AQUARIUM INTERACTIVES THAT ENGAGE AND INSPIRE: BEYOND FINDING NEMO

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Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Arts
in
Museum Studies
in the
School of Education and Liberal Arts
At
John F. Kennedy University
Berkeley, California
18 July 2006

Approved:

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Department Chair                          Date
Acknowledgements

The Faculty of John F. Kennedy University for all their assistance and inspiration. The staff at the John G. Shedd and Monterey Bay Aquariums for sharing their knowledge, time and allowing me to study their work. All the people whom I interviewed for their time and assistance. The staff at Academy Studios for their assistance throughout this project. Jonathon Goodrich and Mandy Baughman for being there during all the tough times. Danielle Skeehan for everything. My parents for their unending support. The 2004 World Champion Red Sox—inspiration.
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Executive Summary

Introduction

Once visitors have read one graphic panel and a few tank labels, most tend not to read more. They don’t come to aquariums to read; they come to enjoy themselves. We must capitalize upon their desire for enjoyment and provide a rich learning environment in which we can turn the visitor loose to choose his own path. What is important is that we pave the path with brief, dynamic, and responsive educational experiences, messages, and intriguing challenges.¹

- Paul J. Boyle Chief Scientist, New England Aquarium

Public aquariums have undergone significant changes in focus since they first appeared in the United States in the nineteenth century. Initially commercial entertainment ventures and later small menageries, they have diversified to focus more on conservation and education, conducting scientific research and running propagation programs.²

In *The Connection to other Animals and Caring for Nature*, psychologist Joanne Vinning sees a human-nature split, with people reluctant to see themselves as part of nature. Referencing a 2002 study by researchers at the Institute for Learning Innovation, she believes that aquariums (among other places) can promote caring about animals with opportunities to interact with the natural world: “Emotion is at the core of caring specifically, and of relationships between humans and animals in
general.” Marine Biologist Todd Newberry writes about the disconnect at aquariums between the animals and the visitor. He cites the lack of an olfactory experience found at a zoo (because the fish are behind glass), speculates that many of the animals seem strange and otherworldly, and calls for a change in the exhibit experience at aquariums.

This project examines one way that aquariums can address the issue of this disconnect, through offering interactive experiences to their visitors. These allow the visitor to an aquarium to go beyond merely looking at animals to engaging with the animals directly or with devices that can serve as mediators between the animals and the visitor. For the purposes of this project, I am defining an interactive as a mediating device that offers the visitor the chance to engage physically with it in order to explore or understand the ideas presented by the interactive.

The first section of this report reviews the literature about the many learning theories that support the use of interactives, especially those of John Dewey and George Hein, who argue for experience based learning. Additionally covered is the social component of learning described by psychologist Lev Vygotsky and physicist Frank Oppenheimer’s implementation of these theories with “props” at the Exploratorium that could be manipulated by visitors.
Research studies based on evaluations, performed predominately at science museums, have shown the benefits of interactives. They have been shown to increase conversation, interest and time spent at otherwise static exhibits, as well as strengthen visitors’ memories of the museum experience.

While aquariums have only more recently incorporated interactive elements into their institutions, there are a few studies revealing their utility. Specifically, a dissertation examining interactives at the New England Aquarium showed that many of the same benefits discussed in the preceding paragraph also hold true in an aquarium setting. However, not much has been written on what elements make interactives more engaging experiences at aquariums.

This project utilized four methodologies to attempt to find what does make aquarium interactives more successful. The first was reviewing the literature (as discussed above) on educational theory as it pertains to interactives, what is known about interactives in museums in general, literature on aquarium visitors and finally what is known about aquarium interactives. Secondly, site visits were conducted at the Monterey Bay Aquarium in Monterey, California and the Shedd Aquarium in Chicago, Illinois to ascertain what types of interactives these model institutions were developing. Museum professionals who develop aquarium exhibits
were interviewed about aquarium interactives and the field (of exhibit professionals) was surveyed as to their feelings and interest about these interactives.

From these various methodologies I found that interactives are often not included in exhibitions because they are harder to develop, cost more than traditional displays and are difficult to maintain. However, professionals felt interactives offer an experience worthy of these obstacles. I found that the idea that interactives distract attention from the animals was not a concern amongst the museum community or supported in the literature. Design attributes that I found to improve an interactive include feedback, authenticity of the experience, encouraging socialization, touch, and being intuitive or easily approachable.

Prototyping was the most commonly used evaluation tool, though front end, summative (exhibition wide) and other forms of formative evaluation were also utilized by aquarium developers to assess the efficacy of interactives.

Since most evaluation of aquarium exhibits looks at exhibitions as a whole, I recommend conducting evaluation that focuses on whether a particular interactive meets the developer’s goals. This will help to protect the institution’s investment in the interactive experience. Most of the aquarium exhibitions I have seen are linear, which I think can minimize
the visitor’s use of interactives. By experimenting with different floor
plans, aquariums may be able to entice visitors to engage more with the
institution’s interactives. During my research for this project, I found the
lack of standard terminology for the many types of interactive experiences
made discussing them very difficult. I propose that such a common list of
terms be created and utilized and have attempted to do so in my product,
an article submission to *The Exhibitionist*, the biannual journal published
by the National Association for Museum Exhibition and distributed to its’
members.
Statement of Purpose

The purpose of this project is create tools to help aquarium exhibition developers decide what types of interactives to use—and how to design them. This information will be disseminated to the field through an article with two sections for submission to the Exhibitionist. The first section will provide information for creating interactives that draw visitors to further engage with the animals and increase their interest in the aquatic world, while the second lists the types of interactives possible for exhibit aquarium exhibit developers to offer.
Goals and Objectives

From the limited amount of research on aquarium interactives and the large amount on interactives at other institutions, I have sought to combine what is known about interactives in general with what is known about aquariums and their visitors to determine the best criteria for developing aquarium interactives. The following are the overarching goals and objectives for this project.

1. To assess characteristics of successful interactives for aquariums.
   *Conduct interviews with museum professionals and view in person interactives that are considered successful in aquariums.*

2. Identify vocabulary to categorize various types of interactives in aquaria (spotting scopes, immersive rooms, mechanicals w/ or w/o animal involvement etc.)
   *Categorize the uses and characteristics of various aquarium interactives.*

3. To formulate ways to improve interactives in aquaria.
   *Offer concrete parameters for developing interactives in aquariums.*
Methodology

There were four methodologies utilized in this project. These included a literature review, site visits to two aquariums that utilize interactives, interviews with twelve professionals involved in the development of interactives associated with living organisms and a survey mailed to 110 exhibit professionals involved in developing interactives.

Literature Review

To provide the background and context for my project on developing interactives for aquariums, I searched for papers, books and dissertations on interactives, aquarium visitors, aquarium history and zoo or aquarium interactives. To accomplish this, I utilized online databases such as Wilson Select Plus, Proquest, Google Scholar, ERIC and Digital Dissertations. Additionally, I searched the Exhibitionist, Museum News and the American Zoological and Aquarium Association (AZA) Conference Proceedings manually. Journals that detail evaluations and research such as Curator, Informal Learning Review, Science and the Journal of Research in Science Teaching were particularly helpful. Websites such as www.informalscience.org, www.museumdeveloper.net
and www.museumlearning.com were useful in finding additional resources. Books on informal learning such as George Hein’s *Learning in the Museum* and John Falk and Lynn Dierking’s *Learning from the Museum* were reviewed as well as several books on aquarium history such as *The Ark Evolving*, edited by Christen Wemmer. Finally, a small number of dissertations that examined aquariums such as Alexander Goldowsky’s *Learning from Life* were examined in depth.

*Professional Interviews*

Twelve professional interviews were completed, either on site or by phone/email depending on availability and location. The interviewees included professionals involved in developing interactives both at private firms and as in house staff. Two of these interviews were conducted with evaluators of aquarium exhibits. (See Appendix A for the full list of those interviewed as well as Appendix B for questions posed).

*Case Studies*

The third methodology in my project was cross-comparative case studies of two aquariums: the Monterey Bay Aquarium in Monterey,
California and The John G. Shedd Aquarium in Chicago, Illinois. These aquariums were selected because the preliminary interviews regarding this topic revealed these institutions as having interactives which interviewees recommended I examine. During the visits I viewed the aquarium as a whole and then used the interactives and watched visitors utilize them. I noted the various types of interactives utilized and took particular note of mechanical interactives. Each site visit consisted of two ½ day visits and at least the latter of these visits occurred after interviewing staff there, which allowed me to see, in person, the interactives the interviewees discussed.

Survey

I mailed 110 surveys to individuals at private firms and aquariums who develop interactives; exhibit directors at science centers, aquariums, and zoos; and audience researchers at aquariums and private, audience research firms. These individuals were selected using the National Association for Museum Exhibition (N.A.M.E.) and the American Zoological and Aquarium Association (AZA) directories. Thirty nine surveys were returned, a thirty five percent response rate.
The survey was printed on paper, double sided and included ten open ended, true/false and multiple choice questions. I enclosed a self addressed stamped envelope for the convenience of respondents. Using this survey, I hoped to determine whether the institution used interactives, the types of interactives the institution uses, reasons for interactives inclusion, how they develop them and what the individual considers to be a good interactive. Analyzing the results was both qualitative and quantitative, noting trends as well as rates of use and audience feedback. (See Appendix C for a copy of the survey instrument).
Limitations of Methodology

This study was limited geographically to aquariums in the United States. Interactives were the focus of this project and therefore the many other methods in which visitors are engaged in aquariums such as labels, graphics and the design of the tanks and habitats are beyond the scope of this project. Additionally, educational programs, even those using interactives, are not covered in this project.

Another limitation for this study is the focus on aquarium interactives directly associated with the animals on display; separate interactive areas such as discovery rooms and visual or object theater rooms are beyond the scope of this project. I feel, however, that the findings will at least in part be relevant for all aquarium interactives, especially the list of types of interactives that can be found in the product attached to the end of this paper. The focus on aquariums and not zoos is also a limitation, but again, many of the findings may be pertinent to zoos in the same way they are for aquariums, especially as the two types of institutions have sometimes blurred the line between them. That is, zoos are increasingly displaying aquatic animals and aquariums increasingly have terrestrial ones.
My work history may be seen as limiting my impartiality. I have worked in the aquarium field at two institutions, the New England Aquarium in Boston, MA, and the Aquarium of the Pacific in Long Beach, CA, the latter as an intern in the summer of 2005. I am also presently working at Academy Studios in Novato, CA, an exhibition design firm, where several of the survey respondents work. I feel the benefits of additional access to staff and resources in the field outweigh these potential conflicts.

Visitor evaluations were limited to those already completed and accessible. No new visitor studies were completed for this project, which limits the audience information I gathered to those questions in available studies. Evaluations were also limited to those reports which institutions were able to share.

The site visits were limited by my ability to visit only two, not all, potentially useful institutions. Those visited were limited by their accessibility in the time frame and resources available for this project.

Finally, the survey results are limited by the survey sample, other potentially helpful people were not contacted due to time and resource considerations. This is also true for the interviews, as the sample was limited by those whom I was able to get in touch with as well as those whom I determined would be helpful and available.
Literature Review

To illuminate the issue of utilizing interactives in aquariums, this literature review gives the background on key theories supporting the use of interactives in museums, studies of how visitors actually use these interactives, considerations for optimal design and studies on aquarium visitors and interactives.

Learning Theories Support Interactives

Educational theorists have long suggested that experience is a necessary component for learning, with educational philosopher John Dewey writing in the 1930s “that all genuine education comes about through experience.” Dewey argues for experience based learning, where the learner is at the center of the experience. While his thoughts on education have spawned a range of schools as well as the progressive education movement, the informal education arena of museums has been slow to incorporate his ideas.

In 1998 science center exhibit developer Ted Ansbacher wrote that museums need to revisit Dewey’s educational ideas and relate them to the museum field. He believes that Dewey’s theories need review because museums are not incorporating Dewey’s philosophy of experience based
learning into their exhibits and programming. Ansbacher writes that in a science museum, “interacting with an exhibit is actually doing, and therefore learning, science.”6 Taken another way, reading a label about science is not really doing and learning science.

Ansbacher describes Dewey’s two types of experience-based learning, that from within and that from without. Learning from without is the traditional model of knowledge being put into a vessel - the learner (or in this case the visitor). Knowledge from within is that which can be gained from experience.7

Another important point Ansbacher makes about the relevance of Dewey’s theories to museum learning is that of the visitor fashioning the experience. Moving beyond a didactic style of learning, Ansbacher argues that if “one accepts Dewey’s idea that visitors develop learning from their own experiences, then the exhibition goals shift from the outcomes to the experiences themselves.”8 The fact or conclusion reached by the visitor is therefore less important than the experience the visitor had getting there.

