ABSTRACT

Museum Methods:
Creating a Useable Database for the Experiential Education Objects of the CASPER Physics Circus

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The CASPER Physics Circus at Baylor University seeks to improve the local school system by presenting the science of physics in an understanding and engaging way, often through the use of objects which demonstrate scientific principles. In the past, those objects have been put away into storage after the Physics Circus is completed for the year often with no record of their condition or use. This project outlines the creation of a collections database of objects for the experiential education program of the Physics Circus. The database was developed using FileMaker Pro software. This allows for cross-platform use for individuals who will use and maintain the database in the future. This project also outlines important steps taken in its development which may be looked to for similar projects that could be designed by other organizations or groups.

Museum Methods:

Creating a Useable Database for the Experiential Education Objects of the CASPER Physics Circus

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With love, a special thanks to Crystal Smedley, my muse, who serves continuously as a model of dedication in the face of adversity. As well to my parents Marylou and Tony Patterson who have never doubted my ability to accomplish any of the goals that I have set.

CHAPTER ONE

Introduction

Science education in school systems in the United States is falling further behind our global rivals, as is shown by various international reports comparing standardized scores on science literacy exams.[1] Yet there are many programs, collaborations, and efforts that seek to improve this situation. Many outstanding efforts have been developed through museums of science, children's museums, and technology centers. At Baylor University, in Waco, Texas, the CASPER Physics Circus seeks to enhance the local science education by presenting the science of Physics in an understandable and engaging way. By using objects which can demonstrate scientific principles, the Physics Circus works to create educational experiences which can help students better understand higher science concepts.[2]

My work with the Physics Circus began when I worked as a graduate assistant. In this role I participated in the 2009 exhibit where I was able to make observations, which ultimately inspired this project. The objects used in the exhibits draw on scientific principles but are simple enough to be self-operated, with the aim of being evident showcases of science in today's world. During the development of the 2010 Circus performance, it became evident that the objects which were used in past years had not been discarded, but nevertheless had been forgotten for months. Few individuals knew the location of all the objects, and if someone needed access they often would have to find an individual who knew where it was. Once an object was located its condition was

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[1] National Science Foundation. Science and Engineering Indicators: 2010. Table 1-7 http://www.nsf.gov/statistics/seind10/start.htm (accessed February 1, 2010).
[2] CASPER Physics Circus. http://www.baylor.edu/physicscircus (accessed September 7, 2010).

still unclear. Sometimes an electronic device had to be fully reassembled to see whether it would work properly. The standards, or best practices, in place for museums with regards to the upkeep and information management on the collections seemed to offer benefit in this environment.

Thus, this project builds upon the CASPER Physics Circus program by establishing a database in which to catalogue the items and objects within their collection. The process of creating the database began with an evaluation of the needs of the Circus. The faculty and staff who work with the program discussed various storage or maintenance issues which were important for overall accountability for the objects. In some instances few individuals were aware of where an object was or even the condition at any given time. A database would allow easy access to the information one might need. This project will explore the ways in which this database can be used in future functioning of the Physics Circus objects.

The objects selected for this database are from the 2010 performance of the Physics Circus. An objects-centered database also has the capacity to list all of the teachers within the local schools that form the target cohort, as well information regarding each school. The information that is included for the schools is accessible either from the school district website or from the annual state reports found on the Texas Education Agency website.[3]

Using FileMaker Pro, the database was constructed without using a template. However, current museum standards and museum databases already in use were looked to as examples. The choice of using FileMaker rather than other programs such as

[3] Waco Independent School District
http://www.wacoisd.org/publications/state_accountability/DistrictPerf.pdf
Texas Education Agency http://www.tea.state.tx.us/

PastPerfect, a leading museum collections management system, or some other system, was determined through a needs assessment. The issue of who would be using the system and how it could be used in the future led to the choice of a flexible multi-platform program that would allow modifications over time to continue addressing new concerns as they might arise. The database will be able to run on either Mac Operating System X or Windows, the platforms that the staff and users most often utilize.

The Physics Circus, and the database in support of the Circus, is part and parcel of a series of developments in pedagogy at science centers and museums. Collections management is important for these institutions not only for organizational purposes but also to allow for an easier delivery of the information stored. This system will be a resource for the future planning of Physics Circus activities and for teacher lesson planning. In the end, it is the objects that separate museums from other organizations who work with education. If it were only stuff and not specific, unique, objects that made up the collection then it would be barely worth the effort to create a database. Since it is important, keeping accurate records for each object is a cornerstone of effective management.

The use of pedagogical methods developed by many of the great figures in the history of education and museums is important to frame the context of this project. Founders of educational pedagogy such as John Dewey, individuals like John Cotton Dana who sought to make libraries and museums relevant to the public, even forward thinker and teacher Frank Oppenheimer, the founder of the Exploratorium, all added something to the larger collective of programs and education that is now in use across the world. The idea that personal experience is directly tied into the learning process is not a new one. Each of the people listed above felt that experience is tied to directly into understanding a subject, as well that developing a passion for something early on could be a goal of museums.

