological products of scientific understanding have a major effect on our daily lives and the influence of scientific knowledge and methods of enquiry colour our view of the world and of ourselves.

The majority of the professionals that were interviewed also mention the great importance of a better scientific literacy amongst the public, and that contemporary science issues were very important to address in institutions like science centres. This would bring a great guidance for the public not only particularly in science issues, but also in order for them to make more informed choices in all sorts of issues that have a direct or indirect influence on their lives.

Durant (2004) distinguishes between what he calls "finished" and "unfinished" science. Finished science represents the body of scientific knowledge that scientists take for granted as they go about their work, and unfinished science represents the work itself. Notoriously, finished science dominates the lives of most science teachers and students, whereas by contrast unfinished science dominates the thoughts and activities of working scientists. Clearly, the boundaries between finished and unfinished science are not fixed. It is commonplace among exponents of science and scientific method that all scientific findings – however apparently "finished" – are open in

principle to challenge and revision. What is taken for granted by the scientific community at one time can come to be regarded by the same community as in need of radical revision.

In the interviews, it is stressed by some of the professionals that science is ever evolving, and if only science that is "finished" is presented, then people are not really being told about the whole enterprise of what science is. Furthermore, it is of great importance to eliminate misunderstanding and disillusions that science should be equal to the truth. Scientific knowledge is based on temporary conclusions, which could be revised whenever new knowledge is added. When encouraging a dialogue on contemporary science issues in science centres, the process of scientific investigation could be better understood by the public. Some of the professionals also stress that the public at present are in a process of becoming more and more aware of the world around them and that contemporary science as a part of that world is ever changing. Hence, they will also be more scientific literate.

A suggestion made by some of the interviewees was that one way of addressing the "open questions" issue could involve having games where different outcomes and different people's opinions could be seen. That can encourage people to think about what the possibilities could be, what it would result in, and how they would live their lives as a result of that.
One of the findings of the questionnaire was in fact that computer games were among the most popular techniques to use. A previous study by Bradburne & Wake (1994) of the exhibition "Mine Games" at Science World, Vancouver, Canada, state that the use of simulation games proved very popular and successful.
I believe that the reason for this kind of technique being so popular is that visitors feel that they get the opportunity to be in power for a while, without the risk of consequences afterwards. During their efforts to master the game, they will slowly but steadily realise that knowledge not only means power, but also is fun.

The most popular technique was Film. This was not very surprising, since At-Bristol also have an IMAX theatre which is very popular. Probably some of the visitors had those films in mind. However, I do believe that the visitors also very much appreciate exhibitions and events that includes moving images and films. That makes the activities much more lively and vibrant. Closely after Film, in terms of popularity among the visitors came Lab Experiments and Workshops. The visitors here get a chance to play the role of a scientist for a short while, to investigate and learn. They get an opportunity to be creative and use their own body and mind. The explainers working in At-Bristol stated in a survey that it is good if there is also an opportunity to take material home.
I believe that the visitors engaging in these kinds of activities can get a feeling of both power and satisfaction over the fact that they achieved something, produced something or were part of the process. As they become personally engaged with contemporary science, they also are more likely to support it.

A reason for the popularity of these techniques could be the engagement continuum that Einsiedel & Einsiedel (2004) are talking about, along which a museum's activities can be located. To which degree is the activity interactive or passive? On the interactive side of the continuum, the public understanding of research occurs in a social, economic, political, and environmental context of society. In this context, the learners are regarded as experts in their own right, adults whose experiences, perceptions, beliefs, and concerns are valued and recognized as another valid

way of knowing. The passive side of the continuum can be suggestive of the traditional role of museums where content – whether it was artefacts, historical, artistic, or scientific knowledge – was presented without representations of context. Activities on the interactive side of the engagement continuum are learner centred, collaborative, and inquiry based. Inquiry learning involves understanding knowledge in the context of authentic and personally relevant problems and meaningful tasks.
Lab experiments, Workshops and "Meet the Expert" all fits well into the criteria for being on the interactive side of the continuum, and that might also be the reason for its popularity among the visitors.