Museum consultant Peggy Cole Ruth agrees that Dewey’s ideas need to be incorporated into the museum world but she notes that Ansbacher fails to discuss the importance of context and the visitor’s prior knowledge in creating the personal experience Dewey promoted. She describes two approaches to address context. One is to provide a common
baseline of knowledge for visitors and to work from there. For this Ruth uses the example of the Bronx Zoo’s “Animal Homes” exhibition where the introductory signage stated that everyone has a home. Making the connection to visitors’ everyday life, exhibit designers could then explain the various types of homes animals have. The other method is to provide an experience and have the visitors use that as context. Here she uses the example of having visitors respond to objects in a museum’s collection—all visitors are taking a common experience (viewing the objects) and responding.9

In a more recent (2002) article published in the museum journal *Curator*, Ansbacher goes beyond the idea of incorporating experiences into museum education to incorporating *meaningful* ones. He says there is little meaning in exhibitions where the visitors push a button to light up a bulb. Rather, he encourages the “see and do” approach where an exhibit component, such as an interactive, tries not so much to teach but to encourage interest in what visitors are seeing. This could be especially valuable to institutions like aquariums where the living animals draw a crowd which is then visually stimulated, but where graphic heavy, didactic text does little to inspire most visitors intellectually.10

For many people, a trip to an aquarium, or any museum, is a social event with friends, family and/or classmates. Even someone who visits
alone is bound to have some degree of a social experience with the other visitors as they crowd around tanks, overhear other visitors’ comments or watch others engage with interactives. The social aspect of learning was introduced by the Russian psychologist Lev Vygotsky in the early twentieth century. He theorized that acquiring knowledge is a sociocultural experience. His theory sought to show the importance of looking at not just the learner but the others who are involved: classmates, teachers or parents.

Vygotsky built upon Swiss psychologist Jean Piaget’s theory of “scaffolding,” which is a form of cooperative learning where one learner is able to advance further in understanding a concept than their knowledge would usually allow due to the assistance of other learners “filling in” educational gaps. Scaffolding is not limited to the obvious parent-child interaction, where a parent can assist the learning of their child by explaining difficult concepts and abstract ideas, but applies to adults as well. Two friends with equal but different bases of knowledge are able to understand a concept or issue they would not be able to comprehend individually. Vygotsky terms this phenomenon, where collective knowledge can increase the individual’s learning potential, the “zone of proximal development.”
Educator Lois Silverman seems to agree, although she does not use the same terminology. She cites her 1990 dissertation on adult conversations in museums to suggest that a visitor’s companions significantly affect the outcome of his/her experience in the museum, noting the significance of one’s companion’s ability to “fill in” the experience and knowledge gaps of the other. She comments that “visitors learn new things through the past experience and knowledge of their companions. Thus, as in so many other realms of human life, people create content and meaning in museums through the filter of their interpersonal relationships.” Therefore, the prior knowledge and context of not only the individual but the group which accompanies the visitor in the museum must be taken into account. Silverman calls this phenomenon “meaning making.”

Educator Samuel Hausfather has categorized Vygotsky’s ideas of cognitive development into three main themes, the second and third being the most relevant to developing museum interactives. The second theme is the idea that Silverman sees-- that higher thinking occurs with meaningful social interaction. The third theme Hausfather locates in Vygotsky’s work is a theory on the importance of “tools” in social learning. Here, speech and conversation are noted as important tools in mediating learning. This
helps detail the importance of looking at conversation as an assessment of social learning.

Conversation is not the only tool educators see as important for social learning. Museum educators John Falk and Lynn Dierking conclude in their book, *Learning from Museums*, that “conversation is the primary mechanism of knowledge construction and distributed meaning making.” They note that this formation need not occur in verbal communication, but can also happen in “modeling,” where one person or group observes the way another person interacts with components of an exhibition.14

Beyond whether the visitor can engage with an exhibit is the question of whether he/she will choose to do so. Given all the necessary concepts and knowledge, a visitor can choose whether or not they move forward at any particular moment. Professor of Human Development Mihályi Csikszentmihalyi’s “flow” experience theory is relevant in a discussion of the utility and design of interactives as it goes beyond responding to peoples’ needs during an experience to their interest in continuing. Csikszentmihalyi believes that flow is an experience which is intrinsically rewarding. An almost spontaneous state of mind is achieved where the visitor can be lost in the moment. In these moments, a level of intense interest and attention is attained. Csikszentmihalyi and doctoral student Kim Hermanson argue that these types of experiences are needed
to maintain a visitor’s attention and focus long enough for the intellectual and emotional changes that museums are looking to help their visitors attain.¹⁵

But how do museums assist visitors to attain this level of intense interest and attention? There are certain conditions necessary for the flow experience to occur. The first is that goals should be clear to the user. A second is that feedback is immediate and straightforward. Finally, the skills required for the activity must match the skills of the user. This is true both in situations where users’ skills are far above or below those required by the activity.¹⁶ Overall, a flow experience can only be obtained if the visitor is both intrinsically interested and feels comfortable enough to enter this state of mind.

Educational theorist George Hein agrees with Dewey’s experience model of learning and sees two different types of interactive (experience based) learning: discovery and constructivism.¹⁷ Discovery is the experience model where the visitor is active in the learning, but where the outcome is programmed externally by a teacher or exhibit developer. Hein explains the limitation of this method by stating that “the purpose of this hands-on approach is still for the student to comprehend ideas and concepts that are independent of the learner,”¹⁸ meaning that knowledge
they derive from the experience is that which the exhibit developer-- as an authoritative voice-- intended.

The model Hein sees as best able to serve the diverse interests and knowledge of museum visitors is constructivism. This type of learning occurs when the visitor constructs the experience, like in discovery learning, as well as the knowledge they gain from the experience.\(^\text{19}\) Hein explains:

The constructivist classroom or exhibition includes ways for learners to use both hands and minds, to interact with the world, to manipulate it, to reach conclusions, experiment, and increase their understanding.\(^\text{20}\)

Experiments are crucial for constructivist learning, whether in science or other subjects. An experiment, as distinct from a demonstration, is a situation in which a range of results are possible and acceptable.\(^\text{20}\)

Active involvement in the learning process is as vital to constructivism as in discovery learning because if learners cannot change or alter the experience physically, they cannot change the experience mentally. The second requirement, that the conclusions reached by the learner have value and should not be judged by other, external standards, is linked to the above idea.\(^\text{21}\) However, it is important to note that in constructivism the learner creates the outcome from their experience, rather than being led to it by an outside voice of authority as in discovery learning.
Ansbacher agrees with the constructivist notions where the learner is in charge of the outcome, and that the goal of an experience in a museum can be that experience. He suggests that designing exhibits which provide visitors with engaging experiences should be an educational goal in itself, and that the transfer of information is not as important.\footnote{22} Outcomes are internal, and the process a person takes to that internal outcome can be the goal. Exhibition designer Tom Hennes adds to this discussion, agreeing that information transfer need not be the goal of an experience, but that problem solving should be encouraged, which help to make experiences driven by the visitor’s curiosity and interest.\footnote{23}

Moving from theory to implementation, in the late 1960’s physics professor Frank Oppenheimer noted a widening gulf between people’s daily lives and current science and technology. He called for props (interactives) to be used in educating the populace about science, saying: “Explaining science and technology without props can resemble an attempt to tell what it is like to swim without ever letting the person near the water.”\footnote{24} Without allowing people to directly interact with the physical manifestations of a subject, Oppenheimer is saying, there is no experience upon which to understand, and therefore really know, something.

Like Hein, Oppenheimer believes that there are different kinds of experiences that lead to learning, and that some are superior to others.
When talking about discovery learning and exploration, he explains that “many of the people who talk about the discovery method of teaching are really talking about the arranging of a lesson or an experiment so that students discover what they are supposed to discover. I don’t think that is exploration.”

The learner, therefore, must construct her own experience, not simply push a button or pull a lever.

Oppenheimer called for relevance in exhibits and scaffolding onto what visitors already knew, building on their prior knowledge through experiences with props to create new knowledge. Ahead of his time, he said these props should include “an apparatus that people could see and handle and which display phenomenon which people can turn on and off and vary at will.” While many interactives exist that can be turned on and off, very few go beyond this binary activity to meet Oppenheimer’s original vision of the visitors constructing their experience.

**What is Known about Interactives**

Moving beyond the theories for the inclusion and design of interactives are the evaluations of actual exhibitions that have looked at these two issues. Most of the literature discussing the evaluations of interactives comes from the science center community, which has been using interactives since Oppenheimer put his theories into practice by
founding the Exploratorium in 1969. In 2004, *Curator* devoted an entire issue to interactives, revealing the level of interest as well as the need to exchange ideas about them. One article by Institute for Learning Innovation Researcher Marianna Adams et al. reviews what is known about interactives in their thirty-five year history and suggests that museum professionals try to provide meaningful experiences: “those which provide choice and control in exploring ideas, concepts and objects.”27 Additionally Adams et al. argue that visitor interest in interactive experiences has increased, citing a study (Falk et al 2002) which shows that visitors think interactives are a meaningful way to learn and an important social stimulus.28

Museums that exhibit objects want visitors to spend most of their time, as well as attention, on these objects. Some museum professionals, therefore, fear that interactives will detract from the original object, or in the case of aquariums, living organisms. Adams et al. counter this skepticism, defining a good interactive for these type of museums as one which leads the visitor to pay *more* attention to the collection, serving as a scaffold to the objects or animals. They cite conflicting studies at different museums. One (Adams and Falk 1996) showed that a computer interactive didn’t draw people away from the artwork, but in fact encouraged them to look more closely at the objects covered by the interactive. However, a
A study at several European museums (Heath and von Lerh 2002) showed that while the computer interactives were popular, the visitors didn’t connect them to the objects to which they were supposed to draw attention. Finally, a 1999 study by Adams showed that while interactives may initially draw visitors’ attention away from the collection, repeated visits diminished the novelty effect of the interactives. From these reports, the authors conclude that “while an interactive may at first be the seducer that museum professionals fear, it is ultimately a way to stimulate interest in and learning about the objects.” Thus, interactives at their best aid rather than deter a visitor’s engagement with a collection on display.

Although there are no definitive answers to the question, the issue of “hold time,” or time spent at an exhibit is one way to measure learning in museums. Many evaluators consider hold time an important indicator of learning and it is one tool commonly used to evaluate exhibits, such as with timing and tracking studies, a naturalistic method for analyzing exhibitions where the visitors’ movements through an exhibition are recorded as well as the time they spend at the individual components. Museum consultant Beverly Serrell has tested the theory of “hold time,” developing the Sweep Rate Index (SRI) to measure the speed at which a visitor moves through an exhibit. It seems intuitive that a visitor would likely spend more time at an exhibition when interacting than when simply
looking at objects or reading labels. However, a study conducted at the Exploratorium showed that longer hold time did not necessarily mean more learning and some have questioned measuring hold time as a tool to determine an exhibit’s success. This is not to say longer time spent at an exhibit cannot mean more learning, just that it does not always correlate.

One alternative to using “hold time” as a measure of learning in a museum exhibition is analyzing conversation, the social context of learning that was discussed in the previous section. In a 2002 study examining a temporary exhibition at the Exploratorium entitled “Frogs,” Sue Allen, Director of Visitor Research at the Exploratorium, used “visitor talk” as a method for assessing learning. What is worth noting here is the methodology, where the amount of quality conversation rather than total conversation is used to assess the learning stimulated by an interactive.

As with art museums, aquarium visitors do not always anticipate an active experience. They visit to look at animals, not engage physically with exhibition components. Can visitors change their perception of what happens at an aquarium and incorporate interactive experiences into their visit? A study led by John Falk found that a shift in visitor expectations of interactives can change, so one could argue that visitors not expecting interactives at an aquarium can accommodate them and perhaps shift their
expectations of future visits. They also found that a visitor could come to more than one learning outcome from the same interactive, suggesting constructivist learning. However, this short term outcome did not necessarily translate to changes weeks or months later. When present, the long term results tended to be shifts in awareness and perspectives.36 Similarly, a study by John Stevenson showed that visitors to the interactive exhibition “Launch Pad” at London’s Science Museum recalled how they felt and thought even if they didn’t remember facts. Visitors also made it clear that attitudes about science had changed.37

Allen writes that through the evaluation of exhibits at the Exploratorium, the museum has found four aspects with which to assess an interactive’s success. These include initial engagement, the degree to which a visitor can approach and get started with the interactive; physical interactivity, the level of response or feedback to the visitor; conceptual coherency, or the clearness of the concepts covered; and finally the ability to reach visitors with a diversity of learning modes.38 In another article, Allen and Senior Researcher Joshua Gutwill add that it is important when developing an interactive to consider its ability to foster prolonged exploration or experimentation. This way, once the visitor engages there is a degree of long term engagement offered.39 Adams et al. offered three other means to evaluate the efficacy of an interactive: 1. design factors, 2.
social engagement and learning and 3. clarity of purpose and underlying assumptions.\textsuperscript{40}

Related to the idea of clarity of purpose is the issue of authentic experience. In \textit{Learning Science with Interactive Exhibits}, Science Center Director Elsa Feher notes that “good interactive exhibits are designed so that visitors can experience and explore a real phenomenon.”\textsuperscript{41} She has reservations about an article that discusses an interactive globe where visitors push a button to turn earth’s gravity on or off which causes “people” to stay put or fall off respectively. Fehr notes this interactive gives an inaccurate picture of gravity and since gravity was modeled (people on the earth “stuck” with magnets) but was not actually produced, the activity lacked authenticity.\textsuperscript{42} Therefore, visitors may not make the connection between their actions and those of the phenomenon any more than pushing a button to activate a video. Even worse, the visitor could make the literal connection of the interactive, which is not authentic and therefore incorrect.