"The kindling of curiosity by discovering the pleasure of understanding," was a way in which Frank Oppenheimer expressed to a PTA one of his goals in teaching science.[4] The passion, or retention of interest, is a goal that drives the educational goals of the Physics Circus effort. The aim is to influence youth or adults and inspire them to become lifelong learners. Often with subjects in the sciences abstract concepts are difficult for individuals to comprehend. When subjects are taught only with pictures and words, it is difficult relate ideas to what a person already understands. The use of objects in enabling educational experience allows the individual a better way for a positive overall experience.

The debate over how educational systems work to include improved object use has been a series of trial and error. Trends of public opinion often lead to changes in public education's standards every decade or so. The government-led No Child Left Behind Act, established by act of Congress in 2002, is under evaluation as a new president seeks to address concerns.[5] The system in its current state is often the butt of jokes or of horror stories, yet most Americans acknowledge that there should be something done in order to assure continued educational success of future generations.

The benefit of the database is more direct for the Physics Circus in the scope of this project, yet as a whole it encompasses an attainable collection system which could be devoted to continued enrichment of the Physics Circus programming. Once in use, the

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[4] Frank Oppenheimer, *Teaching and Learning.* The Exploratorium. http://www.exploratorium.edu/about/our_story/history/frank (accessed January 9, 2010).
[5] U.S. Department of Education. http://www2.ed.gov/nclb/landing.jhtml (accessed 18 May, 2010)

database would allow educators and individuals a chance to be part of the Physics Circus experience which that they might not have through the Physics Circus yearly show. The end potential of the database is expressed by the actual use, and part of this project will outline further ways in which the system can be used, continue in its development, and provide ultimately an extra educational service to the public at large.

CHAPTER TWO

Historical and Philosophical Background of Experiential Science Education

A necessary step before discussing this project in depth is to outline a historical perspective for the work done by the Physics Circus. Along with identifying important individuals and their lasting effects upon the study of museums, the importance of including objects in education will be analyzed. Since the database is being developed with an understanding of the philosophical intellectual legacy of museums it is important to address pedagogical theory while looking to some particular examples. This should help to illustrate the present conditions which gave inspiration for this project.

Philosophy of Knowledge

Philosophy broken down linguistically means love of wisdom, and in philosophical terms wisdom is being able to use knowledge in the best possible way. Education plays a key role in advancing knowledge in the lives of individuals and our communities. Where education takes place is as varied as the types of knowledge one can acquire. Museums are one such venue, and as institutions they serve the public as much more than storehouses of objects and information. There are many ideas that have influenced the development of education at large and specifically within museums.

The philosopher David Hume famously said, "All our knowledge falls within the bounds of possible experience."[6] Knowledge is in essence a purpose of education along with the ability to use it well, education being a training of minds in order that they gain

[6] Immanuel Kant, *Critique of Pure Reason, trans.* J. M. D. Meiklejohn. http://www2.hn.psu.edu/faculty/jmanis/kant/Critique-Pure-Reason6x9.pdf (accessed February 28, 2010)

more understanding of the world we live in. This notion is one that in many ways leads to some of the difficulties in modern education. What role does education play in the lives of the everyman? What common knowledge should all people be taught on their way into adulthood? Where are places that effectively seek providing quality education in unique, experiential ways?

Within museums the ability for the visitor to relate with what they see, whether it be art, history, or science is one of the prime motivators for visitation and support. The goal might be seen as a dissemination of knowledge into the public through objects, which can be experienced through the senses, and thus provides an ultimate goal of exposure to vast collections or unique places and history. A visitor may be a first time or repeat visitor. For a first time visitor the ideal situation would be to provide a quality experience that would encourage positive experience and a desire for more. Those individuals who are repeat visitors chose to return for a continuation of their previous experience, or are seeking a new one to build upon the former. The positive reaction of an individual in these situations is often in how they can relate to the objects, which are the focus of exhibits.

The perception of an object is established in the brain or consciousness of an individual attempting to process a thing in relation to all that the person knows and is. How does this relate to me emotionally, physically, spiritually? For many, this can be an important factor in their lives, as those who love museums in their adult life often are able to reference an experience from their childhood that created the special memory. The relationship which becomes established through the educational use of objects is enhanced with a greater freedom that can be applied through increased knowledge.

The possibility of experience mentioned by Hume is, in the case of this project, based on the relationship between an object and the user/viewer. For the Physics Circus, the individual in this is a student. In the field of museum studies we try and adjust our efforts to allow the greatest possible experience which can in turn cause the knowledge of a visitor to expand. Within this understanding the Physics Circus attempts to create a positive experience by using objects in educational situations with the goal of retention of interest in knowledge based in the sciences.

