Evaluation: A Critical Step in Creating Effective Museum Exhibits

Heather Hudec's Graduate Thesis, 2004

Since their inception, museums have always included public education as part of their mission along with preservation and research. As Hooper-Greenhill notes, "…education is a key component in every museum's *raison d'etre*." ("Museums and Their Visitors" 1994:8) Recently, most American museums have come under increasing pressure to place an even higher priority on their role as informal educators as they have gradually come to rely more and more heavily on government funding. Often, funding requires assessment in order to demonstrate value for money and the success of the project to the funder. (Hooper-Greenhill "Museums and Their Visitors" 1994:70) In the museum field, such assessment takes the form of visitor studies, better known as evaluation. Frequently, museum evaluations address how appealing an exhibit is to visitors. Since learning is voluntary in a museum setting, appeal determines whether or not visitors will interact with an exhibit. Primarily, however, the function of evaluation is to judge, to the greatest extent possible, an exhibit's educational and communicative capacity. (McLean 1993:69)

Three types of evaluation may be used to determine how likely it is that an exhibit will successfully communicate its message to the public. First, front-end evaluation sets out to identify what visitors already know about the exhibit's subject matter and brings to light misconceptions visitors may have about the topic. Or, as noted by Kathleen McLean in her work, *Planning for People in Museum Exhibitions*, "front-end evaluation determines the public's general knowledge, questions and concerns regarding an exhibit topic." (1993:58) This type of evaluation is typically conducted early on in the exhibit development phase. Front-end evaluation usually consists of visitor interviews and/or questionnaires.

Secondly, formative evaluations can be used to test the prototypes of an exhibit being developed. Prototypes are models of a proposed exhibit or models of components of a proposed exhibit. These evaluations often use prototypes to test what aspects of an exhibit's design are likely to work and what parts need alteration. Formative evaluation should discover changes that need to be made to the exhibit in order to allow it to communicate its message as clearly as possible. Additionally, they identify what changes can be made to make the exhibit more accessible both physically and intellectually to the museum's target audience. (Screven 1991:9)

Lastly, once an exhibit is complete, a summative evaluation can be used to determine how successfully the exhibit communicates its message to the public. Often referred to as a remedial evaluation, these seek to identify means for improving a completed exhibit. Summative evaluation focuses on looking at how visitors interact with exhibits and what visitors are learning from exhibits. (McLean 1993:75) However, significant problems identified by them are usually costly to fix because they evaluate the final versions of the exhibits. Therefore, by conducting front-end and formative evaluations early on in the exhibit development process helps to reduce the number of problems a summative evaluation is likely to turn up.

Although most museum professionals agree that conducting evaluations at various stages of exhibit development provides valuable information that can be used to improve the educational quality of their exhibits, many museums do not routinely conduct evaluations. Most often, limited funding and resources are sited as the reasons, particularly by small museums. Commonly, corners have to be cut so that an exhibit can see its way through to completion. One of the ways in which the budget for an exhibit's development may be slimmed down is through scaling down or all together eliminating the evaluation process. Hence, it is unknown how effective the existing exhibits at many museums really are in achieving their educational goals.

Including evaluation in the exhibit design process is even more crucial, however, in the case of museums operating with limited financial resources and staff. It is all the more important for them to conduct front-end and formative evaluations precisely because these museums do not have the resources to make expensive and significant changes to finalized versions of exhibits. By conducting evaluations early on, they are able to identify potential problems and correct them in as cost effective manner as possible. Evaluation is vitally important because, as Bicknell states "Inaccessibility through ineffectual presentations means limited appeal, limited audiences and ultimately limited public support. Understanding your actual and potential audience can help with effective targeting, planning and timing, and an efficient use of resources." (1995:283) Through the process of conducting visitors studies, researchers attempt to find out the extent to which exhibits will achieve their intended purposes and recommend changes for maximizing exhibits' educational potential.

Even when museums do carry out evaluations, however, they frequently only address practical concerns (such as 'did the visitors understand the language of the text labels' and ' are visitors able to operate interactive components of the exhibit') and neglect focus on the educational value of exhibits. Many museum professionals believe that, in order to address educational goals in evaluations, they must be time consuming and require hiring additional staff. But this is not necessarily true. And, it is imperative that evaluations focus on whether or not the educational goals of the exhibit are being accomplished as well as practical concerns. For, when the educational aspect of the exhibit is not addressed in the evaluation process, museums can often be left wondering whether or not visitors are truly learning anything in their institutions. Therefore, not only is it vital for museums to conduct evaluations, it is also necessary that evaluations address the exhibit's success in achieving its educational goals.