Allen and Gutwill also write about many design characteristics for exhibit developers to avoid when developing interactives, including offering activities with several options with equal consequences, features that allow users to disrupt each other, options that allow users to disrupt the phenomenon, aspects of interactives that make it difficult to find main
phenomenon and secondary features that obscure the main one. To optimize interactives they suggest limiting or segmenting the functionality of the interactives. Reducing the options or inputs can make a clearer experience for the visitor without limiting exploration.

A visitor engaging with an interactive can seem like he is merely playing, especially in loud, chaotic science centers like the Exploratorium. According to Adams et al. research is limited on the effects of play on learning, especially with adults, and notes that some museum professionals are wary of visitors having too much fun. Nonetheless, the authors stress that play is not random and designing for play when developing interactives is an important consideration. Museum developer Dan Spock agrees, writing that “the embrace of play as a worthy learning activity cannot be encouraged enough.” Although not universally acknowledged, many museum professionals do believe that play is an important component of the museum experience.

Although Spock writes that he appreciates the breadth of research on interactives in the Adams et al. article, he notes they do not suggest how to approach developing interactives. Here Spock directs the reader to Hein and his writings on constructivism and discovery learning. Spock says he has found that designing exhibitions that promote discovery learning result in a high failure rate, and he refutes Adams et al.’s findings.
that computer interactives are not useful since they tend to be designed
with a discovery approach instead of constructivism. He believes
designing with a constructivist approach would produce successful
computer interactives because they employ play and have less of a
tendency to be overloaded with content, making the interactive more
visitor-centric.\textsuperscript{47} Perhaps discovery based interactives are just designed
poorly, trying to convey too much information, whereas a visitor to a more
open constructivist interactive has less chance of being “wrong” since
there is not one specific outcome.

\textbf{Research on Aquarium Visitors}

There is a little information about aquarium visitors and how they are similar to, and different from, other museum goers. What does exist,
Furthermore, is not very current. Beverly Serrell notes in 1978 that aquarium visitors are more interested in education than recreation, as opposed to visitors to zoos.\textsuperscript{48} In another study a few years later at the Shedd Aquarium in Chicago, she notes that aquarium visitors experience the same museum fatigue by the end of an exhibition that other museum goers had, and that they therefore spent more time at the beginning of the exhibition than the end. Visitors were found to spend more time at larger tanks with exotic species like sharks than at smaller tanks with less exotic...
animals such as grunts. Finally, she found that aquarium and zoo visitors wanted information that they could relate to what they saw in the animal habitat.

Beyond the visitor’s interests at an aquarium are what the visitors experience during their visit. A study at the National Aquarium in Baltimore in 2000 shows a visit to the aquarium positively affected visitors’ knowledge in the short and long term. However, attitudes favoring conservation of endangered or rare species and habitats were only affected in the short term, reverting to pre-visit levels in the long term.

Another paper written regarding the same study notes the importance of prior knowledge of visitors in their experience. When visitors were segmented into groups depending on prior knowledge, the changes evidenced in the preceding paper were only seen in two-fifths of the groups. This seems to call for more specialized evaluation as well as exhibitions that better account for the varied prior knowledge of visitors. However, an internal study at the Monterey Bay Aquarium in Monterey, California showed more positive results. Levels of concern about environmental issues as well as information learned on conservation were maintained for weeks or months. Likewise, the authors cite unpublished evaluations by evaluators Jeff Hayward and Randi Korn as showing that the most memorable aquarium exhibits were those that dealt with
charismatic animals-- that is, colorful, large, playful or otherwise compelling animals such as penguins or sharks- and those that included a visual, rather than conceptual, experience.53

A 1986 dissertation at University of California, Berkeley examined visitors to the Steinhart Aquarium in San Francisco and their interests. By soliciting visitors’ questions, Sam Taylor found that visitors to the aquarium were interested in concrete information that they could observe at the aquarium, familiar objects and animals and hands-on/participatory elements.54 Subjects the visitors were less interested in included more abstract ideas such as those related to interactions with other fish or habitat and range.55

**Limited Research on Aquarium Interactives**

Few studies about aquarium interactives exist. Oppenheimer noted that fish in an aquarium are always moving and therefore always interesting, and he felt this movement helped inform him in his ideas for the Exploratorium’s “props.”56 While true, he inadvertently introduces the problem aquariums face: of having a vivid “attraction” with which to capture visitors’ attention and not wanting competition for that attention.

A 1994 presentation at the American Zoological and Aquarium Association’s annual conference by Tom Krakauer of the North Carolina
Museum of Life and Science (NCLMS) and researchers at Informal Science, Inc. revealed the results of a previously held planning conference. A panel of aquarium, zoo, private firm and science center staff had come together to discuss exhibits with living collections utilizing interactives because NCMLS was planning a new animal exhibition. The panel felt that visitors were more attracted to animals than interactives and that visitors do not want habitats and landscapes cluttering these primary experiences. However, panelists agreed that interactives can play an important role by helping to “illuminate and reinforce the conservation message” that the institution is supporting with their animal displays. While noting the apprehension about and interest in using interactives in living museums such as zoos and aquariums, Krakauer and the researchers concluded that interactives should be used to support the experience of viewing animals.

Kodi Jeffery and James Wandersee of Louisiana State University in Baton Rouge, Louisiana presented a paper in 1996 at the Annual Meeting of the National Association for Research in Science Teaching based on Jeffery’s dissertation examining family learning at the Aquarium of the Americas in New Orleans. Fourteen family groups were tracked as they went through the interactive displays of the exhibition “Living Water.” They were interviewed immediately after their visit and then one
to two months later. These groups were asked open ended questions to determine which exhibits were memorable and which encouraged learning. The paper focused on locating what trends were similar in the exhibits found to be most memorable to families. The researchers found that emotions, such as fear and humor, are important to incorporate into the design. The shark touch tank and electric eel interactive (where the visitor turns a know to receive a mild shock) both involve fear and had the highest recall of the five exhibits studied. Köp and Wandersee call for exhibits with a multi-sensory experience, mirroring the impact of the above well recalled exhibits.

They also note that it is important to tie the interactive portion closely to the knowledge one is trying to convey. Visitors to a push button interactive that cued up fish sounds sometimes remembered pushing a button but not which fish made which sound. Problematically, the well-remembered eel display led half the groups to the (dangerous) misconception that they had felt the full power of an eel shock. This disengagement between activity and the message it is trying to convey is one reason for trouble with defining “interactive,” for just having a kinesthetic experience removed from the content does not allow the learner to connect actions with results, since the feedback is not authentic.
A 2002 dissertation conducted at the New England Aquarium in Boston analyzed the consequences of adding an interactive component to a penguin display to see the effects on visitor behavior. This exhibit was augmented with behavioral enrichment: a light station consisting of a flashlight and mirror which reflected the light upon the water below, causing the penguins to chase what it is postulated they perceived as a fish. In the automatic condition, this light station moved to shine the light below around without visitor interactivity, to separate the increased penguin activity of the light station from the visitors interactivity. Interestingly, the study’s author, Alexander Goldowsky, found little difference between these first two conditions as far as increasing visitor stay time or qualitative differences other than an increased number of visitors noting the chasing behavior. (Goldowsky subsequently assumed the position of Director of Exhibits and Programs at the EcoTarium in Worcester, MA and I was able to interview him for this project).

However, adding interactivity to the light station, that is, visitors controlling the light’s movements, significantly increased visitor stay time (three times the control). This increase in stay time correlated with the length of visitor conversations and revealed an increase in investigatory behavior, as visitors carried out a range of experiments. Goldowsky refers...
...to the aforementioned theories of Csikszentmihalyi on feedback to back up the value of experimentation here.\textsuperscript{62}

The penguin light station promoted a behavior in penguins that was easily understandable and observable to the visitors. Goldowsky found that visitors valued the increased choice and control that Falk and Dierking of the Institute for Learning Innovation\textsuperscript{63} pointed to as a source for increased motivation at interactives. It also allowed visitors to engage with animals, leading Goldowsky to speculate “that perhaps because of a greater feeling of a relationship or connection to the animals, visitors in the interactive condition were also more likely to speak in terms of the penguins’ motivations or reactions, and to express concern for the penguins.”\textsuperscript{64}

Summary

While there are many education models related to interactives, theorists and educators increasingly agree that experience is a valuable component of learning. The theorists progress from the general utility of experience in learning (Dewey) to the specific aspects of experiential learning that are important (Vygotsky) to the types of learning most important with experiential education such as constructing one’s own meaning (Hein). Important to many learning theorists, and similarly
museum practitioners like Adams who write about these theories, is the idea of the experience being a goal in itself, as opposed to specific knowledge acquisition outcomes and perhaps by using interactives to help create what Csikszentmihalyi refers to as a “flow experience,” this event can be more meaningful.

While interactive experiences were shown to increase both short term and long term changes in visitors, the effect of interactives to produce long term changes has not been extensively studied in aquariums. An aquarium visit has historically been passive and aesthetic. However, exhibitions as a whole have shown that these changes can occur in aquarium visitors but depend on prior knowledge and future experience.

From this limited review, the evidence suggests that interactive elements are an integral part of the visitor experience in a museum generally and aquariums specifically. Interactives are shown to enhance rather than detract from collection based exhibitions at places like aquariums. Hold time and conversation can be increased when interactives are present. Communication need not be verbal, as watching a visitor engage with an exhibit is a form of social communication and relates to interactives. Limited research has shown that the qualitative effects that a museum can facilitate such as experimentation can also be increased.
Not all interactive experiences are equal. Just because an experience is interactive does not make it valuable. The authenticity of the experience is important for developers to consider: an interactive that causes visitors to engage in a manner unrelated to the concept or phenomenon can leave visitors confused or even worse, misinformed. Successful interactives tend to be those that are not only authentic, but multi-sensory, eliciting emotions (good or bad) and offering the visitor control over his experience. In aquariums, memorable interactives are those in which the visitor can relate the interactive experience to something they can see or observe such as the shape of a fish or the movement of a sea star.

The research reveals the need to include interactives as a part of the aquarium experience to assist the visitor in meaning making. There is also literature elucidating what has made interactive experiences successful in science centers. However, there is little research on how best to develop interactives for aquariums as well as the various experiences that can be defined as interactive in aquariums.
Findings

My primary research revealed that, as suggested in key literature in the field, simplicity, authenticity and immediate feedback to visitors are important components of an interactive. My initial observations and conversations support the use of the different learning theories described in the literature, especially those of Dewey, Hein and Vygotsky. However, perhaps because the theories present large ideas but offer no specific practical guidelines, each aquarium seems to approach planning and organizing interactives differently and there is a large disparity in the field about what constitutes an interactive, resulting in a wide variety of interactive experiences and evaluation techniques. These findings are described below in more detail, organized by my site visits, interviews and survey results.

Site Visits

John G. Shedd Aquarium, Chicago, IL

I visited the Shedd Aquarium in Chicago on Sunday April 3rd 2006. The Shedd has evolved over the last seventy-six years, so the main building through which I entered differs from the two additions, the “Oceanarium” in 1991 and “Wild Reef” in 2003. The original building has
many tanks which date from the Shedd’s founding, although text and interactives have been changed/added. One gallery, “Amazon Rising,” was renovated more recently (2000) so most of its components date from the same period.

Upon entering the original galleries I noted that there were many computer driven interactives as well as audio/video content. These computer driven interactives included touch screen ID’s, games and Flash type stories that were activated by the visitor. The audio/video interactives were similar to the computer stations, where the visitor started short films.

“Amazon Rising” immersed visitors in an environment using artifacts from the people of the Amazon as well as sounds and videos of its’ people, landscape and animals. Adaptations to the flooding by the Amazonian animals and people was the theme in this exhibition. The water level of the tanks started low at the beginning of the exhibition, while later tanks had a higher level which corresponded to the changing seasons, from dry to flooded. The rainy season was evoked with water falling and mist rising. In the high-water area, visitors can observe the bigger fish and other animals such as the turtles that inhabit this environment.