Pedagogical Development

Philosophical thought is often far reaching across time. Hume in many ways provided groundwork for thinkers who followed, as well the systems that came from those who led changes in the educational structure. One of these people was the American thinker John Dewey (1859-1952). Dewey's lifetime was fully set within the years of the Industrial Revolution and into the World Wars. Famous for being a founder of the Pragmatic movement, Dewey was also a proponent of education reform. He is considered by some to have "more than anyone else…helped make education central to a museum's mission."[7]

Dewey himself was well educated and had opportunities growing up that allowed him to reach the highest rank in academia. After graduating with a bachelor's degree Dewey spent three years working in a high school, teaching and trying to find ways to function within the status quo. Though he considered himself unsuited for the position of teacher in the standard sense, Dewey moved on to higher degrees, eventually earning a

[7] Marjorie Schwarzer. *Riches, Rivals, and Radicals*, (Washington D.C., American Association of Museums, 2006) 9

Ph.D. Throughout his own education, though, he sought to find ways that could better facilitate learning through the many educational systems established in America, even those outside of schools. The changes sought in the reform were aimed at addressing education within our cultural system in order to assure community for individuals.[8]

The system of education which Dewey came through and worked in is similar to our current system. Then and now, technological renaissances were revolutionizing the way in which people lived. Thus schools were to be places that taught a new generation how to live within the rapidly developing new age. The ideal would be that students are introduced to the developments in a way they could understand while also being exposed to the values and history of past generations.

Dewey strongly believed that for learning to occur, participation must happen by way of social consciousness, in order to establish a relation between one's personal life and something larger. The relationships which someone can form with another person, or an object, are based in how perception is established through the connection with a person's experience. The connections between individuals are often a bridge which allows a person to help others with a subject. Thus, in a classroom the social aspects should be similar to public life. An educational system would then allow for more interaction between individuals, with a focus upon relating what is taught and known with the world of the individual.[9]

As schools are seen as the location where a majority of the public finds common ground with one another, the thought follows that all things people are assumed to know

[8] John Dewey, *Democracy and Education* http://www.worldwideschool.org/library/books/socl/education/DemocracyandEducation/toc.html (accessed August 17, 2010)
[9] *Ibid.*

should be taught in schools. In essence, objects that make up the technology we all use and which influence the world's forward development, it is ideal for explaining vivid concepts that all people should know. In the modern era, science educators have developed machines specifically for demonstrating the properties of science, specifically physics. These objects are the embodiment of principles that lead to their creation in the first place. The further that technology has come, the more advanced the manipulation of these principles. Yet that does not change that there are often simple examples which are able to demonstrate the rules that govern everything.

Education systems must address a wide range of ages and capacities that can affect the overall potential for learning. Dewey knew that, "The child's own instincts and powers furnish the material and give the starting point for all education."[10] All children have a natural capacity to establish value and worth through their innate curiosity. The way a baby murmurs and coos in imitation of vocal interaction can be understood as the developing child learns the language of the world around them. So too does the grasp of understanding form in any other situation with which a child might gain experience. This trait continues, hopefully, for the rest of a person's life. The use of objects can help students who have never had an opportunity to learn in such a way or to form the right connections. This leads to an advantageous method allowing for relation through the educational experience. In part, this is a development that has influenced education within museums, as their contents are for the public good and are valuable tools in understanding life, past, present, and all possible futures.[11]

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[10] John Dewey. *My Pedagogic Creed*, http://dewey.pragmatism.org/creed.htm (accessed June 30, 2010)
[11] David Wiley. *The Instructional Use of Learning Objects.* http://www.reusability.org/read/ (accessed October 3, 2010)

Dewey idealized school as, "A place where certain information is to be given, where certain lessons are to be learned, or where certain habits are to be formed."[12] Yet the correct strategy to assure this is often at question. What we see in the failings of individual schools is shown through testing scores or graduation/drop-out rates are often the after-effect of teachers' influence upon the students or subjects. The ability to bring in outside help is of great benefit to augment these situations. Many times an alteration to the standard curriculum may be able to affect the retention or help students understand the relevance of more difficult subjects such as the sciences.

Even when a school is seen as a failing system there are often students, parents, and teachers who work to keep interest in subject areas going. Yet when schools only present information as a source of *future* usefulness, the retentive drive in individuals is lost. The common question asked by students, "Why do we need to know this?" is met mostly with the response, "You will use it someday when you are older and have a job." How can this system truly engage and encourage positive experiences in education when often subjects are not able to engage a majority of students? Their own understandings and value systems fail to comprehend why school is important. But all life is a building project. We seek to create a foundation for young people that they can be build upon later in life. Yet when all knowledge and learning is seen through a mirror of experiences and negative views of such experiences are the foundation, then only disinterest and bad understanding comes.

Dewey firmly believed that, "Science is of value because it gives the ability to interpret and control the experience already had."[13] One of the established benefits of the

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[12] Dewey. *My Pedagogic Creed*,
[13] *Ibid.*

understanding of science is the ability to process information at a much better rate and depth. Much of science is the understanding of that which is just beyond the scope of what might be perceived with the senses. For even when something can be viewed by the eye or heard by the ear, the understanding of how is usually unclear. Our ability to grapple with understanding can benefit from a background in learning and experiencing phenomena through which perception directly can lead to comprehension. The sciences seem abstract to many individuals because there is often not an effective way to explain or showcase examples that could relate to the population at large. By using objects to create new experiences which can influence the learning of science, students are able to ensure what Dewey felt science offered a better life.