The Wellcome Trust and the OST believe that an "engagement model" of science communication – a two-way dialogue between specialists and non-specialists – is more appropriate than the "deficit model", which just gives people more information about science (2000). While stimulating and informing an inclusive debate involves the dissemination of scientific information, it also requires the identification of "hooks" which link in with people's everyday lives and concerns – so that their attention is attracted and information retained (ibid.).

The presentation of unfinished science (Durant, 2004) obliges museums to engage with their visitors in new ways. No longer can a museum or science centre pretend to "have all the answers" and no longer, either, can it presume that the role of the visitor is simply to look, to listen, and to learn. When the science is unfinished, the story must be open-ended, and the true import of what is being dealt with must remain open to question. Mayfield (2004) argues that we are moving into an era when visitors are co-authors of content, not merely the passive recipients of expert knowledge. Several museums and science centres have begun to move in this direction; producing exhibitions and programs that plainly value the visitors' input and make their opinions part of the show.

A finding from the interviews is that dialogue could also help prevent people's knowledge base from getting distorted. People tend to pick up only small bits of information. They are remembering some bits but not the whole picture. An increased dialogue could, as well as bridging the gap between scientists and citizens, get people to find out things directly from the scientists rather than just believe what they watch or read in the news. The more people get involved in a longer term ongoing dialogue, the less likely they are to have the wrong perceptions of things.

From the questionnaires with visitors, it was found that many people would like to "Meet the Expert". This was one of the most popular techniques. I believe the reason for this is that people realise that if they get to meet a person that works with the issue in focus, they will be able to get answers to their questions directly from someone that is closely involved in the process of change.

Einsiedel & Einsiedel (2004) and Ucko (2004) mention the contact between scientists and visitors as a way to understand scientific research. The scientists could be observed while conducting research in the museum itself. The visitors have the opportunity to ask questions directly to the scientist, without any middle-man or facilitator. However, the scientists that participate must be chosen because of the potential audience interest in the topic, and they must have a strong willingness to participate.

This is also one of the findings in the interviews with the professionals. All the interviewees believe that the most important characteristic for a scientist to have, when participating in events, is to be a good communicator. It doesn't matter how much knowledge the person has if he or she cannot communicate it in an interesting, energetic and meaningful way. If there is a dull performance, the audience are not motivated to listen.

The public should have a chance to form their own opinions and to debate different issues of their concern. I believe that science centres can be useful tools in this ever-ongoing process. With the use of different media within the science centre environment, a broader awareness of, and thereby hopefully also a deeper understanding of, contemporary science and scientific processes can be brought about.
The professionals stressed the great importance of having as many varieties of presentation techniques available as possible. Not everybody learns in the same way.

The professionals also thought that the encouragement of a dialogue on contemporary science issues is very important. However, the findings of the questionnaires show that the most dialogue-encouraging devices, at least in the direct sense of it, are the techniques least liked by the visitors. Audience Voting, Opinion banks and Citizen Juries all rate high on the list of devices that people do not want to use or facilitators to use, in the science centre. Maybe the visitors are not as interested in having their say, at the same time as the literature and the professionals state that it is very important to get the visitors their voice. In that case, we have a sad situation where science communicators strive in a direction that is not wished for by the public. Perhaps it is too early to predict anything, since these kinds of activities is yet in an early phase of their development.

However, there were also many visitors that said "I do not know" on these techniques. These answers might depend on that they simply do not know what these techniques involve. Would the opinion for the use of these techniques be different with an audience other than the At-Bristol visitors? At present, At-Bristol has not yet developed many of these kinds of events. The Citizen Science Programme is however one excellent initiative that is currently running, that moves in this direction. My opinion is that it is crucial to try to find hooks in a particular issue and in the way of presenting it that really makes the visitors motivated to engage in dialogue. But dialogue is however complicated to analyze, because unlike with learning behaviour there are not any specific factors/indicators that makes dialogue. However, in The Citizen Science Programme Policy document (2002), five phases in action when engaging in a dialogue process are listed. These are Discover, Discuss, Decide, Articulate and Take Action. These are very good focus points. The current research is also a part of the process to start the development of more dialogue-encouraging activities.