Inside a replica of a villager’s home was a radio with buttons which allowed visitors to change the stations to different programs such as
a soccer game or news that the villagers might listen to. This element seemed more immersive or atmospheric than interactive, and didn’t correspond directly to any animal or tank.

Many tanks had touch screen ID panels next to them that gave the name and some basic information about the animals in the corresponding tank-- such as size, weight and diet. The interaction here was similar to a web site or a graphic that must be flipped for the visitor to read: the user was intended to read information. I learned upon speaking with staff later the reason is that the trend towards multi-taxa exhibits has made having a separate label for each animal more difficult. The purpose, therefore, of these touch screen ID’s was to reduce the clutter that would result from having individual labels for each species. Staff also found it easier to add information about an animal to a computer kiosk than to add a label should the tank inhabitants change. (See Appendix D.1 for photo of touch screen ID).

Towards the end of “Amazon Rising” was an interactive associated with the electric eel tank. Here, visitors could view the level of an eel’s electric charge, shown in light emitting diodes (LED’s). They could then put their hand on the rail to read their electric level, allowing them to compare their electric level with an eel’s. I observed that this activity seemed to be popular, yet I cannot prove people were
understanding the educational message that a human’s voltage is much lower and fluctuates less than an eel’s. (See Appendix D.2 for photo of eel interactive).

Other updated but not fully renovated galleries had a mix of computer driven games but no real mechanical interactives. One game was located by the sea horse tank. Pressing “start” on the touch screen activated a cartoon drawing of a fishing boat dragging a net. The user is supposed to use the touch screen to pull up the net before it drags on the cartoon seahorse’s habitat along the seafloor. Another computer interactive dealt with invasive species to the Great Lakes. Different cartoon images of invasive animals were shown and visitors were asked to select one. They could then choose, from among several options, ways to prevent the animal from taking over the lake and becoming a problem. This had to be done within a specified budget. These options changed depending on the animal but included selections such as legislation, poison and constructing barriers, all with different costs. After the selection, the game told the user the result of their actions, (whether or not you stopped the invasive animal from becoming a problem), and how much money was left to try again, if needed. While the options were all predetermined, there was feedback during the game to engage visitors after making their selections.
The Shedd’s “Oceanarium” wing focuses on the marine animals of the Pacific Northwest. Like “Amazon Rising,” it is an immersive habitat; the visitor walks through a forest of trees and plants, while rockwork makes up the floor and walls as well as the amphitheater for the dolphin shows. A lower level has underwater viewing and most of the interpretive elements, including non-computer interactives. Some were fairly simple where the visitor flips a panel or pushes a button to reveal text. For example, a visitor to a panel about penguins can push a button to light up an answer to the question “why is this penguin waving.” The answer is backlit when the button is depressed.

Another interactive consisted of an otter fur sample which visitors could touch. A similar available experience was a replica cross-section of a portion of a whale-- the skin, blubber and muscle layers could all be touched, each having a different texture. Having the two side by side allowed for comparison of two different marine mammals using a sense other than sight. These interactives were both heavily used by visitors, who formed a small line to touch them. (See Appendix D.3 for photos of the fur and cross section exhibit elements).

Two related interactives near the underwater dolphin viewing were exactly the type of mechanical interactive I had been seeking. They each consisted of two small round acrylic containers with a spin wheel on top
connected to a dowel that went down to the bottom of the containers. The first examined moving an object in air versus water to illustrate why being streamlined is so important to fast moving aquatic animals like dolphins. These two containers had the same wood block on the dowel, one in water and one just air. Visitors could spin the wheel of the container with air and find it is much easier than spinning the one with water. If the visitor stopped turning, the resistance would fade and increasing spinning caused increased levels of feedback. The second set of containers both contained water but the wood block had two different shapes, one similar to the block and another more streamlined, like the dolphins visible in the tank behind this station. The main concept of this set, that being streamlined is an important adaptation for aquatic animals, could be understood without reading a text panel. (See Appendix D.4 for photos of the Air vs. Water interactives).

The next day I visited “Wild Reef,” the latest wing to open at the aquarium in 2003. This was also immersive, with a lot of touchable fabricated coral and rockwork. Like “Amazon Rising”, there were many computer interactives including touch screen ID’s and games. The touch screens here were hard to utilize because several were broken and others were often in use. (See Appendix D.5 for photos of the touchable rockwork).
An enlarged anemone model near the beginning of “Wild Reef” was aesthetically pleasing and often had a crowd surrounding it, some visitors even having their pictures taken with the model. Two buttons along the rail could be depressed; one caused the reproductive organs on the anemone to glow and another made mist come out the top, as if the animal was releasing reproductive cells. Determining which button was causing which action was difficult since two different visitors could push at the same time. Furthermore, depressing one button did not immediately make the glow or mist activated by the other button stop. It was, however, heavily used. (See Appendix D.6 for photo of anemone model).

The Build a Shark computer game that an interviewee from another aquarium recommended I seek out was not working. Here, a visitor is supposed to select different parts of a shark’s body like teeth and fins to create their own shark. If the creation does not correspond to a real shark, it explodes. If it does correspond, the computer tells you what type of shark you created.

Another interactive gave little feedback. The visitor was to turn a dial to increase the size of a wildlife reserve on a model island-- as more was set aside as a reserve, more LED’s lit up. Other than lighting up, there was no feedback on the consequences of the visitors’ choice, which
seemed confusing to me as well as other visitors I overheard. (See Appendix D.7 for photo of this interactive).

I observed that many interactives caused visitors to stop, even to break stride, in order to try them. The interactives definitely drew people to them, although some did this more than others. From my experience and brief observations, the level of engagement and interest once the visitor stopped varied by interactive and visitor.

As part of my site visit, I spoke with four staff members involved in evaluating and developing the exhibits at Shedd. When asked about their use of interactives, Director of Exhibits Dana Thorpe said that “people are coming to the Shedd for a broad variety of reasons, and that our position is that [interactives add] additional opportunities for engagement and learning, allowing the visitor to select tools that they are comfortable with.” Yet Raul Silva, the audio/visual person in charge of the computer interactives, mentioned the challenge of creating interactives that were engaging but do not draw visitors’ attention from the animals. Throughout the discussion, Shedd staff stressed that adding a variety of interactives acknowledges the many types of experiences visitors want to have, but it is a challenging endeavor.

At the Shedd, interactives are added to the exhibition plan during the design and research phase. Staff consider questions that center on the
delivery of content including: how big is the story that they are telling; what is needed to tell that story; and what can’t be communicated unless we use an interactive? Interestingly, hold time was not a reason for including interactives. The staff I spoke with felt that people are often in the building with children and that even without them, visitors generally have a limited amount of time set aside for their stay.69

When they are designing an interactive, staff prototype elements to see how visitors will use them and what needs to be improved. However, this does not ensure success, so developers monitor their work once it is installed. Several mechanical interactives were prototyped and installed in the “Sea Star Quest” special exhibition, but were later removed because they kept breaking. It was felt that it was not worth the time and money necessary to redesign them for the short run of the exhibition.70

After opening an exhibit, staff indicated that evaluating interactives is difficult because there are so many different types in an exhibition. Evaluation is normally performed on the exhibition as a whole, rather than on a particular interactive. Evaluation is also usually more concentrated on usability rather than how the interactive is achieving certain learning outcomes with Director of Audience Research and Evaluation Linda Wilson stating that their interactives are currently “not user centric, they are content and design centric.”71 To correct this, the
Shedd’s evaluation department will evaluate the interfaces of the computer-based interactives in the summer of 2006, looking at the way people use them and how to improve that experience.

*Monterey Bay Aquarium, Monterey CA*

I arrived at the Monterey Bay Aquarium in Monterey, California on March 22nd, 2006. The first area I visited was “Splash Zone,” an area devoted to families and young children. There were many opportunities for hands-on activities here, all with an aquatic theme. These included a jungle-gym like play area similar to something one would find at a playground, and a water activity where children could create dams and play with animal models in the water. Most were play oriented— for example, there was a “climb in” penguin egg which was used by many of the young visitors. Exhibit Developer Jenny-Sayre Ramberg later said that the goal here was to mix fun with messages, and that the exhibit team had looked to children’s museums for inspiration when developing this area. (See Appendix E.1 for images of this area).

Near the penguin habitat in “Splash Zone” is an interactive that examines penguin communication. It features three pairs of puppet penguins. Each has a knob with a message below— “hello,” “I’m happy” and “go away.” One penguin’s movements and call “communicate” the selected message to the other when the visitor spins the corresponding
knob below each pair. This was very intuitive, enjoyable and often in use. (See Appendix E.2 for photo of the penguin interactive).

Next I visited the “Near Shore” wing downstairs, a newly renovated area which focused on the Monterey Bay shore habitat. Many exhibit components were touchable models or immersive elements like fabricated rockwork or pilings that the visitor could touch. For instance, the octopus area contained a touchable scale model octopus outside the tank. This, Ramberg said, was added by the exhibit team to give visitors a unique experience similar to one that staff enjoy - touching the octopus.73

_Tide Pool Olympics_ is an arcade style interactive that allows up to four people to play at once. A large tabletop screen sits in the center showing a tide pool habitat and there is a small screen and joystick on each of the four corners. Visitors choose to touch, pick up, take a picture of or observe objects/animals they encounter. The game gives them more points for the most environmentally conscious answer. For example, the visitor earns points for taking a picture of a crab, but receives fewer if they select to touch the animal. When asked about selecting the type of interactive to be used, Exhibit Developer Ava Ferguson gave this as an example of an experience selected for a slightly older audience while a similar (content wise) interactive in “Splash Zone” was mechanical
because of the cognitive limitations of the younger audience’s abilities.74
(See Appendix E.3 for photos of Tide Pool Olympics).

Two interactives in “Near Shore” allow visitors to interact directly with living animals. The Barnacle Feeder and Surge Channel both have a tank with a turning mechanism below for the visitor. In Barnacle Feeder, turning a crank releases food into the tank, which the visitor sees make the barnacles open up to feed, a behavior not often observed by the casual observer. By turning the crank below Surge Channel, the water in the tank moved in the direction and speed the visitor chose and they were able to observe the way that the fish in the tank reacted to these changes. The crank was low enough for young children to reach but not all who could turn it would be able to see what was happening in the tank above. (See Appendix E.4 for photos of these interactives).

Several components here could be termed viewing aides and ranged from simple object additions for tanks or habitats to more complex, electronic ones. A viewing scope near the shorebirds did not actually magnify what the viewer saw. Accompanying text instructed the visitor to “Look outside, you’ll find…” and listed several of the organisms found in the exhibit. Ramberg told me that the point of the scope was to have people stop and look at the scene more intently and to notice animals visitors might not see if they were looking at the entire habitat at once.75
Another viewing aid was a magnifying lens suspended in front of a tank by a mechanical arm. The visitor was able to move the lens to see a section of the tank of their choice more closely. This was almost always in use. A similar interactive experience consisted of floating magnifying lenses in a tide pool tank. This tank contained many tide pool animals that could not be picked up as in the touch pool. However, the lenses could be freely pushed around the tank, offering a kinesthetic experience with the unstructured outcome of exploring the tank visually utilizing a tool.

More complex viewing tools used cameras for exploration. One tank in this area had a large flat screen monitor above it and controls located below. The tank contained marine animals and plants as well as a circular shaped camera. The visitor could move the camera 360 degrees and zoom in and out, the resulting image displayed on a screen in front of them as well as the large monitor above. The larger screen was viewable by other people walking by the exhibit as well as friends/family members who were not operating the camera. A similar device in the shorebird area had controls mounted on the rail that resembled a periscope flipped upside down- from the controls a line went down to the water connected to a camera. A viewing screen was mounted along the controls. There were several of these stations along the pathway through the shorebird habitat.
and were all almost always in use. (See Appendix E.5 for photos of viewing aids).

*High Tide Feast* consisted of a video screen on a graphic panel with a lever. By moving the lever, a visitor caused a short animation to show the tide rising on a rocky shore and the way that animals responded. I observed that many visitors moved the lever, watched for a brief period as the water level on screen changed and then moved the lever again while the “water” was still rising. However, the animation needed to run full sequence before it could respond again, so was unresponsive to the visitor’s actions during the animation. After trying to move the lever again and seeing nothing happen, several visitors walked away while the animation was still running. Moving the lever didn’t really move water or even simulate moving water, it was just a toggle switch to start tide movement. (See Appendix E.6 for photo of *High Tide Feast*).