Libraries and Museums Coming to the Public

Near the turn of the twentieth century, along with new thinking on education in the broad sense, there were movements within certain communities for increased public access to information. At the time, many individuals were highly unlikely to be exposed to collections of knowledge. John Cotton Dana and others developed a practice of public engagement that sought the accessibility of public services such as libraries and museums to the general public. Dana and the revolutionary changes which he instituted in many libraries are often looked at as preliminary steps to the standard practices of today.[14]

Though Dana's role as a motivator of change is primarily in the realm of libraries, the transition that he brought about affected more than just these institutions. Museums were also in the thoughts of Dana, and often he worked to include exhibits or museums into his libraries. The role of objects within institutions was for educational purposes,

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[14] Timothy Crist. "A John Cotton Dana Library". Newark Public Library. http://www.npl.org/Pages/AboutLibrary/JohnCottonDana.pdf (accessed November 3, 2010)

while attempting to assure value to varied groups. In particular Dana sought to have children exposed to unique objects. If children were able to have an experience in which they learn or are exposed to new things that engage their attention, then retention in the higher knowledge systems were more likely. It is common for people within science and technology fields to trace their reason for being in the field to childhood experiences.

A museum founded by Dana was initially housed on the top floor of the public library in Newark, where he was director from its founding in 1909 until his death in 1929. He felt that as part of the public service provided by the library there should be an exhibits-based collection, which would allow knowledge to become an active part of experience. Learning from books was important, but there was something unique in tangible objects. Part of the benefit with having both types of learning experience was that there could be cross-understanding. Those who might see an object and wish to know more about it could go downstairs to the library and access information.

While living in Colorado, Dana led a campaign to remove the "hands off/do not touch" policy by which the library used to run their collection. At the time the formal library in Denver was in the high school and not public as now are most libraries. He voiced his opinions on the actions of the Denver public school system in a local paper and grew to be a well known individual because of them. This in turn led to Dana being put in charge of the library. There he sought to allow access to the knowledge it contained for the benefit of the general public. The use of the materials, the hands-on experiential exposure that was part of true learning had to be part of the options available to the people.[15] The new allowance of use was revolutionary at the time and became part of the further development of the library system that eventually became an international

[15] John Cotton Dana. *The New Museum*. American Association of Museums. Washington D.C. p 205

standard. Part of the success that developed because of the introduced changes came in the 1920s with the expansion of the Carnegie Libraries.

One of the main effects Dana had upon the libraries came in his division of the library materials into specific knowledge areas. Though history had provided a successful foundation there were limitations to each library. For instance, at the Newark Library Dana initiated a permanent section that pertained to business, establishing this as a noteworthy change over the vague cataloguing of the materials. This specialized section allowed for specific ideas to be grouped together for those who could benefit most from the specific knowledge.[16]

Dana's goal was to make the library relevant to the daily life of each individual within the community. He chose to include all members of the community regardless of class or group. America was a place where people from other parts of the world would come to live new lives leading to large immigrant populations. Sensitive to the difficulties which might arise for immigrants, he created a foreign language section within the library assuring those new residents a chance to be included as well.

Dana felt especially certain that there should be a separate section for children's content. Dana understood that children had their own needs and might respond well to the distinction. Allowing access was a new expression of value of children's minds which enabled educational experiences in a way that had previously been overlooked. Dana initiated an open stack policy as well that encouraged larger exploration by individuals. These changes allowed for a broader forum for the information and curiosity to which an individual might indulge.

[16] Crist. "A John Cotton Dana Library"

The Modern Age and Change in the Field

In the realm of experiential learning in museums one of the foremost changes was instituted at the Boston Children's Museum. Though the class of museums we call children's had been around for many years, the earliest being the Brooklyn Children's Museum in 1899, they held to museum standards of the times. Even though they might be more filled with children's related themes, they were places where objects ruled, were out of reach, and their relation to the visitor determined only by the words that might accompany them. The policy of hands-off visitation changed in the 1960s when Michael Spock pioneered hands-on, interactive, experience-based learning around objects and the user.

Spock is the son of the famous children's doctor, Dr. Benjamin Spock, so his background of knowledge in understanding children could be seen as already in place. [17] As a youth, however, Michael often struggled with his school work and reading because of dyslexia. His personal experience tied into his overall understanding as he in turn had to learn to overcome these limitations in unique ways. Though he struggled with the standard education experience, he found expressive interest through exploration of the museums in New York City where he was raised. The exposure to these places, by his curiosity, is seen by him as derivative influence upon his later life and the changes that he eventually was able to pioneer. [18]

Beginning his term as director of the Boston Children's Museum in 1962, Spock led the development of the museum until 1985. During his tenure Spock took the opportunity to re-envision the museum and created a new theme for an exhibition series

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[17] Author of, *The Common Sense Book of Baby and Childcare*
[18] Michael Spock. "Education of Dropout." Boston Children's Museum. http://bostonstories.childrensmuseums.org/bostonstories/Spock.html (accessed July 12, 2010)

entitled “Please Touch”. Altering the standard of what a museum could do was a big part of initiating this concept change. This revolutionary thinking, to learn by doing, allowed children to become a part of something not attempted before within museums. In many ways the success that we see in children’s museums across the country is tied into the successful strategies employed at the museum.