In museum evaluations that do address educational concerns, their objective is usually to measure what extent to which visitors are grasping the specific concepts that the exhibit is designed to communicate. This is because the educational objectives of exhibits tend to be quite specific. Thus, it is assumed that it is possible to measure, with a fair degree of accuracy, whether or not instruction was successful. This approach, also known as the *behavioralist model*, contends that knowledge is transmitted to the learner who then takes it in and incorporates the new information into their existing understanding of the world. (Chaille 2003:5) In other words, evaluations have a tendency to ask the question 'did they get the point or not' without considering what other types of learning may be taking place as visitors interact with the display.

An alternative approach to understanding education, and one that has been argued by museum professionals is known as the *constructivist model*. In this model of education, the student is not a passive recipient of knowledge, but rather one who constructs knowledge on an individual level. According to this model of learning, the role of the teacher (or, in the case of a museum, the exhibit) is not to disperse knowledge but to provide incentives by which students can build it up. (Fosnot 1996:7) This is, of course, in contrast to the previously discussed behavioralist model, which sees the role of the teacher/exhibit as a transmitter of objective information. Therefore, in order to understand this idea of knowledge as a construct of the learner rather than objective fact, we need to conceptualize the learning process as one in which children are constantly building theories. (Chaille 2003:5)

Because behavioralists and constructivists have different understandings of how people learn, they also tend to disagree on how information should be conveyed, what are ideal learning environments and how one should determine whether or not learning is taking place. In the museum field, all of these points can cause differences of opinion among museum staff on how to build effective exhibits and how one should go about evaluating whether or not an exhibit has achieved educational goals. First, whereas a behavioralist would argue that information is conveyed through dissemination of knowledge from the exhibit to the learner, a constructivist would argue that the value of an exhibit is in allowing the learner to experiment with the process of trial and error. Or rather, "Educational experiences for young children should, then, should emphasize the construction of knowledge, not its transmission." (Chaille 2003:7) Additionally, to determine if learning was taking place, a constructivist would consider not only whether or not the learner absorbed the data presented, but would investigate to see if other types of learning were taking place. "Rather than behaviors or skills as the goal of their instruction, concept development and deep understanding are the foci…" (Fosnot 1996:10) Therefore, in the process of exhibit development and evaluation, differences of opinion on learning theory can result in differences of opinion on whether or not exhibits are fulfilling their purpose of educating visitors.

The project discussed in the following paper illustrates the relevance of evaluation in the exhibit development process through the examples of a front-end and formative evaluation, which I conducted at a children's science museum. First, in the front-end evaluation, thirty visitors were interviewed regarding their background knowledge and misconceptions on subjects covered by new exhibit designs. Secondly, the formative evaluation, which included both visitor interviews and observation, gathered information on visitors' reactions to several exhibit prototypes. Examples of evaluations conducted at museums are usually done in-house and are not published. However, guides on how to conduct evaluations are available. Several were consulted in the development of the methodology of this project including Judy Diamond's *Practical Evaluation Guide,* Mina Borun's *Introduction to Museum Evaluation,* Samuel Taylor's *Try It! Improving Exhibits through Formative Evaluation* and Lynn Dierking and Wendy Pollock's *Questioning Assumptions: An Introduction to Conducting Front-End Studies in Museums.*

Typically, the goal of exhibits at science museums is to provide visitors with an accurate understanding of specific scientific concepts. Therefore, these evaluations tended to take behavioralist approach, seeking to measure the extent to which visitors were likely to grasp the specific educational messages of exhibits through considering appeal and comprehensibility. These are the factors on which I believe an individual exhibit's success hinges. For, if the exhibit is not appealing, visitors will not interact with it and it cannot get its message across. Similarly, if the information is not presented in a clear and comprehensibly manner, the visitors will likely not learn the concept being presented. By conducting evaluations, however, a line of communication between museum professionals and visitors can be opened. (Screven 1991:9) This enables museum staff to gain insight into the likelihood a museum exhibit will be appealing to visitors and successful in communicating its educational message to the public.