There were many text panels in this area that required some degree of kinesthetic activity to read. Some graphic panels needed to be lifted or flipped like pages in a book. Similar to these were panels with buttons which when depressed, lit up text. Still another in this theme were artifacts, like a picnic basket, that when opened contained text. These could all be termed active graphics, since the interactive component here consisted of the manner accessing the text. The graphics that needed to be
lifted reset so the next person encountering the graphic did not become confused if the answer is presented to them before the question. (See Appendix E.7 for examples of active graphics).

While not the type of interactivity I had been seeking, their inclusion has been shown to be useful to visitors. An internal study showed that adding active graphics to an introductory panel increased the amount of people who read the text (in contrast to the inactive state) as well as people’s knowledge of the content.77

There were several other exhibition components that expanded on the theme of active graphics by adding a sculptural component. One was a replica of a piling where visitors could press a button on a rail panel next to a model of an animal. This caused the larger model on the piling to light up, revealing where on the piling that animal lives. At another station, the visitor touches a model of an animal which causes it to illuminate and play a short film about the animal. (See Appendix E.8 for photo of piling).

A pair of interactives in this area offered the kind of mechanical experience I had been seeking. One had a model of a flatfish under an acrylic bubble floating above a sandy bottom. A joystick allowed the visitor to arc the flatfish around in a circle, while depressing it moved the fish down into the sand. To completely bury the fish one needed to both push the joystick down to lower the fish, and then move it left and right to
cover the animal with sand, mimicking the movements of a real flatfish. The other interactive here consisted of a model tubeworm and a lever. Pushing the lever caused the tubeworm to extrude internal parts they use for feeding. Upon release of the lever, the parts return inside. The actions of the visitor were not as tied to the actions of the real animal here as in the previous interactive. Both were very popular with visitors during my visit. (See Appendix E.9 for photos of these mechanical interactives).

An exhibition entitled “Sharks: Myth and Mystery” had many touchable components including artifacts such as a full size dugout canoe. The exhibit examined indigenous people around the world and the way sharks are part of their culture. One station allowed children to put their face up to a mask mounted on a pole and look in the mirror. Another station had crayons and paper where children could rub a carving of a mythical shark mounted on the wall. While the shark was not real, the children’s experience with the carvings was genuine. (See Appendix E.10 for “Sharks” interactives).

Both Monterey exhibition developers with whom I spoke emphasized the importance of offering an authentic experience when developing interactives and the need to be clear about the goals. Incorporating elements that allowed for social activity was another design characteristic they agreed was important. Noting the broad range of
experiences at the aquarium, I asked about the value of push button interactives. Ava Ferguson felt that if the act of pushing a button is not content related; people will push them randomly. She felt that the “action of the interactive should be trying to replicate real world actions.” Buttons, she noted, can work if they offer a similar action to the manner the subject is interacted with in reality. Flip books are just active graphics, for example, but using them in an exhibit about marine animals in literature makes sense because the real experience of the content replicates flipping the pages of a novel.

When asked at what point during planning are interactives added to an exhibit, there was a two-fold answer. Ferguson noted that an aquarium is “different from … a science center, for the animals come first, and are planned for accordingly. [The aquarium] plans to immerse people in the habitat, which is more of a priority than non-living interactives. Developers are given the leftover space that remains after the exhibit team has laid out the live animal experience.” So although the addition of interactives needs to be decided early, the type and location cannot come until the animals and life support are designed and accommodated. A second and related factor noted by Ramberg is money; interactives are expensive to build and maintain and thus must be planned for early in the budgetary process.
Despite these monetary and planning issues, Ferguson noted the aquarium includes interactives when exhibit developers ask, “How can we enhance the visitors’ experience?” and find that an interactive can do so.\(^{83}\) Both developers saw interactives as a way to give visitors a view or experience not otherwise possible. Even the spotting scopes, which don’t add content or some ability for mechanically enhanced vision, do give visitors a view they may not otherwise have.\(^{84}\) The floating magnifier in *Shale Reef* was cited by Ferguson as one her favorites. She felt that it was successful because it was a real experience. In addition it involved live animals, allowed visitors to get up close, encouraged discovery since there were no labels and was less programmed than the tide pools which necessitate (because of handling) a docent.\(^{85}\) (See Appendix E.11 for photos of *Shale Reef*)

Another driver for the creation/selection of interactives is the audience. The exhibition “Jellies: Living Art” was more targeted to adults, so when making “Sharks: Myth and Mystery,” Monterey’s exhibit team decided that they were going to target a different audience: multigenerational families. Ferguson described the influences for creating interactives as “a pyramid; audience, space, message all interwoven to decide what to make. What’s the richest experience we can offer? The richest is: multi-sensory and multi-age/ability while supporting content.”\(^{86}\)
So, many factors go into the inclusion and selection of the type of interactive experience offered.

Both Ferguson and Ramberg said there is not a definitive reference they use for creating interactives. Personal libraries on a range of topics are used for the many different types of interactives and Minda Borun’s PISEC study on family learning was mentioned as a good resource for family oriented exhibits.87

Monterey’s evaluation strategies echoed those described by the Shedd. In an interview, Steven Yalowitz, Audience Research Specialist at the Monterey Aquarium, said the aquarium’s typical unit of measure for summative evaluation is the exhibition, not each component, such as one interactive. While they do periodically conduct studies of specific exhibits as part of a summative study, focusing on the exhibit is more common in the formative stage of exhibit evaluation. However, timing and tracking studies do note if and how long people stopped at each interactive. It is hard, however, to judge what is gained conceptually from the interactives during summative evaluation since they are part of a larger themed exhibition. He explained “each component in an area has a role, they are pieces which work together.”88 Therefore, it can be difficult to ascertain if one interactive is not aiding the visitors’ understanding of the main message. This is similar to the process at the Shedd.
**Additional Interviews**

I conducted five additional interviews with exhibit professionals at museums with living aquatic collections (or in one instance a person who had worked at an aquarium). Much of what they said echoed what I saw and heard from staff at the previous two institutions. These professionals listed a broad range of resources including journals and books they referred to when creating interactives. The PISEC study was mentioned by several as a good resource as well as literature published by the Exploratorium staff. Overall, the main theme was building on experience that the developers had in their careers and inspiration from what other institutions had done, trying to use those mechanisms with the content they are presenting.

Evaluation of some sort was mentioned by all the professionals interviewed. The large cost prohibited some from completing as much as they would like, but all mentioned using some form of formative and front end evaluation. Similar to the Shedd and Monterey aquariums, summative evaluations focused on the exhibition as a whole, and not on specific individual interactives. Prototyping and mock-ups were mentioned by all as a necessary part of the process for creating an interactive. Prototyping was used to show the exhibit team how people will use their interactives.
and what may break. Like at the Shedd, prototyping was primarily used to solve usability issues.

Two interviewees mentioned occasional apprehension among other staff when including interactives for fear of detracting visitors from looking at the animals. Most, however, dismissed this as a concern of the past. Director of Exhibits and Programs at the EcoTarium Alexander Goldowsky said the evidence is clear what people do at non-interactive animal exhibits. “It’s very sobering and consistent, the visitors see the obvious, physical features (of the animals), the obvious behaviors, and that’s it, they are gone, unless there is a hugely compelling behavior.’” Interactives, he said, are able to be a mediating experience that graphics alone cannot perform.

While within the exhibit field the value of interactives as part of the aquarium experience may be accepted, Beth Redmond-Jones, Director of Exhibits at the Aquarium of the Pacific, noted changes still need to be made. She said the animals provide tough competition for interactives, and visitors still come expecting to look, not to interact. To change this, “hurdles need to be crossed by both the visitors and the developers to include hands-on components (to aquarium visits).” In other words, increasing visitor expectations of having hands-on experiences at an
aquarium needs to be coupled with aquarium developers creating relevant, engaging interactives.

Including a variety of experiences was mentioned by interviewees as an important element of design for interactives, and was seen in both the Shedd and Monterey Aquariums. Director of Exhibits at New England Aquarium Dr. Billy Spitzer said these multiple types of experiences help reach the many different types of learners and interest levels seen at an aquarium.91

Constructivism was seen by many, but not all, as an important theory to consider when developing interactives. However, many of my interviewees noted that visitors will create their own experience regardless. It also is difficult to create an exhibit with a conceptual message that can be evaluated, with Spitzer saying “it’s a paradox that you can have a constructivist exhibit with a message.”92 That being said, he noted the importance of front end evaluation studies to determine what people know about a subject, since constructivism is based on the idea that the learner will incorporate the current experience with their previous knowledge, beliefs and experiences.

Eugene Dillenburg, an exhibit developer from the Science Museum of Minnesota who previously worked at the Shedd, said while he
tried to incorporate the ideas of constructivism when developing interactives, that there are other important considerations.

I always focus on what experience will best convey the message. Effective communication is, almost by definition, usually strongly constructivist. But I do not start there. And I have to balance constructivism with content and mechanics.  

While seemingly useful, constructivism was a goal that developers had mixed feelings about; both how important it was and how or if it could really be incorporated within an aquarium context.

Many mentioned that interactives should be intuitive and simple, and if possible, not require labels. Ferguson noted that “Like Ted Ansbacher, I firmly believe that visitors should learn by interacting with the exhibit—and not just by reading the accompanying label.” Feedback and authenticity of the experience were also noted as important qualities.

**Survey Results**

Of the 110 surveys I sent out to exhibit professionals, (primarily those who work with living collections) I received back thirty-nine. Of these thirteen were from staff at aquariums, seven from science centers and the remaining were from private firms and consultants for aquarium exhibits.
Although the type of interactive I was asking about was explained as a mechanical one where the visitor’s interaction with the component enhances their understanding of the concept, the answers showed a wide degree of definitions about what it means to be interactive. Eight (21%) returned surveys mentioned some type of computer experience and two mentioned tide pools, neither of which are mechanical. Other answers outside of my definition included models and videos.

Mechanical interactives both without and with live animals were used by the survey respondents, with all indicating they had designed or used at their institution at least one type. Twenty-three percent (9 of 39) reported using mechanical interactives where the visitor interacts directly with an animal, although this need not be touching; the aforementioned barnacle feeder at Monterey was mentioned here.

When asked why they used interactives when developing exhibitions, most respondents stated that they wanted to increase visitor interest in the exhibit. Fifty-six percent of all the respondents cited this as a primary reason, seventy-seven percent when only examining surveys from aquariums. Other frequently cited reasons for including interactives were to draw in families, increase hold time, and to help illustrate a difficult subject. The least selected choice, helping visitors notice an unexciting concept, also saw the most significant difference between the
two groups (aquarium and non-aquarium respondents), being selected by only fifteen percent of aquarium people and thirty-one percent of all respondents. Finally, one quarter wrote in an additional reason not offered on the survey for using interactives: that they reach people with different learning styles.

The institutions most often cited when asked to list two zoo or aquarium interactives that people felt were good at engaging the public were Monterey Aquarium in Monterey, California, the National Aquarium in Baltimore, Maryland and the Brookfield Zoo in Chicago, Illinois. When asked to say what is noteworthy about the interactives, a broad range of answers was given. “Being simple” was mentioned by over twenty percent of the respondents. “Giving a new perspective” or “doing something differently” was mentioned as a trait of thirteen percent of these interactives, as was using observation, smell or the other senses. Encouraging social learning was given ten percent of the time. Being open ended or requiring little reading were given by 2 (5%) of the respondents and giving feedback and being an authentic experience were each given by one respondent.

A majority of the interactives people listed as noteworthy were not known (to the survey respondents) to be evaluated. Being noteworthy,
therefore, was intuitive and did not correlate to the scientific results of evaluation. (For a full table of survey results, see Appendices F & G).
Conclusions

My research reveals that aquariums are increasingly interested in presenting interactive experiences to their visitors in order to better engage and serve them. These range from immersive exhibition areas to the mechanical interactive elements that have defined science center exhibitions for decades. While the animals are still the main attraction at aquariums, forward thinking institutions see interactives as ways to further engage visitors with these animals and the aquarium’s mission.

The theories put forth in the literature backing the inclusion of interactives are supported by what I saw at the Shedd and Monterey Bay Aquariums, heard during my interviews with exhibit professionals and learned from responses to the survey. Interactives, by their very nature of being a kinesthetic experience, can provide the experience-based learning that John Dewey felt was so vital to learning. They have the potential to offer open-ended exploration and allow visitors to construct their own meaning in the way that George Hein calls for in *The Constructivist Museum*. A social experience that may not otherwise occur can be facilitated with an interactive, encouraging conversation and learning experiences described by Lev Vygotsky as the “zone of proximal development,” where the social group is able to understand something
each individual may not when isolated from the larger group. Finally, interactives can allow a visitor to become intrinsically motivated in the learning experience, creating what Mihályi Csikszentmihalyi termed a “flow experience.”