Dana Centre in London has concentrated entirely on these kinds of dialogue-focused events. Hence the audience of Dana Centre might have thought otherwise than the At-Bristol audience, if they were to answer the questionnaire of this study. Through the experimenting with different styles of events the Dana Centre was able to develop an understanding of the effectiveness of a range of formats for presenting content to the target audience. What they found was for example that the format of the event itself is critical in facilitating dialogue at an event. By asking participants to discuss in small groups rather than as a large audience body proved to be highly

successful. I agree with that completely, but I also think it very much depends on the demographics of the group in focus. For example amongst teenagers, peer pressure can be a strong force, and therefore a smaller size of the group might help encourage everyone to engage in dialogue and discussion. The issue in focus of the discussion is also an important factor; some issues might be more controversial and therefore more difficult to speak freely about.

When it comes to what issues to be addressed in science centres, the majority of the professionals thought it was of the greatest importance to address the issues that are relevant to people's everyday lives, and what is currently debated in society.
However, some professionals mentioned fields of issues that they thought would become very important today and in the nearest future. These were biotechnology, information technology, nanotechnology and environmental issues.

When asking the visitors of At-Bristol about what issues they would like At-Bristol to address, the issues that were most popular were Future, Infectious Diseases, DNA & Genetics Research, and Climate Change. These are all issues that are very relevant to their everyday lives, and it also suits well into what the professionals thought was of greatest importance.
One conclusion of the OST and Wellcome Trust study is that there is a lack of a framework within which people can access information about new science, access and judge the information and its implications. By coordinating activities, organizations with different perspectives and objectives can begin to address certain clusters with different provisions for science communication, providing a framework for a national debate.

Bradburne (1998) argues that science centres, if they are to be new learning platforms, must stress the acquisition of new skills, not just information. These skills are largely shared by art, science and technology alike—creativity, collaboration, abstraction, thinking in terms of systems. The common ground provided by putting the accent on skills has the effect of making less important the distinctions formerly made according to content—science, ethnology, history, fine arts. Of course information is still indispensable, but it must be linked to the skills of finding, using and appropriating that information.
A new learning platform must place its emphasis on what is unique to its specific locality, and on what cannot be found or done somewhere else. It must set a premium on local culture, local practices, and local experience. It must be firmly rooted in its local conditions, and use them to build a community commitment to the institution (ibid.).

The majority of the professionals interviewed in this study welcome a deeper level of cooperation between science centres and between science centres and other organisations. I believe that these cooperation activities could be very fruitful, but I think that it is important to focus on sharing pedagogical ideas and methodologies, rather than sharing exhibits and equipment. Since every science centre differ from the other, the context of a ready-built exhibit never really fit completely with the context of the institution that borrow it. Visions and ideas however, could always be transformed to suit local circumstances before being put into practice.

The aim of the current study was to determine characteristics of what kind of techniques to use and what issues to address in the "Live Science" areas in At-Bristol Science Centre. This was done through interviews with professionals and questionnaires with visitors, which I believe was satisfying ways to get the information needed. The knowledge gained from the interviews with the professionals was very valuable. However, the information retrieved from the visitors could perhaps have been more voluminous and solid if a more qualitative method would have been used there as well as with the investigations in opinions of the professionals, as for instance focus groups or interviews.

The current study involved professionals in science communication in a western world context. An idea for further research would be to investigate the situation of science centres, and their communication of contemporary science, in other parts of the world.
Another area of research could be to compare the opinions of visitors to different science centres, within the same country, as well as comparisons between two or more countries.

5. References

Aldridge, Catherine (2002). *Citizen Science Programme Policy document.* Unpublished.