As a result of each of the evaluations, I was able to make recommendations to exhibit development teams to improve exhibits under development. These improvements will maximize the likelihood that, in the end, each exhibit will successfully communicate its intended message to visitors. Some might argue that an exhibit can serve an educational purpose even if exhibits do not clearly communicate their intended message to the public. I, however, believe it is the responsibility of exhibit design teams to ensure to the greatest degree possible that exhibits do just that.

Background

One example of a small museum that has expressed concern over the clarity of their exhibits' education message is Sci-Tech Hands-On Museum, Aurora. Sci-Tech museum is located in Aurora, Illinois, a small town about 43 miles east of Chicago in Kane County. According to the city's website, Aurora has a population of about 142,000. 68% of the city's population is Caucasian, of which 32% are Hispanic. 11% of Aurora's population is African America. About 29% of the city's population holds a college degree. The city's website does not provide demographic information on income levels. Sci-Tech is housed with a historic post-office and situated along side of the Fox River. It is run by a staff of about twenty. According to Carina Eizmendi, Sci-Tech's Director of Exhibit Development, museum records for 2003 and 2004 show that the museum receives an average of 50,658 visitors each year. Its annual expenses amount to about 1,218,577. Also, the museums annual revenue is about one million dollars with 36.8% earned, 34.6% from foundation funding, and, 28.6% from government and special projects.

Sci-Tech's mission, as stated on their website, is " to engage people in experiencing and learning science and technology in a fun and interactive way." Sci-Tech is a hands-on museum in that it focuses on exhibiting displays, which include an interactive portion that can be manipulated by visitors. This may include pushing a button to activate a model, experimenting with a display, such as throwing a ball where it's speed and force are measured, or using an interactive device such a xylophone or telescope. The idea behind most of the exhibit designs is that the interactive component of the exhibit demonstrates the concept that the exhibit sets out to communicate to the public.

Sci-Tech's target audience is children who visit the museum as part of a school groups and/or with their families. Most child visitors fall within the Pre-Kindergarten to Middle School age range, though the museum does receive some high school aged visitors as well. Generally, when designing exhibits, Sci-Tech has in mind a target audience of about twelve years old, although, based on observation conducted as part of this project, the average child visitor is younger. Because Sci-Tech's target audience is children, they have made efforts to design a comfortable environment for them. This includes painting the museum bright colors, constructing the museum contents of safe, durable materials and using large lettering and cartoon figures on many of the exhibit labels and graphics.

The indoor portion of the museum is an open environment in that is consists largely of one central wide-open space free of walls where one can view the whole area easily. This was done in response to parents' concerns that they be able to see their children easily as they moved about the museum. Due to this, all of the exhibits are within clear view of many other displays. Exhibits are arranged according to categories though there is no designated pathway to follow through the museum. Despite the absence of walls, a variety of rug colors are used to mark off where one exhibition area ends and another begins providing for organization of the exhibits. In addition to the museum's main floor, the museum also includes an outdoor park area and, there is also an exhibition area and snack room in the basement. While it is important that visitors have fun while experiencing the museum, its primary purpose is to educate visitors about science.

Exhibits at Sci-Tech focus on a wide range of scientific fields. Display subjects include weather, ancient technology, light, sound and magnetism to name a few. While individual exhibits are part of a broader subject category, each one sets out to convey specific educational information on a particular topic. For example, within the Weather exhibit, children can step inside of a device that creates a tornado of water vapor. Through interactive components such as this, children cannot only observe science being carried out; they can interact with it.

At Sci-Tech, conducting short, informal evaluations on the practical aspects of the exhibits' components is not uncommon. Such evaluations have focused on practical concerns such as whether or not visitors were able to follow instructions for operating the interactive components; if children are able to access all of the components based on the prototypes construction and, more generally, did the visitor like it or not and what do they think would make it better. However, according to the museum's director, Dr. Ronen Mir, these evaluations have tended not to focus on assessing the extent to which the museum's visitors are, in fact, learning the scientific concepts the exhibits are intended to teach. Due to limits on time and financial resources, staff are often not able to put a significant about of time into conducting extensive evaluations.