The change developed through Spock’s belief that children were being denied the rightful experience they needed from a visit to the museum. Those who come to the museum are hoping for an experience, and when manipulation and interaction became a part of it, the level of comprehension grew, as did enjoyment. Following their own curiosity the children were allowed to roam more freely and be led by their nature. Objects which were once behind glass and off limits to handling were modified so that experiment would be encouraged and would lead to understanding.

The use of hands-on learning in today’s modern educational system incorporates many of the mechanisms of teaching that can be traced back to the pedagogy of Spock. In the study of museums as a current field there can also be traced a lineage from these changes outside of solely children’s museums. The principles that guided Spock to advocate these changes were eventually brought to the forefront of museum missions as in 1982 the American Association of Museum explained the importance and necessity of education within museum in the landmark publication on “Education and the Public Dimension of Museums” entitled *Excellence and Equity*. This is seen as a radical shift in the focus of museums as it addresses the importance of education in the actions of museums where before there was generally a focus upon collections.

Science Centers and Technology to the Public

Following World War II many changes to the American social and public structure took place. The thousands of scientists and technicians that served the cause of war were now part of the booming personnel influx into colleges and education centers across the country. The interest in developing technologies prompted homeland growth at an enormous rate. Our developing nation had an established group of highly educated individuals whose minds had been turned to the advances of war who with the end of conflict rejoined the public with their brilliance still forging ahead. These scientific minds went into many of the universities scattered across the United States, offering leading thinkers the opportunity to influence the next generation. Yet for some of these individuals there were other venues which drew their attention. Frank Oppenheimer, younger brother of the noted Manhattan project atomic savant Robert Oppenheimer, was one of these.

Frank Oppenheimer worked for decades at various colleges and universities in various roles, however, during the Red Scare of the 1950s he was ostracized from the higher education community for past affiliations with known communist party members. Being unable to continue at the university, he moved to Colorado where he divided his time between ranching and thinking. His passion for education was influenced during this time as he had the freedom from the structured rigors that had constrained him during the war and years after while at the university.

Oppenheimer soon became involved in his local high school, which had three hundred students and only one science teacher. The role was perfect for him as he was able to continue teaching science and influence students' love for learning. After teaching for many years at the high school level, he returned to university research with a focus on creating laboratory experiments and objects which could be used to help in the education of science. Along with the idea of using objects to help educate, he began drafting a set of pedagogical methods that would coincide with his educational tools.

With funding granted by the National Science Foundation these methods led to a "Library of Experiments". While at the university of Colorado, Oppenheimer along with several colleagues and many students worked on the construction of laboratory-based experiments that would "stimulate the thought of the student and make him more familiar with the structure of Physics".[19] The use of the experiments was not meant to replace lectures or any standard classroom time in which science was taught. Rather they were to augment it in a way that would allow an understanding of the concept to be developed through immediate association. The structure of the library was exhibits-based in a large room that could allow the students to roam and manipulate the objects without having to be responsible for learning laboratory methods and be under constant observation. This allowed the students freedom to learn at their own pace and be driven by a natural curiosity that was being drawn out by this new style of learning.

Oppenheimer was then awarded a Fellowship in London where he was exposed to the famous Science Museums of Europe such as the ones in South Kensington, London and the Deutsches Museum in Munich. These museums were of a newer breed which brought the focus of the objects into a new relation that would allow visitor greater chance to explore and develop understanding on their own and through their own curiosities. Similar institutions in America had not reached the pervasiveness that was seen in Europe nor the depth of the craft they produced for the public. It was during this

[19] Frank Oppenheimer. "Library of Experiments," American Journal of Physics 32, iss. 3 (March 1964) 221

time that Oppenheimer renewed his interest in public education and the ways in which it might be accomplished. Seeing how participation by the public was handled by these museums Oppenheimer turned to expanding his educational pursuit from a closed system to an open one that allowed freedom of discovery in a public venue.[20]

This led to a new project which Oppenheimer chose to locate in San Francisco. He used the Palace of Fine Arts, which was created for the Panama-Pacific Exposition held in San Francisco in 1915. The three acre complex had been used for various non-important jobs over the years, even serving as a parking lot. The early 1960s saw a campaign help ensure the preservation of the structure. In 1965 it was chosen to be the location of Oppenheimer's new project. When the doors of the Exploratorium opened in 1969, the nearly empty cavernous halls were starting to be filled with objects donated or created by colleagues.

The aim of Oppenheimer's project was to bring physics to the masses in ways that could be understood without having to spend enormous amounts of time in book reading or lectures. Building on the success of his earlier library Oppenheimer himself oversaw implementation of exhibits and their corresponding pedagogy. The experiments and objects that were scattered around the floor of the Exploratorium were not only designed to be engaging but were also moved regularly to encourage visitors to search and follow no true path. Even repeat visitors who had favorite objects were continually challenged to locate that which drew their attention the most in past visits. This allowed the same objects to be used for long periods of time without becoming stale.[21] In continuing the

[20] Hilde Hine. *The Exploratorium: the museum as laboratory*. (Smithsonian Institution. Washington D.C. 1990)
[21] *Ibid.*

efforts of Oppenheimer's work, The Exploratorium still works to devote science education as being accessible, experiential, and fun.