Allan, Stuart (2002). *Media, Risk and Science*. Issues in Cultural and Media Studies. Buckingham: Open University Press.

Barbosa da Silva, António (1996). Analys av texter. In *Kvalitativa studier i teori och praktik*, ed. Svensson, Per-Gunnar & Starrin, Bengt. Lund: Studentlitteratur. (p169-206)

Bennett, Jim (2000). Beyond understanding – Curatorship and Access in Science Museums. In *Museums of Modern Science*, ed. Lindqvist. Canton, MA, USA: Science History Publications. (p55-60)

Bennett, Tony (1995) *The Birth of the Museum – History, theory, politics.* London: Routledge.

Bloom, Joel (1992). Science and technology museums face the future. In *Museums and the public understanding of science,* ed. Durant. London: Science Museum. (p 15-20)

Bradburne, James M. (1998). Dinosaurs and White Elephants: the Science Centre in the 21st Century. *Museum Management and Curatorship*, Vol. 17, No. 2, pp. 119–137. U.K.: Elsevier Science Ltd.

Bradburne, James M. & Wake, Drew Ann (1994). *Mine Games – the science centre as social forum.* La Revue Spring Edition 1995. Amsterdam: Wake & Bradburne Partnership.

Brookes, Bill (1992). Asking the public what they want. In *Museums and the public understanding of science*, ed. Durant. London: Science Museum. (p 97-100)

Cathery, Andrew. & Aldridge, Catherine (2004). *Live Science Arena – Exhibition Brief.* Unpublished.

Collins, Valerie (2004). Private Communication.

Colwell, Rita R. (2003). The Role of the Citizen. In *A Parliament of Science: Science for the 21st Century*, ed. Tobias, Michael & Timmers, Teun & Wright, Gill. Albany: State University of New York Press. (p72-77)

Cossons, Neil (2000). Museums in the New Millennium. In *Museums of Modern Science*, ed. Lindqvist. Canton, MA, USA: Science History Publications. (p3-13)

Derry, Gregory Neil (1999). *What science is and how it works.* Princeton, NJ: Princeton University Press.

Dolby, Riki G. A. (1996). *Uncertain knowledge – an image of science for a changing world.* Cambridge: Cambridge University Press.

Driver, Rosalind. & Leach, John. & Millar, Robin. & Scott, Phil. (1996). *Young people's images of science.* Buckingham: Open University Press.

Durant, John (2003). Hope, Anxiety, and Doubt: The Public View of Science. In *A Parliament of Science: Science for the 21st Century*, ed. Tobias, Michael & Timmers, Teun & Wright, Gill. Albany: State University of New York Press. (p62-71)

Durant, John (2004). The Challenge and the Opportunity of Presenting "Unfinished Science". In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p 47-60)

Einsiedel, Albert A. Jr. & Einsiedel, Edna F. (2004). Museums as agora: Diversifying Approaches to Engaging Publics in Research. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p73-86)

Farmelo, Graham (2004). Only Connect: Linking the Public with Current Scientific Research. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p 1-26)

Fehlhammer, Wolf Peter (1997). Contemporary Science in Science Museums – A Must. In *Here and Now – Contemporary Science and Technology in Museums and Science Centres*, ed. Farmelo, Graham & Carding, Janet. London: Science Museum. (p 41-50)

Friedman, Alan J (2000). Museums, Communities and Contemporary Science. In *Museums of Modern Science*, ed. Lindqvist. Canton, MA, USA: Science History Publications. (p43-51)

Gammon, Ben (2004). *Final report: Naked Science – 18 months of Contemporary science dialogue events.* Unpublished.

Hein, George E. (1998). *Learning in the Museum.* London: Routledge.

http://www.astc.org/resource/visitors/index.htm

http://www.at-bristol.org.uk

http://www.at-bristol.org.uk/cz/Default.htm

Jackson, Roland (1997). The Virtual Visit: Towards a New Concept for the Electronic Science Centre. In *Here and Now – Contemporary Science and Technology in Museums and Science Centres*, ed. Farmelo, Graham & Carding, Janet. London: Science Museum. (p173-179)

Kelman, Ian. (1995) Responsive evaluation in museum education. In *Museums, Media, Message*, ed. Hooper-Greenhill, Eileen. London: Routledge. (p204-212)

Kvale, Steinar (1997). *Den kvalitativa forskningsintervjun.* Lund: Studentlitteratur.