The museum, however, has been able to expand the number of people working to develop and ensure the success of their exhibits by working with institutions such as Northwestern University and the University of Chicago. Programs coordinated with these institutions and others have allowed graduate students to participate in all aspects of the exhibit development process at Sci-Tech. In this way, students are able to gain experience and work with museum professionals and the Sci-Tech is able to increase the number of individuals working to develop new exhibits.

For the past three years, the University of Chicago has been sponsoring the Material Presentations in Science Program (MPS) in coordination with Sci-Tech, Aurora. The program assembles teams of graduate students from both the University's Sciences and Social Sciences Divisions to design new museum exhibits for Sci-Tech, Aurora. Students then present their exhibit design concepts to Sci-Tech staff, which choose the exhibit designs to construct. Interns are divided into two teams, the Astronomy Team and the Material Science Team, each of which work under the direction of an internship coach. Throughout the academic year, students learn about the various aspects of museum work and develop exhibit design concepts that address a concept in the particular science field, which their group represents. In the 2004-2005 academic year, the Astronomy Team was encouraged to create exhibit concepts that would compliment one of the exhibitions the museum had been working on, *Out Reach to Space*.

The *Out Reach to Space* (OTS) project is one that Sci-Tech had been developing since early 2004. According to the project description, the overall goal of OTS was to present cutting-edge science that would draw the attention of rural, low-income populations. Survey responses had indicated that the scientific topic in which this target audience was most interested is space and space exploration. Therefore, several exhibit ideas were put together based on this topic and a grant to fund the project was procured. Additionally, the 2004-2005 MPS Astronomy group set out to develop new exhibits that would complement the OTS exhibits already under development.

The following project summary illustrates how evaluation was incorporated into the exhibit design process of the OTS exhibits. The project includes two evaluations. First, the front-end was conducted in the preliminary stages of exhibit development carried out by myself, a member of the MPS Astronomy Team. Secondly, I conducted a formative evaluation in regards to the prototypes developed by Sci-Tech for several OTS exhibits. The results of each evaluation demonstrate how concerns and problems were identified with exhibit designs and prototypes in the early stages of exhibit development. Therefore, issues could be corrected relatively inexpensively to maximize the likelihood that the exhibit will communicate clearly to the audience. In this way, the educational potential of the exhibit can be maximized.

Front End Evaluation

The MPS Astronomy team set out to develop several exhibit designs that would teach Sci-Tech's target audience astronomical concepts, complement OTS exhibits already under development and incorporate current scientific research. Additionally, each design was to include an interactive component. Several exhibit designs were developed and two were chosen to continue on to the development process. The team decided that a front-end evaluation would be valuable in helping them determine if the designs they had come up with would be appropriate for Sci-Tech's target audience, the 8-12 year old age group. The front-end evaluation was intended to determine two things. First, it would determine what level of knowledge the museum's child visitors already had regarding the subject matter being covered in the exhibit designs. Second, it would determine what, if any, misconceptions child visitors held about these topics. By collecting this information, the team would be able to modify their exhibit designs to maximize their educational value. The exhibit designs included in the front-end evaluation were *Kaboom* and *Infrared*.

The Exhibit Designs

The *Kaboom* exhibit was intended to teach kids about the nature of explosions. More specifically, it set out to illustrate that the same forces that operated to cause explosions here on earth caused explosions in stars as well. It was envisioned to include two panels. One panel would explain what caused explosions to occur and would offer examples of different types of explosions that were familiar to the audience. The interactive component for this portion of the exhibit would be a rubber glove fitted over a device that could be initiated by the visitors to release heat. When heated, the rubber glove would expand illustrating that an increase in temperature would cause an increase in pressure, which would cause expansion and, eventually, explosion. The other panel sought to address what was believed to be a widely held misconception among Sci-Tech visitors, that the Big Bang was an explosion. This component would teach visitors that the Big Bang theory was, rather, one of an ever-expanding universe. Its interactive component would involve a piece a elastic material, with dots on it to represent stars, that could be stretched by visitors to illustrate that no matter where one's position was in the universe, it would seem that the universe was expanding away from you. It was hoped that visitors would leave the exhibit with an enriched understanding of what the Big Bang theory was all about. Primarily, however, the educational message of *Kaboom* was that the same phenomena that causes explosions we see everyday causes stars to supernovae.