These theories were clearly incorporated in some of the interactives I visited, but in a wide variety of ways. From my visits and interviews, it is clear that this variety is intentional, for an institution that offers varied experiences acknowledges that their visitors come with a range of interests and abilities. However, the survey’s wide-ranging answers reveal that much of the variety of approaches is between, rather than within, institutions. That is to say, I saw a variety of approaches to creating interactives in the field, but the survey did not show these diverse methods translated to offering multiple experiences to visitors at individual aquariums.

A second theme of my findings is that there are certain qualities that can make interactives better experiences for the visitor. These include authenticity, feedback, touch, and creating simple, intuitive and straightforward experiences. Several of these concepts are interconnected, so by designing for one, another may be easier to incorporate.

I believe that authentic experiences are key to interactives, and lacking this, simply are making the visitor work for information or, worse,
misinform the visitor. Pushing a button to illuminate the answer to a question is rarely the way a person would find the answer to that question in real life. Push button devices lack authenticity and are not truly interactive in the spirit of Dewey, Hein and Vygotsky. The *Air versus Water* interactives at the Shedd gave visitors a real experience, spinning an object in real air and real water, to feel the difference in densities. In the seahorse computer interactive, on the other hand, the action the visitor took to pull up the net didn’t involve the fisherman who was dragging the net from above the water, as would happen in real life. Rather, the user moved the net independently from the fisherman, underwater. This disconnect between the visitor’s actions and the content gives the experience less impact and even potentially misinforms the user about how fishermen use nets.

An authentic experience can often be the best way to achieve another important design factor for interactives, feedback. Push buttons fall short in this respect also; with a button there is one action that the visitor can make and one outcome that will result. However, an experience where the visitor makes choices which result in variable, continual feedback can keep visitors deeply engaged for a longer period of time. Moving the lever again at the *High Tide* interactive once the video began did nothing, leaving visitors frustrated and disengaged from the activity.
Allowing the visitor to keep receiving variable feedback based on their actions would keep the visitor engaged and interested. Using a spin browser to control the animation like the one on a nearby tidal video would give the visitor more feedback by allowing them to stop, slow or reverse the footage. (To add some authenticity, the film could consist of footage from a piling near the aquarium, and taking a cue from the EcoTarium in Worcester, MA, the footage could be constantly updated, the visitor able to browse through the last 24 hours of tides.) Adding feedback and real footage can transform a push button video to a dynamic, fun experience.

Variable amounts and types of feedback are critical to achieving the open-ended experiences that Hein calls for when describing the constructivist museum. Open-ended experiences are difficult to create in an environment that seeks to evaluate what content has been absorbed by the visitor, but their value is high and therefore they are a worthy goal. The Shale Reef magnifier gave no instructions on what to look for; visitors simply looked, explored and decided what they wanted to know or see. Similarly, the Penguin Light Station at the New England Aquarium (as described in Goldowsky’s dissertation) allowed visitors to create experiments and explore on their own, sparking conversation and engagement. In both of these examples, the visitor determined how long...
they wanted to engage with the interactive based on their interest, rather than “being done,” since they were exploring rather than seeking a specific answer.

Touch is another design attribute that can make an interactive more appealing. This can be as simple as the touchable otter fur at Shedd. Similarly, the model octopus at Monterey was interactive only in that it could be touched; yet both of these offered an engaging experience that was unique and authentic (the model was not real but the touching sensation was). While not as deep as some experiences, touching can eloquently achieve its goal - to better engage the visitor with the animals - by helping to inform the visitor about an aspect of the animal they may otherwise not think about or experience.

The best interactives were straightforward and simple. This does not mean that they were limited to simplistic topics or that they were easy to develop. Rather, a visitor could approach them intuitively, that is, no instructions are needed to start using the interactive. For example, the electric eel interactive at the Shedd is a very simple and straightforward experience. The electric charge of the visitor and eel are easily, and authentically, represented by the LED’s, so I believe most were able to understand the message (that the eel has a higher electric charge) without
much reading. In fact, the whole exhibit was very intuitive, requiring only people to read which was the eel’s level and which was theirs.

Computer interactives can seem less authentic than mechanical ones but this is not always true. When they are used to explore an idea rather than present an encyclopedia of facts, computers can tender experiences that could not otherwise be offered. A computer interactive that allows for exploration, selection and gives varied feedback such as the *Great Lakes* computer game is a useful tool, just as a mechanical one with these attributes would be.

Evaluation in many forms improves the efficacy of interactives. Front-end evaluation lets developers find out what the intended audience knows about a subject so a comfortable entry point can be made at the interactive. Prototyping is used widely to help developers see how people will use an interactive as well as design flaws that make it prone to breaking. Summative evaluation is almost universally performed exhibit-wide but not on each interactive.

Interactives can be expensive to build and maintain, and this leads some aquarium exhibit professionals to avoid using them. Interactives are not only expensive to create, but money and staff time need to be set aside for their upkeep since visitors encountering a broken interactive are disappointed about the experience they cannot have. If the interactive is
the only way of accessing certain information, such as a touch screen ID, the fact that it is not working can make for a less enjoyable and fulfilling visit.

The inclusion of interactives is supported by both the literature on educational theory as well as what exhibit professionals say and do at their institutions. Several attributes can make an interactive a better experience for visitors including feedback, authenticity, touch, and being intuitive. A variety of experiences is the best way to program for the range of visitor interests and abilities, but a lack of standard terminology prevents developers from being able to easily discuss and compare what each other is doing.
Recommendations

The following recommendations are for exhibit developers, designers and others involved in the process of creating interactives at aquariums. These suggestions are derived from speaking with the professionals who create them, observations of interactives at aquariums and information and observations about what is currently being offered at many aquariums.

1. **Common terminology needs to be agreed upon so people creating aquarium exhibits can better communicate to each other. Interactives need to be described by their objective and the users’ actions, not their physical mechanism or properties.**

   During the research for this paper, I found one of the most difficult issues was trying to communicate with exhibit professionals about interactives. Some said the word was too vague and that looking at the fish could be construed as interactive. Others mentioned tide pools and docent talks as interactive experiences. While technically true, these were not the experiences I was interested in examining for this project.

   When Marianna Adams et al. worked to compile all we know about interactives in their article *Interactivity, Moving Beyond Terminology*, they did not want the discussion of what constitutes an
interactive to muffle the discussion about what is working. However, the experiences offered by interactives are so broad, how can they be lumped together if we are trying to examine their utility and design in a particular context or setting? The objectives are so varied, that while an interactive that asks a visitor to touch seems less interactive than one that explores a phenomenon and encourages experimentation, it may be the best experience for an exhibitor designers goal.

By terming interactives by their objective rather than their mechanism, the best mechanism for the intended objective can be used. Instead of trying to determine if computer interactives are more or less useful than mechanical ones, developers can talk about what they want to convey and find the best language for doing so.

2. Evaluate aquarium interactives separately from the whole exhibition.

Prototyping is often performed on interactives to test their durability and interface during the design phase. Once they are set out on the exhibit floor, however, interactives become part of a larger whole-- the exhibition. As Jenny-Sayre Ramberg noted, goals need to be set for each interactive and so it is intuitive that they could be individually evaluated once the exhibition is up, to ascertain if they are reaching those goals. The
multitude of interactives may preclude every one from being rigorously evaluated, but certainly more than timing and tracking studies, which only look at the amount and length of use, are needed. As Jessica Strick showed at the Exploratorium, more time at an exhibition component is not a direct correlate of more learning.\textsuperscript{97}

I am not advocating for the context of the exhibition to be taken away from the interactive when it is evaluated. Indeed, the interactive’s environment is important since prototyping, the main tool for seeking visitor input to interactive design, is often performed before the exhibition is installed, therefore lacking the full context. Rather, the goals of the interactive need to be examined separately from the goals of the exhibition to determine if that particular component is earning its space on the floor.

3. Determine the intended audience for the interactive.

It is difficult to design an interactive that will be engaging for everyone; adults interested in marine life have, for example, different cognitive and mechanical abilities than preschoolers. This audience may only be part of the exhibition’s audience, since every component does not need to reach every visitor. Deciding what the intended audience for an interactive is and researching the needs and characteristics of this audience allows front end evaluation to be more precise. Knowledge about a
specific group’s interests and abilities allows the institution to provide a more rewarding experience for that audience.

4. Children’s museums and science centers have been creating and evaluating interactive exhibits for decades. Their experiences should be used as models.

There is no need for aquariums to start from scratch when developing interactives. Models of what is working can be found at children’s museums and science centers, and these institutions should be examined to see what works and what does not with respect to interactive experiences. Both of these institutions’ audiences overlap with those at aquariums, so the knowledge about the way visitors engage with interactives can help inform aquariums where to begin. Modifying what has worked in science centers and children’s museums, and merging this with the mission of engaging people with the animals is a better route to take to create successful interactives than starting from scratch.

5. When possible, make the actions required of the user of an interactive as authentic to the subject matter as possible.

The most rewarding interactives allow the user to faithfully replicate the actions of the subject. There are many tools and processes to achieve this, although it is not always the easiest way to design an
interactive experience. However, the experience is more likely to be a memorable one and the ideas presented in the interactive more likely to make sense if the actions taken correlate faithfully with the subject matter.

6. Experiment with different layouts that encourage more open-ended learning.

A linear exhibition plan can work well in some instances, but if an exhibition has several interactives, I believe that a linear approach can inhibit people’s use of interactives. Virtually all the aquarium exhibitions I visited were linear, and it can work. However, visiting Monterey’s Near Shore wing elucidated the many positives of non-linear, interactive, exhibitions. Here, visitors could choose the experiences they wanted in the order they desired and an interactive that was busy could be re-visited without backtracking against other visitors. Also, the exhibition felt more inviting to experimentation because of its open plan-- visitors could see activity across the floor and may have been less self conscious about using interactives when other people were not cued up behind them filing through. An open floor plan is just one alternative, the point is just to experiment with what will work most effectively with the audience and the content for a particular exhibition’s goals.
7. Use interactives to engage visitors with the less charismatic animals.

Since interactives can be used to encourage visitors to observe longer and stimulate conversation, they could be used to help visitors engage with the animals they might otherwise ignore. Many of these animals do not have attributes that draw people in immediately, whether the animal moves slowly or rarely, or is not aesthetically pleasing or interesting. An interactive can be an opportunity to slow people down so they will see the movement or inform them of some interesting attribute that makes the animal more interesting.

Aquariums can use their own staff to help find ways to pique visitor interest in less charismatic animals. The husbandry staff who work with the animals often know what makes the animals they work with every day interesting, even if it is not readily apparent to the novice. For example, the elusive octopus at Monterey was something staff enjoyed touching, and barnacles are much more interesting when they are feeding. The octopus model and barnacle feeder interactive are discussed in the Findings section.

I became interested in exhibition development as an aquarist at the New England Aquarium. Seeing the animals every day, for much longer periods than the visitors, I learned many qualities about them that made
me most interested in some of the animals paid less attention to by
visitors. These animals are no less important ecologically than the colorful
or playful ones, so the visitor must still somehow be engaged to teach the
full story. Using interactives can help achieve this by acting as a mediator.
Contrasting with their role in science centers where interactives often help
demonstrate a phenomenon that cannot be viewed as an object,
interactives at an aquarium can help visitors “see” the remarkable qualities
that a quick glance of an animal does not offer. By allowing people to
experience the animal beyond kinetic works of art, aquariums can better
serve their visitors and the aquatic environment they work to protect.
Endnotes

7 Ibid.: 37.
8 Ibid.: 39.
16 Ibid.
17 Hein describes four types of learning which are created when two continuum, Learning Theories and Theories of Knowledge are juxtaposed. In both the Discovery and Constructivism the learner constructs the knowledge. What distinguishes them is whether the knowledge comes from the outside or within the learner. The source of knowledge separates the other two learning theories, Didactic, Expository and Stimulus-
Response from each other but is distinguished from Discovery or Constructivism in that both require incremental learning. For more detail see pps. 16-36 of Hein’s *Learning in the Museum*.


19 Ibid.: 23.


21 Ibid.

22 Ansbacher, "On Making Exhibitions Engaging and Interesting."


26 Oppenheimer, "Rationale for a Science Center," n.p.


28 Ibid.: 156.

29 Ibid.: 159-160.

30 Ibid.: 160.


32 Jessica Strick, “Paying Attention to Distraction : Science Museum Environments and Visitor Attention” (John F. Kennedy University, 2003), 77.


34 Allen broke down conversations into different categories to assess which were indeed learning oriented and about that exhibit- conversation related to other exhibits and navigating the museums were excluded.