Lewenstein, Bruce V. & Bonney, Rick (2004). Different Ways of Looking at Public Understanding of Research. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p63-72)

Lindqvist, Svante. (2000). Introduction: Einstein's Pipe. In *Museums of Modern Science*, ed. Lindqvist. Canton, MA, USA: Science History Publications. (p VII-XII)

Loomis, Ross J. (1993). Planning for the visitor: the challenge of visitor studies. In *Museum Visitor Studies in the 90s*, ed. Bicknell, S. & Farmelo, G. London: Science Museum. (p13-23)

Macdonald, Sharon (2002). *Behind the scenes at the Science Museum*. Oxford: Berg.

Mayfield, Heather (2004). What about the Audiences? Tailoring PUR Programs for Museum Visitors. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p109-126)

Mazda, Xerxes (2004). Dangerous Ground? Public Engagement with Scientific Controversy. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p127-144)

Miles, Roger (1993). Grasping the greased pig: evaluation of educational exhibits. In *Museum Visitor Studies in the 90s*, ed. Bicknell, S. & Farmelo, G. London: Science Museum. (p24-31)

Office of Science and Technology and the Wellcome Trust (2000). Science and the Public: A Review of Science Communication and Public Attitudes to Science in Britain. London: The Wellcome Trust.

Penny, Helen (2004). *Explainer Survey Results.* Unpublished.

Persson, Per-Edvin (2000) Science centres are thriving and going strong! *Public Understanding of Science,* No 9, 2000. pp 449-460. UK: IOP Publishing Ltd and The Science Museum.

Popper, Karl (1989). *Conjectures and Refutations – The Growth of Scientific Knowledge, 5th edition.* London: Routledge.

Quin, Melanie (1997). Programming for Success: People take Centre Stage. In *Here and Now – Contemporary Science and Technology in Museums and Science Centres*, ed. Farmelo, Graham & Carding, Janet. London: Science Museum. (p77-82)

Schaffer, Simon (1997). Temporary Contemporary: some Puzzles of Science in Action. In *Here and Now – Contemporary Science and Technology in Museums and Science Centres*, ed. Farmelo, Graham & Carding, Janet. London: Science Museum. (p31-39)

Sismondo, Sergio (2004). *An introduction to science and technology studies*. Oxford: Blackwell Publishing.

Sjöberg, Svein (2000). *Naturvetenskap som allmänbildning – en kritisk ämnesdidaktik*. Lund: Studentlitteratur.

Starrin, Bengt & Renck, Barbro (1996) Den kvalitativa intervjun. In *Kvalitativa studier i teori och praktik*, ed. Svensson, Per-Gunnar & Starrin, Bengt. Lund: Studentlitteratur. (p52-78)

Stewart, Larry (2004). La buona e non mascherata filosofia, or the Exhibitionists. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p 29-46)

Storksdieck, Martin & Falk, John (2004). Evaluating Public Understanding of Research Projects and Initiatives. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p87-108)

Ucko, David A. (2004). Production Aspects of Promoting Public Understanding of Research. In *Creating Connections – Museums and the Public Understanding of Current Research*, ed. Chittenden, Farmelo, & Lewenstein. Walnut Creek: Altamira Press. (p211-234)

U.K. House of Lords (2000). *Science and Society. Report of the House of Lords Select Committee on Science.* London: Her Majesty's Stationary Office.

Ziman, John (2000). *Real Science: what it is, and what it means.* Cambridge: Cambridge University Press.

Appendices

Interview guide

Dialogue

Do you think contemporary science should be presented in science centres and museums? Why is it important?

What do you think constitutes the “dialogue” model”?