The second exhibit design, *Infrared*, was envisioned to include an infrared camera and a video screen showing what the camera was seeing. *Infrared* would allow visitors to see themselves on the monitor and manipulate a remote control device that emitted infrared light. Although the visitors would be unable to see the infrared light with their own eyes, the infrared camera would be able to detect it and show it on screen. Graphics and labels would be used to contextualize this interactive exhibit and teach visitors that we are only able to see some light waves; infrared being an example of one that cannot be seen, but is nonetheless present. Proposed signage would include a reproduction of the electromagnetic spectrum showing the small range of light waves our eyes are able to detect as well as where infrared and ultraviolet light waves were on the spectrum. It would also provide a list of things that emitted infrared light and a list of everyday items that could detect infrared light. Through the front-end evaluation, exhibit designers hoped to learn how much background information on the nature of light and the color spectrum would need to be included in order to clearly explain infrared light. The educational goal of this exhibit was to teach children that there are things that exist in the world that we can't see with our own eyes.

Methodology

The front-end evaluation consisted of conducting short interviews with visitors at Sci-Tech. The Astronomy group developed the questions used in the front-end evaluation as a team. At first, the group had considered using a questionnaire to maximize the number of visitors who would be included in the evaluation. However, since interviewees would consist of children, many of whom would not possess sufficient reading and writing skills to fill out a questionnaire, it was decided that interviews utilizing open-ended questions should be used. In this way, interviewees would likely offer information without the researcher having to ask leading questions. Since the interviewees would be primarily elementary school aged children, it was decided that a conversational format would be the best method of eliciting information, as it would enable the researcher to make the interviewee as comfortable as possible. The questions were designed to hone in on specific concepts that would be included in each of the exhibits as well as answer specific questions about what information should be included in the graphics and labels of the exhibits to make them accessible to the widest possible educational level of child visitors. After coming up with the list of questions, they were posted on the SCOPE Program's Internet forum and Sci-Tech's staff were notified and encouraged to look over the question list to provide criticism and feedback. Some suggestions were offered and incorporated into the question list. (Appendix B.1)

The front-end evaluation interviews were conducted on a Friday afternoon at Sci-Tech. This day was chosen because the local school districts were on spring break and it was anticipated there would be a lot of visitors to the museum. A total of thirty interviews were conducted with children ranging in age from pre-school through fifth grade. In all, 4 Pre-K students, 4 Kindergarteners, 5 first graders, 6 second graders, 4 third graders, 2 fourth graders and 5 fifth graders were interviewed. While all relevant questions listed on the questionnaire were asked of each interviewee, questions were posed in a conversation style so as to make the children as comfortable as possible. Therefore, the wording of questions was slightly different amongst interviews. Parental permission was verbally requested by the researcher and granted prior to each of the child interviews. (Appendix A.1) All of the parents who were asked to allow their children to participate agreed. Each child was also asked for assent prior to the interview. (Appendix A.2) Only one child who was asked declined to participate. Interviews were conducted during a 4 hour period of time at various places in the museum during the children's visits. Children's responses were recorded on separate questionnaire sheets by the interviewer. While it was originally intended that interviews be audio-recorded, it became apparent after the first few interviews that the presence of the tape recorder was making the children uncomfortable and shy. So, from that point forward, responses were recorded by hand.

Results

The first set of questions included in the interview was in reference to the *Infrared* exhibit. 29 of the 30 children interviewed were not able to offer any sort of explanation as to what light is. One child stated that they did know what light was but were not able to explain it. When asked where light comes from, close to one third responded that they didn't know while almost two-thirds answered, "the sun." Additionally, 4 children mentioned electricity, lamps or power plants. 19 out of 30 children had no idea why we were able to see different colors or rather, what caused things to appear to be different colors. Two children responded that the reflection and refraction of light allowed us to see colors, two stated that light mixing together allows us to see colors, and two believed that the sun created different colors.