CHAPTER THREE

The Physics Circus

The CASPER Physics Circus was developed in the 2000-2001 school year in an effort to extend an outreach program into the local school system. CASPER stands for the Center for Astrophysics, Space Physics, and Engineering Research and is a leading research partnership between Baylor University and Texas State Technical College in Waco. The funding for the Circus has come through many different agencies and was initiated through a grant from GEAR UP Waco. Gaining Early Awareness and Readiness for Undergraduate Programs is a U.S. Department of Education program aimed at low-income students who are preparing to enter into postsecondary education.

The Physics Circus brings a research group of undergraduate, graduate, and post-doctoral fellows into a collaborative effort which seeks to influence the future decisions of students for retention within the sciences. In essence the design seeks to provide future technicians and scientists to fulfill the needs of the growing workforce, thus furthering the effort of GEAR UP and CASPER. With additional funding coming through additional sources and even National Science Foundation grants, the Physics Circus has grown into a program recognized for its efforts in using best practices in education through powerful learning experiences.

The design of this initiative is built around the endeavor to demonstrate principles of science through objects and demonstrations which allow a student to make observations which enable them to gain an understanding of physics through participation and self exploration. Over the years in which the Physics Circus has been in production, the nature of the program has expanded and in its current state encompasses an onstage performance that pairs with object demonstrations. The objects are set up in an exhibitionary manner and more currently are aiming at following museum guidelines for display and label copy. Intentionally, most of the objects are tailored to specific concepts paired to state standards which relate to specific examples in real life. To provide an "AHA" moment which can create an awesome experience in their memory is a goal that continually advances the mission of the Circus. Each year the theme and concepts discussed in the show are changed as does the style of the performance.

The exhibition portion is referred to as the Fun House, and hosts an ever-changing variety of objects which can best illustrate laws and principles which govern physics along with posters which coincide with the education and curriculum. Each station is at is designed to build upon the theme for the show and to entertain with physics in order to lessen the unease often felt by students in advanced science. Ideally, the program is designed to have enough variety and scope that it will be able to provide some form of inclusion for all the students who come through.

The host of the performance is the Mayborn Museum Complex at Baylor University where the show is set up in the traveling exhibit hall. As a member of the larger collection of collaborative organizations the Mayborn has been able to provide on occasion public open viewings of the Physics Circus even though the show is targeted to school groups. The timing of the performance has coincided with the March spring break schedule of Baylor University and the local school districts permitting an additional interest point for museum visitors.

What the Physics Circus Seeks to do.

The current aim of the Physics Circus is to impact the science, technology, engineering, and technology (STEM) education in a set of local secondary schools with a focus specifically on physics topics. This impact is identified as an increased appreciation, understanding, and retention of students within the sciences while at the same time promoting skills used in most every science. The program is continually in development, as each year's show works to include more successful practices and the topics of each year's presentation change.

The target grades for the Physics Circus for the 2010 show are ninth and tenth, though the overall exposure extends beyond those two grades. The exception to this inclusion is mostly due to either students retaking the classes or having transferred in from other districts where differing standards were established. In directing the performance into accordance with this specific audience, the standards for educational material that the student should be exposed to, the Texas Essential Knowledge and Skills (TEKS) and the National Science Education Standards (NSES) are consulted. In addition, the teachers themselves are often asked for their opinions on certain materials that the students might have more difficulty grasping, giving the Physics Circus the opportunity to address specific concepts seen to be struggled with in the classroom.

The show's design is to take only a single half of the school day so that there is not too much disturbance normal curriculum. Each day there are two showings: the first at 9:30 a.m. and the second at 12:30 p.m. The dates of late January through early March are established so that the students can experience the Physics Circus before standardized test preparation begins in the schools. State testing, the Texas Assessment of Knowledge and Skills or TAKS, is in April. The use of these dates allows an entire semester in the fall where the curriculum can be developed and distributed.

Ideally, the Physics Circus is scheduled to end around spring break, which in our target districts is often the second full week of March. The program itself only is designed to take two to two and one half hours, though because of travel time and organization of the students at school it is in essence a half day. This allows the stage performance to be an average of one hour with another one hour for the exhibit. The extra time is either used to help the students work through the Fun House or to participate in group questions relating to the performance and science. It is important in this allowance that the students' needs are addressed either as a group or individuals. There is also a laser light show that is designed to accompany a musical number that also changes every year. The light show is enhanced by refraction lenses that the students are able to keep. The laser show demonstrates not only science in an entertaining way but some of the options available to those with technical understanding.

The theme for the 2010 production was CASPER Science Investigators (CSI). This is also the theme set for 2011. The performance provided the framework of a mystery that could be solved through the use of information initially explored in the show which would then be used in the Fun House. The booths that made up the exhibit paired clues which were analyzed and explored in the show but required the students to perform some certain skills in order to achieve answers. There were five main clues that led the students through solving the mystery. Though not every station was directly tied into the show or the investigation, all booths related concepts which paired with the clues or particular science that was in part discussed.