What sorts of advantages could there be in strengthening a dialogue between science/scientists and (other members of the public)/citizens?

What issues should be presented?

Are there any issues that should be avoided/are taboo?

What do you describe as the most challenging issue to present in a science centre?

How do you balance facts & evidence/ethical issues/policy issues?

How would you present the fact that there are open questions in contemporary science, as it is of a changing nature?

How can you capture people’s opinions?

Should you censure views?

Devices

How can contemporary science best be presented in science centres? Give some examples.

? Hands-on exhibits
? Interactive exhibits
? Objects
? Graphic panels
? Debates
? “Talk show” style - debates
? Drama
? Consensus conferences
? Citizen juries
? Lab experiments
? Newspapers
? Journals
? Radio
? Video recording
? Movie making
? PDA (personal data assistant; Palm Pilot? or equivalent.)
? Data point
? Computer games
? Swipe cards
? Internet
? Opinion banks (electronic/on paper)
? Audience Voting
? Meet the expert/scientist in residence
? Workshops
? Seminars
? Suggestion boxes
? Other

What are the issues of working with experts, and how are they selected?

Should there be an area dedicated to contemporary science issues, or should it be integrated into other exhibitions?

How should a venue, which is meant to be presenting contemporary science, be designed?

Open spaces	Private spaces
Colours	Light
Acoustics	Textures

Audiences

Are there any target group(s) that is/are particularly difficult to reach?

Should a science centre focus on one target group in particular, or rather try to reach an audience that is as broad as possible?

What could be seen as challenges with having contemporary science in science centres?
? Practicalities (outreach, staffing etc.)
? Costs
? Issues – is it appropriate for the audience?

How could science centres co-operate?
? Locally
? Nationally
? Internationally

How important is it for a science centre to have autonomy? (Not governed by other instances (government, business etc.)

Visitors questionnaire

We would like your views. At-Bristol is currently redeveloping the exhibitions on the First Floor of Explore. We are planning an exciting new exhibition, called "Live Science". This will be all about science in the news, and cutting edge discoveries. Please spend a moment of your time giving us your input.

Age (Please tick appropriate)

10-19 ( ) 20-29 ( ) 30-39 ( ) 40-49 ( ) 50-59 ( ) 60+ ( )

Gender (Please tick appropriate)

Female ( ) Male ( )

Which of these topics interests you? (Please tick appropriate)

	Very interested	**Interested**	**Indifferent**	**Not interested**
Artificial Intelligence				
Climate change				
DNA and Genetics research				
Drugs and Alcohol				

	Very interested	**Interested**	**Indifferent**	**Not interested**
Ethics in Science				
Energy (e.g. Nuclear, Solar, fossils				

fuels etc.)				
Future – What will happen?				
Genetically Modified Foods				

	Very Interested	**Interested**	**Indifferent**	**Not Interested**
Human Fertility Testing Infectious Diseases				
Mental Illness				
Space Exploration				

Sports	**Very Interested**	**Interested**	**Indifferent**	**Not Interested**
Technology (e.g. mechanics, robots etc.)				
Tele-communicatio n (e.g. Information Technologies, mobile phones etc.)				
Travel and Transport				

Are there any other topics that you are interested in?
Please write them below.

Why do you consider these to be important?
Please write below.

What kind of techniques would you like to use in exhibitions and events in At-Bristol?
(Please tick appropriate)

	Yes	No	I don't know
Objects			
Graphic panels			
Opinion Banks			
Computer games			

	Yes	No	I don't know
Internet			
Radio			
Film			
Newspapers			

	Yes	No	I don't know
Lab experiments			
Drama			
Meet the expert/scientist			
Workshops			

	Yes	No	I don't know
Debates			
"Talk show" style debates			
Citizen juries			
Audience Voting			
Seminars			

Are there any other techniques that you would like to use?
Please write them below.

Do you have any other comments on how contemporary science issues could be presented in At-Bristol? Please write them below.

Thank you very much for your time!

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