The Astronomy team had decided to ask the interviewees if they had ever heard of ultraviolet light as well. It was thought that children would be more likely to be familiar with ultraviolet light due to popular discourse regarding sunburn and sunscreens. But, when asked if they had ever heard or infrared or ultraviolet light, 28 of the 30 children stated that they had never heard of either before. Of the two who said they had heard the terms previously, one child said that he had no idea what they were or where they came from while the other stated that infrared light was heat, which enabled snakes to see. This same child said that, although he didn't know what ultraviolet was, he did know it was a dangerous kind of light. Neither of the children who stated that they were familiar with the terms infrared and ultraviolet light knew how scientists would know that they existed if we couldn't see them. (A summary of interview results on *Infrared* is listed in Appendix C.2)

Additionally, the Astronomy team had decided to include questions about gravity since the overarching concept that *Infrared* hoped to teach was that there are things in the universe that we cannot see. By asking children about their understanding of gravity, the team hoped to find out what would convince the children that things that we cannot see really do exist. It was assumed that the concept of gravity would be one with which the children would be familiar. But, only about half of the children were familiar with the concept of gravity. 16 of the 30 children stated they knew what gravity was. All 16 stated that we knew gravity existed because it holds us down and keeps us from floating away. When responses to the gravity question were broken down according to grade level, a definite distinction between age groups became apparent. While none of the Pre-K or Kindergarten students knew what gravity was, all third, fourth and fifth graders did. First and second graders were split in whether or not they knew what gravity was. Surprisingly, all of the children who were asked, 'how do you think we know gravity exists if we can't see it,' responded that we knew because it holds us down and keeps us from floating away. In other words, children knew that gravity existed despite our not being able to see it because we could perceive of its effect.

As for *Kaboom,* whereas it had been a central concern of exhibit developers that children would likely hold the misconception that the Big Bang was an explosion, this was not at all the case. In fact, 29 out of 30 interviewees had never heard of the theory of the Big Bang before. As to the questions regarding explosions, only sixteen interviewees stated that they had seen explosions occur, either in real life or on TV. Of those who had seen explosions, two mentioned volcanoes, one mentioned having seen a building explode and twelve stated that they had seen explosions on television. When asked what they thought caused things to explode, two thirds of the children stated they no idea what caused things to explode. Of those that offered an explanation, responses included matches, bombs, lava, dynamite, gas, chemicals and fire. None of the children mentioned a build up of pressure as causing explosions. Also, only one child, a home-schooled child, had ever been taught about explosions and what causes them. Also, 29 of the 30 children said that they didn't know if stars ever exploded. One child stated that he believed they could, but didn't know what might cause a star to blow up. (A summary of interview results on *Kaboom* is listed in Appendix C.1)

Discussion

As for the *Infrared* exhibit, the front-end evaluation made it clear that most of the museum's child visitors were completely unfamiliar with the nature of infrared and ultraviolet light. Therefore, any explanation of these phenomena would be all new information to most of the visitors. Also, when asked questions about things such as what is light and how is it that we can see different colors, none of the children mentioned the color spectrum. At least some of the children likely had been introduced to the color spectrum at school; however, none made an immediate connection between that and inquiries as to the nature of types of light that humans cannot see such as infrared and ultraviolet light. Also, despite mention of ultraviolet light in popular discourse, the children interviewed were no more familiar with ultraviolet than they were with infrared.

The front-end evaluation revealed that the concept of infrared light is virtually unknown to most of Sci-Tech's child visitors. This can be seen as encouraging in that the *Infrared* exhibit has the potential to teach visitors something new that was previously unfamiliar to them. However, because visitors did not have any background knowledge regarding the nature of light as it had been assumed they would, it would be very difficult to get the point across that infrared light is a type of light that we cannot see with our eyes because it is not within the visible part of the color spectrum. As a result of the front-end evaluation, it was recommended that contextualizing information regarding the nature of light and the color spectrum would have to be made clear to the visitors before they could understand the nature of infrared light and its relationship to other kinds of light. Furthermore, because the target audience was children, background information would have to be presented in a creative manner to ensure that children would pay attention to it and, thus, learn what infrared light is rather than just play with the camera.

Based on the evaluation results, it is clear that the *Kaboom* exhibit was in need of adjustments as well. While the concept of explosions is somewhat familiar to museum visitors, none had a very good understanding of what causes explosions. While children weren't able to explain why explosions occurred, they did mention several things that frequently contribute to creating the conditions that cause explosions. As for the Big Bang, it was obvious that the misconception of the Big Bang being an explosion was not one held by this particular age group. As a result of the interviews, it was recommended that the exhibit should focus on explaining what causes explosions rather than centering on comparisons between different types of explosions. Also, it was suggested that the exhibit explain how things that kids mentioned as causes of explosions contributed to creating the necessary conditions for an explosion.