37 John Stevenson, "The Long Term Impact of Interactive Exhibits," 
38 Sue Allen, "Designs for Learning: Studying Science Museum Exhibits 
39 Sue Allen and Josh Gutwill, "Designing with Multiple Interactives: Five 
41 Elsa Feher, "Learning Science with Interactive Exhibits," *Curator* 36, 
42 Ibid.
43 Allen and Gutwill, "Designing with Multiple Interactives: Five 
Common Pitfalls," 201-208.
47 Ibid.
48 Beverly Serrell, "Survey of Visitor Attitude and Awareness at an 
49 Beverly Serrell, "Looking at Visitors at Zoos and Aquariums," *Museum 
50 Ibid.: 40.
51 Leslie Adelman, John H. Falk, and Sylvia James, "National Aquarium 
in Baltimore's Impact on Visitors' Conservation Knowledge, Attitudes and 
52 John H. Falk and Leslie M. Adelman, "Investigating the Impact of Prior 
Knowledge and Interest on Aquarium Visitor Learning," *Journal of 
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Naturalistic Study of Visitors to a Public Aquarium” (University of 
55 Ibid., 83.
57 Tom Krakauer, Robert L. Russell, and Robert M. West, "Interactive 
58 Kodi R. Jefferies and James H. Wandersee, "Visitor Understanding of 
Interactive Exhibits: A Study of Family Groups in a Public Aquarium," in
Annual Meeting of the National Association for Research in Science Teaching (St. Louis, MO: 1996), 7.

59 Ibid., 8.

60 Ibid.


62 Ibid., 268-269

63 Falk and Dierking, Learning from Museums: Visitor Experiences and the Making of Meaning, 279.

64 Goldowsky, 284.


66 Ibid.


69 Ibid.

70 Nancy Goodman, Exhibit Developer, John G. Shedd Aquarium, interview by author, Chicago, IL, April 3rd, 2006.

71 Linda Wilson, interview by author.


73 Ibid.

74 Ava Ferguson, Senior Exhibit Developer/Writer, Monterey Bay Aquarium, telephone interview by author, March 28th, 2006.

75 Jenny-Sayre Ramberg, interview by author.

76 This was a term I first heard utilized by Michael W. Burnes, Exhibition Design Director of the Field Museum in Chicago.

77 Unpublished evaluation.

78 Ava Ferguson and Jenny-Sayre Ramberg, interviews by author.

79 Ava Ferguson, interview by author.

80 Ibid.

81 Ibid.

82 Jenny-Sayre Ramberg, interview by author.

83 Ava Ferguson, interview by author.

84 Ava Ferguson and Jenny-Sayre Ramberg, interviews by author.

85 Ava Ferguson, interview by author.
86 Ibid.
87 Ava Ferguson and Jenny-Sayre Ramberg, interviews by author.
88 Steven Yalowitz, Ph.D., Audience Research Specialist, Monterey Bay Aquarium, interview by author, Monterey, CA, March 22\textsuperscript{nd}, 2006.
89 Alexander Goldowsky, Ed.D., Director of Exhibits & Programs, EcoTarium, interview by author, Worcester, MA, April 26\textsuperscript{th}, 2006.
90 Beth Redmond-Jones, Director of Exhibits, Aquarium of the Pacific, telephone interview by author, April 11\textsuperscript{th}, 2006.
91 William S. Spitzer, Ph.D., Vice President for Programs and Exhibits, New England Aquarium, telephone interview by author, April 18\textsuperscript{th}, 2006.
92 Ibid.
93 Eugene Dillenburg, Exhibit Developer, Science Museum of Minnesota, email interview with author, April 16\textsuperscript{th}, 2006.
94 Ava Ferguson, interview by author.
95 Hein, "The Constructivist Museum."
97 Strick, 77.
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Russell, Robert L.


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Appendix A: Interviewees

Eugene Dillenburg
Exhibit Developer
Science Museum of Minnesota
120 W Kellogg Boulevard
St. Paul, MN 55102
e-mail interview, April 16th, 2006

Ava Ferguson
Senior Exhibit Developer/Writer
Monterey Bay Aquarium
886 Cannery Row
Monterey, CA 93940
Phone Interview, March 28th, 2006

John Fraser
Director of Interpretive Programs
Chair of the Living Institutions Metrics Project
Exhibition and Graphic Arts Department
Wildlife Conservation Society
2300 Southern Blvd.
Bronx, NY 10460
e-mail interview, April 22nd, 2006

Alexander Goldowsky, Ed.D.
Director of Exhibits & Programs
EcoTarium
222 Harrington Way
Worcester, MA 01604
In-Person Interview, Worcester MA, April 26th, 2006

Nancy Goodman
Exhibit Developer
John G. Shedd Aquarium
1200 S. Lake Shore Drive
Chicago, IL 60605
In-Person Interview, Chicago, IL, April 3rd, 2006
Beth Redmond-Jones  
Director of Exhibits  
Aquarium of the Pacific  
100 Aquarium Way  
Long Beach, CA 90802  
Phone Interview, April 11th, 2006

Jenny-Sayre Ramberg  
Senior Exhibit Developer/Writer  
Monterey Bay Aquarium  
886 Cannery Row  
Monterey, CA 93940  
In-Person Interview, March 22nd, 2006

Raul Silva  
Audio/Visual  
John G. Shedd Aquarium  
1200 S. Lake Shore Drive  
Chicago, IL 60605  
In-Person Interview, Chicago, IL, April 3rd, 2006

William S. Spitzer, Ph.D.  
Vice President for Programs and Exhibits  
New England Aquarium  
Central Wharf, Boston, MA 02110  
Phone interview, April 18th, 2006

Dana Thorpe  
Director of Exhibits  
John G. Shedd Aquarium  
1200 S. Lake Shore Drive  
Chicago, IL 60605  
In-Person Interview, Chicago, IL, April 3rd, 2006

Linda Wilson  
Director, Audience Research and Evaluation  
John G. Shedd Aquarium  
1200 S. Lake Shore Drive  
Chicago, IL 60605  
In-Person Interview, Chicago, IL, April 3rd, 2006
Appendix B: Interview Questions

Interview Questions

1. What tools/references do you utilize when developing interactives (books, articles websites?)

2. What drives the inclusion of interactives for an exhibit—when are they included, at what phase?

3. What drives the types of interactives (are some better for specific messages or is it a matter of offering multiple experiences for people to choose)?

4. How do you evaluate interactives?

5. Do you try to incorporate constructivist theory in developing interactives?

6. How effective are computer interactives?

7. Do you run into concerns about interactives distracting from the animals when trying to incorporate them in an exhibition?
Appendix C: Survey

Interactives Survey Questions:

For the purposes of this survey, an interactive is defined as a mechanical exhibit component where the visitor’s engagement with the component enhances their understanding of the concept. Please feel free to include additional pages if you wish to expand your answers.

1. Which of the following best describes your institution?
   - Science Center
   - Zoo
   - Aquarium
   - Natural History Museum
   - Private Firm
   - Other _________________

2. Does your institution use interactives on the exhibit floor?
   - Yes
   - No (If no, why not? - and please continue to question 6)

3. How many interactives does your institution have on the exhibit floor?
   - 0-5
   - 6-10
   - 11-15
   - 16-20
   - 21+

4. What types of interactives do you have? (Please check all that apply)
   - Mechanical interactives w/ no direct animal interaction
   - Interactive where the visitor is interacting with an animal directly
     (i.e. Changing currents in a tank, moving a light for the animal to follow)
   - Other____________________________

5. Why did you decide to use interactives?
   Please check all that apply and circle the most important.
   - Draw in families
   - Increase interest in a particular exhibit/tank/animal
   - Increase time spent at an exhibit
   - Help illustrate difficult concept
   - Help an unexciting concept get noticed
   - Other
   Please explain____________________________________________________________

6. Who designs and develops your interactives?
   - In-House
   - Private Firms(s)
   If outside firms, please list:_______________________________________________

7. What would you like to know about developing interactives?
   (PLEASE TURN OVER)
8. Please list 2 aquarium/zoo interactives that you felt were good at engaging the public *(Either at your museum or another institution)*

1. __________________________________________________________

2. __________________________________________________________

9. What do you feel is particularly noteworthy about these two interactives?

___________________________________________________________

___________________________________________________________

___________________________________________________________

10. If the interactives were at your institution, was evaluation used to determine their effectiveness?

Interactive 1  □ Yes   □ No

Interactive 2  □ Yes   □ No

Name:
Title:
Institution:
Address:

Email:

*or please attach business card*

Thank you very much.

Would you like to see a copy of the results of this survey and project?  
□ Yes   □ No

Comments:

___________________________________________________________

___________________________________________________________

___________________________________________________________

Please return by **March 13th** in the enclosed SASE to:
Sean Hooley 1931 San Pablo Ave Unit 102, Berkeley, CA 94702
Appendix D: Shedd Aquarium Interactives

D.1 Touch Screen ID

Visitors selected from the fish on the screen or scrolled over to find more to select. Once they selected, basic fish information is given. More in-depth information is possible, and with the magnifier option the user can drag over an area of the fish and zoom in.
D.2 Electric Eel

Electric eel interactive allowed visitors to measure the amount of electricity they produced and compare it to that of the eel.

D.3 Otter fur

Fur
Small piece of fur from a sea otter that visitors could touch.
D.4 Air vs. Water

Air vs. Water
The visitor twisted the rod to discover that air is thinner than water (pictured) and the difference between a streamlined and a square piece of wood in water (not pictured, but similar design).

D.5 “Wild Reef” Rockwork

Touchable coral and rockwork surrounded visitors to the “Wild Reef.”
D.6 Anemone Model

D.7 Create a Reserve

Visitors spin the dial to create more reserve areas on the island, with increasing reserve being represented by more white LED’s.
Appendix E: Monterey Bay Aquarium Interactives

E.1 Playground

Photo Op
Kids can put face in to get picture taken

Play Area
Fun for kids, themed with animals although no direct messages are being given
E.2 Penguin Talk

Visitors can activate penguins to ‘say’ different things with their body language.
E.3 Tide pool Olympics

Main Screen

Individual user screen
Kids “walk” through a tide pool area and have different choices about the animals/objects they encounter – pickup, touch, photo, look, and get points depending on their decision.
E.4 Barnacle Feeder and Changing Currents

**Plankton Feeder**
Spinning releases plankton that cause barnacles to open and feed.

**Changing Currents**
Spinning the knob changes the current which makes animals react.
E.5 Viewing Aides

TANK CAMS
Tank cam allows visitors to control viewing. Small screen allows them to view, while larger one allows others to see what they are doing.
E.6 High Tide Feast

Pulling the lever up makes an animation of the tide rising begin.
E.7 Active Graphics

A/V
When the visitor touches the models, it lights up and cues up a short video on that animal.
Active Graphic
Pulling up allows visitor to see the answer.

Active Graphic
Graphic is within fabricated habitat.
E.8 Piling

Piling w/ animal models
Models light up on piling when the visitor pushes the button of the corresponding animal- like a 3-D guidebook
E.9 Flatfish and Tubeworm interactives

**Flatfish interactive**
The visitor pushes down the joystick and makes the fish hide in the sand. Visitor needs to move the joystick back and forth a bit to get the animal under the sand, just as you see flatfish do.

**Tubeworm Interactive**
Pulling the lever makes the tubeworm extrude.
E.10 Wild Reef Interactives

Make A Rubbing
Gives kids a theme related (sharks) activity they are familiar with-making rubbings.

Mask try-on
Gives visitors, especially kids, an activity they enjoy outside of museum (wearing a mask) that is related to the theme-the culture of the people who live near these sharks, and incorporate them into their culture.
### E.11 Magnifiers

<table>
<thead>
<tr>
<th>Magnifier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floating Tide pool Magnifier</strong></td>
<td>Simple, inexpensive, allows for lots of exploration, discovery.</td>
</tr>
<tr>
<td><strong>Tank Magnifier</strong></td>
<td>Gets people to be more active in their looking, similar to spotting scopes, no labels needed, simple, complements the animals.</td>
</tr>
</tbody>
</table>
Appendix F: Survey Question 5

*Question 5*

Why did you decide to use interactives?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Aquariums (n=13)</th>
<th>All Surveys (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw in families</td>
<td>62% (8)</td>
<td>51% (20)</td>
</tr>
<tr>
<td>Increase interest in an exhibit</td>
<td>77% (10)</td>
<td>56% (22)</td>
</tr>
<tr>
<td>Increase Time</td>
<td>62% (8)</td>
<td>51% (20)</td>
</tr>
<tr>
<td>Help illustrate a difficult subject</td>
<td>69% (9)</td>
<td>67% (26)</td>
</tr>
<tr>
<td>Help unexciting concept get noticed</td>
<td>15% (2)</td>
<td>31% (12)</td>
</tr>
<tr>
<td>Help with different learning styles</td>
<td>31% (4)</td>
<td>26% (10)</td>
</tr>
</tbody>
</table>
Appendix G: Survey Question 9

Question 9

What do you feel is particularly noteworthy about these two interactives?