The role of the individual in exploring the Fun House as part of the group relies upon each student accepting the responsibility for themselves and their actions while participating. All rules and expectations are explained by the teachers before the students arrive at the Circus as well by the staff when all the students are seated. A notebook, also known as case file, for the CSI production is given to each student that coordinates the information that they should be seeking while listening to the performance. This booklet also serves as the workbook for the clues as the students explore the Fun House. Those who choose to take an active role will benefit from the experience, while those who choose to be a distraction are left to their choices and separated from the group.

There was always a student worker in place to help lead the students through the informal learning associated with the booths and experiments.

Local Education Needs Assessment

The current state of science education in the public school system has reached the level that technology and the sciences may outpace the educational capacity of teachers and thus the students. This is of course not a 100% truism across the spectrum, yet the U.S. is still falling behind other developing countries in terms of retention and success in science. The need for advancing our country's workforce within the sciences and technologies is a growing issue being addressed by educational advocacy groups and learning institutions.[22] Successful strategies that augment the public system are difficult to introduce in widespread programs, yet there is always the need for them.

In Waco, Texas, the population poses unique factors in the advancing of this mission. The schools in the district are in a battle to contain a burdensome

[22] National Science Foundation. "Retention of the Best Science and Engineering Graduates in Science and Engineering." http://www.nsf.gov/statistics/nsf99321/text.htm (accessed 14 April, 2010)

student/teacher ratio as well fiscal balance. The increase in the state population as well adds to the growing efforts of schools to address English Second Language (ESL) students and other underserved populations. There is often also a difficulty in recruiting teachers of specialties, such as science, to work in disadvantaged schools. As an example, at University High school the economic need of the students is 30% higher than the state average.[23] The families of the many students are of a low income class; as well there are a number of first generation American students from immigrant families. Unemployment in Waco before even the economic troubles of the past couple years was over two times the national average.

The need for the Physics Circus is therefore already proven. The students in the district are under-performing, regardless of the efforts of the teachers and administration that are making to improve the performance. The Physics Circus offers an experience that allows the students a new way of learning, that takes away the standard classroom lessons, and puts the students into a new environment designed to address many of the issues lacking in the standard system.

Yet this is not to say that there is a perfect system in place in the Physics Circus. The Circus does work to perform and demonstrate best practices in teaching while providing relevant content, yet there are continually ways in which to improve and adjust the education and development to assure success. This project outlines the multiple uses of some of the factors that already build upon the science in teaching.

[23] TEA Statistics for Waco ISD http://www.wacoisd.org/publications/state_accountability/DistrictPerf.pdf (accessed November 17, 2010)

Need for this Project

One of the factors that limit development during the creation and development of the Physics Circus is the history of almost a decade of objects or experiments. Over the time of its existence, many individuals have come through CASPER while participating with the Physics Circus. As each year's show changes theme and goals, it becomes more difficult to fully picture the history. The imprint of continually changing environment leads to some difficulties of information gathering. As over time there are fewer individuals who have memory of certain aspect of the objects and even their potential for future use. By creating a database in which information about the objects can be collected, there can be an ongoing evaluation of their quality as seen from their success as educational tools.

The information which will be within the database is the content and information for the objects which were in use for this year's Physics Circus show. It is necessary to put a constraint upon the amount of information at this stage to prevent overreaching for the efforts in this project. The choice of how much information on each item is similarly limited so as to not overburden the project by trying to determine the smallest aspect of each item.

As the Physics Circus continues to advance experiential education through object use, new avenues of marketing its program become available, outside the current target districts. With the completion of the database and the condition report, it allows the members of the Physics Circus to access the object data which will improve the efficiency and coordination efforts of using the objects further. As the database expands with future objects there is also the ability to form new lessons based around the items that can meet needed educational goals through their expression of certain principals.

CHAPTER FOUR

Database Process and Development

This project builds upon the history of the Physics Circus program's objects while developing a central database which will organize the information in relation to the objects which are used. The main concept in this development is creating a centralized place for the information. The objects are being established as a collection in order to help preserve the materials used by the Circus and to simplify a pathway to the information. As well, this project looks to recognize the legacy of individuals and their achievement in the history section earlier.

Using FileMaker Pro, the database will work on both Windows and Mac operating systems. This establishes greater flexibility for the users who will work with it in the future. This potential is built into the FileMaker program rather than an option that needs to be selected or enabled. The choice of using FileMaker rather than similar systems, or one more commonly used in museums, was made by evaluating the overall use, future development, and flexibility of the database once created. File maker also allows the database to be formatted into a pdf.[24]

The design of the database will be divided into three main collections and will also have a version of the condition report linked. The objects collection will be the main content of the database established in this project. In this section, the objects used by the Physics Circus as part of the education programming can have their information stored for evaluation and condition. Though the first section will be the base work of this project, the other two sections are being established for future efforts. The second division will create an information system for the teachers and educators who work

[24] Pdf stands for portable document format and is an independent system representation of various file types

within the target schools. This will allow the Physics Circus employees to have access to information about who a target teacher is while allowing updates depending on happenings during any given school year. A third tab will be related to the schools themselves and provide pertinent information about the schools which can be used in conjunction with the teacher info.