The Evaluation's Impact of the Exhibit Designs

Upon completion of the front-end evaluation, written summaries were sent to the Astronomy team members working on each of the exhibits. Once informed as to the results, in addition to detecting practical problems with the functioning of the first prototype of the infrared camera, the interns working on *Infrared* decided to modify the exhibit to be that of an infrared telescope. By using a telescope rather than a camera and video screen, the exhibit would be more hands on and require less explanation to be comprehensible. The telescope would function just like any other telescopes except that it would see infrared light. By using this interactive model, children could immediately recognize a difference in what they perceived with their naked eyes and what they perceived with the telescope. By simply indicating that the telescope was allowing them to see infrared light that they couldn't see with their eyes alone, they would likely learn that there was another kind of light present that they couldn't see, but that could be detected with special instruments. This also more readily helps them make the connection that astronomers use special instruments, such as telescopes for example, to see things in the universe that we otherwise might not know were there.

The *Kaboom* exhibit design was also drastically altered. The internship team decided not to address the anticipated misunderstanding of the Big Bang since most of the visitors had never even heard of it. Therefore, this aspect of the exhibit design was eliminated. As for the rest of the exhibit, its focus was redirected. Since the goal of the program was to present concepts dealing with astronomy and exhibits that would coordinate with the OTS project, MPS designers decided to focus on the notion of exploding stars rather than produce an exhibit aimed at explaining what causes explosions as had been recommended. Additionally, when *Kaboom* interns presented the design concept to the whole of the internship team and Sci-Tech staff, concerns were expressed that the interactive component proposed, the expanding glove, would be too complicated and possible dangerous for display in a children's hand-on museum. *Kaboom* designers decided to rework the exhibit concept since it seemed unlikely that *Kaboom* would be seen through to completion due to the museum staffs' safety concerns. The new exhibit concept focused on a producing a video rather than an interactive exhibit.

The video, it is envisioned, will focus on an animated story of two stars. Each star will be personified as a character. One star will be Dwendle the White Dwarf and the other will be Ned the Neutron star. The storyline of the video will involve Dwendle being sad because he wanted to become a beautiful supernova but did not have enough stellar material to do so. His nearby friend Ned however, being a Neutron star and being very large with lots of stellar material, offered to give Dwendle some of his stellar material. Therefore, material was passed from Ned to Dwendle and a binary star system was created. This went on for a very long time but, finally, when Dwendle had enough material, he was able to transform into a beautiful supernova.

Interns working on this exhibit concept believe that using a narrative format will enable kids get a handle on stellar explosion without having to complicate the exhibit too much with complex scientific information. Although the presentation will offer only a relative superficial understanding of supernovae and binary star systems, the children, it is hoped will walk away with several new bits of knowledge including: (1) stars explode, (2) a binary star system refers to two stars near each other when material is being transferred from one star to another, (3) stars to accumulate a lot of material before they can explode, and (4) when a star explodes it creates a supernovae. It is hoped that by presenting the information in a narrative format, children will be attracted to watching the short 5-minute or so cartoon. Thus, the exhibit development team has modified the exhibit to be more comprehensible for children, bring cutting edge scientific research to the community, cut costs, and provide children with pieces of accurate scientific facts, which they will be able to understand in more detail as they get older and their cognitive skills develop further. The storyboard for this exhibit concept was completed by the close of the academic year and the net group of MPS interns will likely develop the design further.

Conclusions

In sum, the front-end evaluation revealed that the exhibit design team had made erroneous assumptions about the level of background knowledge the visitors would bring to the proposed exhibits. Only through evaluation was the team was able to find out what visitors already knew, and what they could be taught. Thus, based on the information elicited by the evaluation, the team was able to tailor their exhibits in such a way as to ensure that they would serve their intended purpose and educate children, thus fulfilling the mission of the museum.