<table>
<thead>
<tr>
<th>Answer</th>
<th>n=39</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>10</td>
<td>26%</td>
</tr>
<tr>
<td>Fun/Easy</td>
<td>6</td>
<td>15%</td>
</tr>
<tr>
<td>Do or see something differently/New perspective</td>
<td>5</td>
<td>13%</td>
</tr>
<tr>
<td>Senses</td>
<td>5</td>
<td>13%</td>
</tr>
<tr>
<td>Encourage Social/Family Interaction</td>
<td>4</td>
<td>10%</td>
</tr>
<tr>
<td>Exploration/Discovery</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>Inspire</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>Aesthetic</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Little Reading</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Open ended</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Universal</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Many levels/depth</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Authentic</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Feedback</td>
<td>1</td>
<td>3%</td>
</tr>
</tbody>
</table>
Product: Article Submission to *The Exhibitionist*
Aquarium Interactives that Engage and Inspire: Beyond *Finding Nemo*

“There's a fine line between fishing and just standing on the shore like an idiot.”

-Stephen Wright, comedian

Frank Oppenheimer, founder of San Francisco’s Exploratorium, noted that fish in an aquarium are always moving, and therefore always interesting. He felt this movement helped inform his ideas for the Exploratorium’s interactives or “props.”¹ While true, Oppenheimer inadvertently introduces the problem aquariums face: they already have an “attraction” to hook visitors and do not want competition for visitors’ attention. Yet public aquariums have undergone significant changes since Oppenheimer’s observation in the middle of the last century. Initially commercial entertainment ventures and later small menageries, they have diversified to focus more on conservation and education, conducting scientific research and running propagation programs.² From immersive exhibition areas to the mechanical interactive elements that have allowed for discovery learning in science center exhibitions for decades, aquariums are increasingly interested in presenting interactive experiences to their visitors. While the animals are still the main attraction at aquariums, institutions see interactives as ways to further engage visitors with these animals and the aquarium’s conservation mission.
In researching my Master’s Project during 2005 and 2006, I sought to evaluate the various types of aquarium interactives in the United States that related directly to tanks on the exhibition floor and analyze which ones are considered successful by museum professionals at meeting the developers’ goals. I examined the literature, conducted a survey on exhibit professionals’ views on aquarium interactives, spoke with twelve professionals involved in aquarium exhibition development, and visited several aquariums. In doing this, I discovered that there is no efficient way for developers to discuss the experiences they create for aquarium visitors. Therefore, in this article I seek to begin to create and define a glossary of terms relevant to the development of interactive aquarium exhibitions. This glossary, which is summarized in Table 1, helps to explain some of the key findings of my research.

One of the premises of museum interactives is to allow the visitor to actively engage with the exhibit and for the exhibit to engage with the visitor. Interactives, by definition, are a two-way street, unlike a text panel. This aspect of defining interactives becomes, like all definitions, increasingly complicated as there are a multiplicity of relationships that a visitor and an exhibit can have. Professionals and scholars seem to agree that providing a variety of experiences is the best way to engage the widest range of visitor interests and abilities. However, the multiplicity of
definitions for the various terms they use to discuss such interactives prevents a constructive dialogue.

To create interactives, I believe it is necessary to be able to more critically discuss them. “Creating from the gut” may work for very gifted developers, but the rest of us must be able to speak precisely about what we want the visitor to experience in order to best engage the visitor. Thus, I propose using a more standardized set of terms to describe the various types of interactives we can create and group them not by their physical properties but by their intended goal(s). I see three main functions of interactives: information, demonstration, and exploration.

**Information:** Information-oriented interactives’ primary purpose in an aquarium is to deliver didactic information. From basic facts such as species, diet, and habitat to more complex information such as ecological threats, facts are conveyed to the visitor only after they actively and physically engage the content. Informational interactives, such as computer ID kiosks, are useful at reducing visual clutter when a large amount of information is available to the visitor from which to choose. This is especially important in an immersive and aesthetic environment like an aquarium, as opposed to the more chaotic environment of a science center or children’s museum. Information interactives such as flip
panels can also add a kinesthetic element to the experience of watching a video or reading a text panel. However, few of these are interactive in the true sense of the word. The method of engagement can take many forms such as pushing buttons, pulling levers, or flipping panels, but the main idea is that the visitor is doing more than passively reading to garner knowledge. However, this kinesthetic component (pushing the button) only initializes access to the information; the experience then regresses and is limited to the more passive activities of reading, listening or watching.

**Demonstration**: In a demonstration-oriented interactive, the visitors’ actions are determined by the exhibit developer or designer, which educational theorist George Hein described as “discovery learning.” Demonstration interactives are useful for helping visitors understand concepts that may be too complex for text panels, yet are important for the visitor to comprehend. Predetermined concepts are related to the visitor through their actions. Whether the experience is intuitive or there are instructions, the visitor completes a set of actions to reveal a concept or idea. While the visitors construct the experience, they do not construct the end result-- they have been led to this end result whether it be fact, phenomenon, or principle.
**Exploration:** In exploratory interactives, the developer or designer works to help the visitor explore a certain idea, theme or topic, but does not direct them toward a certain set of facts. While the outcome is defined by the visitor (as opposed to the exhibit developer), the experience is mediated by the tools the exhibit developer sets up for the visitor. Building on the constructivist theory of learning described by Hein, the developer’s goal is to create an experience for the visitor and have them explore a concept rather than demonstrate a particular theory or fact.

(see Table 1 for examples)

These categories are informed by the work of four key theorists: George Hein, Lev Vygotsky, John Dewey and Miháli Csikszentmihalyi. Important to these learning theorists is the idea of the experience being a goal in itself, as opposed to the outcome of a specific knowledge acquisition. Interactives, by their very nature of offering a kinesthetic experience, can provide the experience-based learning that Dewey felt was so vital to learning, where the learner is at the center of the experience\(^3\). They have the potential to offer open-ended exploration and allow visitors to construct their own meaning in the way that Hein calls for in *The Constructivist Museum*.\(^4\) A social experience that may not otherwise occur can be facilitated with an interactive, encouraging conversation and learning experiences through what Vygotsky calls the “zone of proximal
development,” in which the social group enables more extensive learning than an isolated individual could accomplish alone.\textsuperscript{5} Finally, interactives can allow a visitor to become intrinsically motivated to learn through what Csikszentmihalyi termed a “flow experience.” In flow, the learner becomes lost in the moment. In these moments, a level of intense interest and attention can be attained.\textsuperscript{6} All of the above theories support the idea of the experience being the primary educational outcome, not specific facts.

These theories were clearly incorporated in some of the interactives I studied, but in a wide variety of ways. Theoretically, it is clear that an institution that offers varied experiences acknowledges that their visitors come with a range of interests and abilities. However, professionals’ wide-ranging answers to my survey questions reveal that much of the variety of approaches to creating interactives in aquariums is between, rather than within, institutions. That is to say, I saw diverse approaches to creating interactives in the field, but did not see these diverse methods translated to offering multiple experiences to visitors at individual aquariums.

In addition to these theories, I believe that authentic experiences are key to interactives. An interactive lacking authenticity simply makes the visitor needlessly work for information or, worse, misinforms the visitor. Pushing a button to illuminate the answer to a question is rarely the
way a person would find the answer to that question in real life. However, the *Air versus Water* interactives at the Shedd Aquarium in Chicago, Illinois gave visitors a real experience, spinning an object in real air and real water, to feel the difference in densities. Here, visitors spun different shaped wood blocks on a dowel in water to see the benefits of the streamlined body type of a dolphin. The disconnect between the visitor’s actions and the content in a simple push button interactive gives the experience less impact and even potentially misinforms the user.

An authentic experience can often be the best way to achieve another important design factor for interactives, feedback. This again is where push buttons fall short; with a button there is one action that the visitor can make and one outcome that will result. However, an experience where visitors make choices which result in variable, continual feedback can keep them more deeply engaged for a longer period of time. An interactive at the Monterey Aquarium in Monterey, California (MBAq) involves pulling a lever to initiate a small animation on some animal’s response to the tide’s movement (mussels closing up when they are exposed to air during low tide). Moving the lever again at the *High Tide* interactive once the video began did nothing, which left people frustrated and disengaged from the activity. Allowing the visitor to keep receiving variable feedback based on their actions would keep the visitor engaged.
and interested. Using a spin browser to control the animation, like the one on a nearby tidal video, would give visitors more feedback by allowing them to stop, slow or reverse the footage.

Variable amounts and types of feedback are critical to achieving open-ended experiences. Open-ended experiences are difficult to create in an environment that seeks to evaluate what content has been absorbed by the visitor, but their value is high and therefore they are a worthy goal. A few magnifying glasses floating in a tide pool tank at MBaq serve as a good example of this open-ended experience with ample opportunity for feedback. The Shale Reef magnifier gave no instructions on what to look for; visitors looked, explored and decided what they wanted to know or see. Here, the visitor determined how long they wanted to engage with the interactive based on their interest, rather than completing a set of prescribed tasks since they were exploring rather than seeking a specific answer.

As designers have known for years, touch is another attribute that can make an interactive more appealing. This can be as simple as the touchable otter fur at Shedd. Similarly, a model octopus at MBaq was interactive only in that it could be touched; yet both of these exhibits offered an engaging experience that was unique and authentic (the model was not real but the touching sensation was). While not as deep as some
experiences, touching can eloquently achieve its goal - to better engage the visitor with the animals-- by helping to inform the visitor about an aspect of the animal they may otherwise not think about or experience.

The best interactives I studied for my project were straightforward and simple. This does not mean that they were limited to simplistic topics or that they were easy to develop. Rather, a visitor could approach them intuitively. For example, the electric eel interactive at the Shedd is a very simple and straightforward experience. The electric charge of the visitor and eel are easily, and authentically, represented by LED’s, so I believe most were able to get the message that the eel has a higher electric charge without much reading.

Important for all interactives is moving beyond the theory and seeing how they are actually used by a variety of visitors. Evaluation in many forms is taken to improve the efficacy of interactives, as the expense of creating interactives warrants such investment. Thus the professionals who participated in my project all strongly support the process of evaluation. Front-end evaluation lets developers find out what the intended audience know about a subject so a comfortable entry point can be made at the interactive. Prototyping is used widely to help developers see how people will use an interactive as well as design flaws that make it prone to
Breaking. Summative evaluation is almost universally performed exhibit-wide but not on each interactive.

Authenticity, feedback, touch, simplicity of approach as well as evaluation and prototyping are critical for creating successful interactives. Even more important are the goals of an interactive. Information, demonstration and/or exploration need to be clearly defined and discussed by an exhibit team so the appropriate type of experience can be selected. Goal-oriented design of interactives will help developers argue for the inclusion of these expensive and labor intensive exhibition components, for they have wide ranging benefits. Without a glossary of terms, however, it is difficult to disseminate what research has been conducted on the wide range of experiences interactives offer. They just need a reason-- and an identity-- to make their case. Aquariums have a vital mission to educate the public on the importance of protecting the aquatic world and inspire them to act. To do so they must engage visitors with their living collections and I do not believe that text panels alone can do so. This is especially true with the less colorful or fear inducing animals in the collection whom are often overlooked in the visitors’ search for a shark or the star of a recent animated movie. Even then, is the visitor just passively looking to find the charismatic animal and move on to the next one?

Interactives, when designed correctly, can make the aquarium visit more
meaningful by allowing visitors to do more than look at the animals-- they experience the animals.

Endnotes

1 Frank Oppenheimer, "Exploration and Discovery," in Acceptance Speech for the AAM Distinguished Service Award (San Francisco: 1982), n.p.
<table>
<thead>
<tr>
<th>Type</th>
<th>Exhibit</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Graphic</td>
<td>Flip panel</td>
<td>Text, video or audio is conveyed to the visitor at their instigation (pushing a button, pulling a lever, etc.)</td>
<td></td>
</tr>
<tr>
<td>Viewing Aid</td>
<td>Floating magnifying glass in tide pool tank</td>
<td>Tool which allows the visitor to better see something</td>
<td></td>
</tr>
<tr>
<td>Tactile</td>
<td>Otter Fur</td>
<td>Experiences such as animal/plant models or rockwork that can be touched</td>
<td></td>
</tr>
<tr>
<td>Phenomenon</td>
<td>Hydrodynamics</td>
<td>Usually mechanical, these interactives use the visitors’ actions to help them understand the concept</td>
<td></td>
</tr>
<tr>
<td>Animal interaction</td>
<td>Barnacle feeder</td>
<td>Device or gadget that facilitates an interaction between the visitor and an animal</td>
<td></td>
</tr>
<tr>
<td>Game</td>
<td>Tide Pool Olympics</td>
<td>Competition, either between visitors or the visitor against the interactive, where the visitor makes decisions which have variable consequences to their successful completion of the experience</td>
<td></td>
</tr>
</tbody>
</table>