Formative Evaluation - Deleted by CS

Conclusion

A hands-on science museum such as Sci-Tech Aurora provides the sort of educational environment well suited for education based on the constructivist model of learning, which see the learner as one who constructs knowledge from experiences. The interactive components provide learners an opportunity to experiment with models through the process of trial and error to derive an understanding of scientific phenomena. In the course of the both working with exhibit designers and speaking with the parents of the museum's young visitors, this view was frequently expressed. Parents stated that they felt that what was important was not, necessarily that their children understood each exhibit, or any of the exhibits even, but that they were interacting in an environment where there was an opportunity for learning based on the availability of accurate models. Similarly, members of MPS's exhibit development team often cited that, perhaps it wasn't really so important that children understood the concept being presented by the exhibit. They expressed the thought that as long as the exhibit provoked meaningful thought and curiosity, this was enough for the exhibit to be considered to have accomplished its goal of promoting learning.

There is much to be said for the constructivist model of learning. There is little doubt that that the process of trial and error experimentation affords learners the opportunity to gain new insights and understanding about the world in which they live. And, by interacting with displays such as those at a hands-on science museum, it is most likely that visitors often are learning more than simply the concept that exhibit designers are trying to communicate. By playing in an environment such as Sci-Tech, children may be learning something new from a display that the exhibit designers never intended. And, even though they may not grasp a full understanding of what is being presented, this does not mean that they are not learning. They may still be learning a more generalized understanding of scientific phenomena.

None-the-less, ideas based on the constructivist model of education should not be invoked as an excuse for exhibits that do not clearly communicate their messages to the public. While interactive models provide opportunities for learning beyond what exhibit developers may have intended, this does not mean that, upon discovering that visitors are not getting the point of the exhibit, it is fair for developers to say that since some sort of learning is happening, the exhibit is successful. For, one of the most valuable aspects of informal education is that it provides the public with an opportunity for learning that they would not otherwise receive as part of their formal education or in everyday life. Therefore, while it is no doubt beneficial that displays provide an opportunity for experimentation and constructing new ideas and understanding about the world, this should not be seen as a reason for developers to throw-in-the-towel on striving to communicate specific concepts to visitors. For, the risk is that visitors will learn no more from playing at a museum than do from playing in daily life.

The evaluation process has been criticized by proponents of the constructivist model for having a sort of tunnel vision where only predetermined goals are seen as important and the evolution of other goals along the way is eliminated. While it is true that evaluation hones in on determining whether or not the specified educational goals for the exhibit are being accomplished, it is, more broadly, a means by which museums are enabled to improve their exhibits by making them clearer and more cognitively accessible to the audience. "When an exhibit is built with a specific didactic function, it is also reasonable to ask whether that didactic function is achieved." (Hein 1995:190) Making improvements to exhibits and exhibit designs will only serve to increase the level of educational value an exhibit will have. As Bicknell points out, within the context of museums, evaluations are statements of worth from the visitors, which are mediated by the evaluator and methodology used to gather information because, an evaluation report doesn't just deal with whether or not an exhibit was worth the visitors time and/or money, it is an instrument of change. (1995:282) Thus, despite the fact that museums are forced to cut costs wherever they can, conducting evaluations is not the stage of the process to cut short.

Despite the value of bringing in professional evaluation services, it is not necessary to spend exorbitant amounts of money to produce an informative evaluation that will provide valuable feedback from museum visitors. With a reasonable amount of training and a few hours time, existing museum staff can effectively conduct evaluations that will likely provide invaluable information for the exhibit design process. Additionally, conducting front-end and formative evaluation early on in the exhibit design process is the most cost effective and efficient way to create meaningful exhibit because it allows for the correction and improvement of designs and prototypes early on when the time and financial costs of making adjustments are minimal. As Friedman put it, "…evaluation is not the cheapest way to build exhibitions, but I have come to believe that it is the cheapest way to build effective exhibits." (1999:1)

The process of designing exhibits that function as vehicles for communication between experts and the public is far more challenging than most realize. As a result, it is often tempting for experts and exhibit designers to surmise that provided the information contained within the exhibit is accurate and people are getting something out of it, that's good enough. However it is important to remember that clear communication is precisely what exhibit development is all about, and that burden falls on squarely on the shoulders of exhibit design teams. Informal educational venues such as Sci-Tech derive much of their value from the fact that they provide opportunities for learning that otherwise would not be available to the public. Therefore, accomplishing the goal of bringing a new understanding of specific concepts and ideas to their audience through their displays is of paramount importance. For, if their exhibits fail to clearly communicate their educational messages to visitors, then museum has failed in its mission to educate the public.