In the creation of any database there are four essential steps. The first is forming the data model through which the information will be sought and stored, in essence a blueprint for the form. This data model also helps in the formation of a condition report as much of the information in both will overlap. The second step is the actual construction of the database, in this case via FileMaker. Ideally, much of the design will be formatted in the first step allowing the construction to be a simpler process as you build with an idea. The third step is the collection of the information. Collecting the information for the database is in the end the most important step as many other factors do not constrain completion of this project in quite the same way. Many parts of the information necessary for the database coincide with information that is catalogued with the condition reporting so it is possible to do them simultaneously.

Lastly is the input of the information into the database system that has been developed. Once a skeleton system has been created editorial changes such as extra scripting of actions, or aesthetic features may be added. The ease of FileMaker's creative controls in the current version of the database will allow it to be updated as new necessary data fields become apparent. Each field also allows for a presentable form which will be useful for all future object development, purchase, or creation.

Within the first step of this process is determining which objects should be included in this project. Knowing where the inclusion starts establishes the basis for how they can be divided. The Physics Circus has been around for almost ten years, creating a variety of themes and projects during that time. The most efficient way of deciding which objects go into the database is to focus upon the most recent 2010 show.

Ideally, the first expansion would then be accomplished during the 2011 show, then working backwards into the previous year's shows, as needed. There are many objects which will not be included regardless of when they were used due to their common and replaceable nature. As an example of a replaceable supply, a slinky would not be placed into the main database as part of the collections. A slinky is able to demonstrate different wave types, yet with the cost being less than $1.00 a teacher can acquire one of these on their own through the school system, if they don't have one already.

The first division of the objects is into the five clues that are directly tied into the Physics Circus 2010 performance. These objects form the base for the Circus Fun House and their inclusion is necessary in order to provide a solid foundation that may be followed in the future. The posters that associate the show, the science, and the steps of each clue are considered objects and linked in the system as such. No poster is meant to be a single, standalone object and as such, there is a data field that poses the groupings of the objects. In many instances, information directly with the case and clues is gained from multiple sources. The show presents the concepts and demonstrates the scientific process for each clue, yet it is the multiple reemphasizing of the steps and process developed in the posters and objects that is the basis for the production. The posters which support the clues are associated to the objects by elaborating and reiterating information from the show as well detailing the process to reach a solution for each clue.

The objects not used with the clues for the shows are supplementary or more interesting and attention-grabbing objects. These objects still have worth to the students as many are great examples of many of the physics theories that abound in the universe and are well taught with their matching posters. Many times these objects are included in the Fun House because of their ability to relate to classroom lessons or state standards for certain sciences.

Each of the objects in the clue sets are matched with relevant TEKS. This is due in part to the fact that the Physics Circus is outreach-based in the public school system. Working in such a system, as well always seeking to assure that there are measurable qualities, requires that justification come in part the from associated TEKS. As well this has become common practice in museums as education programs have gained prominence. When browsing most any Texas museum website, looking at the education section often details the choice and specifics of their use.[25] The schools, in need of justification for taking almost a full half day away from the state required lessons are able to show that the interruption to school classes are being replaced by supported material. In the same way, when these objects are brought into the classroom they will be able to provide explanation based on the states requirements by showing that they are supported by the TEKS.

Additionally, the database will include the publicly-accessible information about the teachers, but will also be able to detail specific notes about each individual. Since the CASPER program offers teacher education and enrichment sessions this may be noted

[25] As example, The Children's Museum Houston http://www.cmhouston.org/standards/

with the information to show which teachers are working through our program gaining enrichment. Some teachers might be more willing to be a part of the Physics Circus curriculum or be part of programs that are offered by the Physics Circus. All this type of information is relevant to Physics Circus workers and concentrating that into a centralized source would increase performance.

Condition Report

One of the important aspects coinciding with creating a database, in which an object's information will be stored, is a platform that will simply and accurately record the current condition of the objects. Implementing a condition report into the database, as part of the whole collection management system, will also allow for components of the object care, such as storage location, to be evaluated over time. As some of the objects might not be evaluated in a six-month timeframe, pre-storage condition might be compared to post; after the object emerges from storage the report could show whether it was adequate or inadequate storage.

Knowing the condition of an object is an important facet of caring for a collection and there are multiple factors that support the necessity of a simple yet quality condition report. First, keeping an accurate log of each item's condition allows for upkeep of the objects to be assured by detailing any flaw or failing. Second, when something is documented as being in unusable condition it allows the right response from those who are able to affect a change and fix the issue. Finally, though not simply the last benefit of condition reports, the better the Physics Circus is able to keep up the knowledge of the condition of an object the greater potential there is for objects to retain their quality of over a longer period of time.

There are aspects of protection that are built into condition reports also. Since each report requires specific documentation of dates, location, person who made the report, etc. there is less potential for losing track of items or where and when something could have caused damage. By having clear documentation, if an incident occurs in which an object is damaged, then steps may be taken in order to prevent future problems.

The database in its working model will have current conditions of the objects detailed. The form for the condition report may be used as a continual recording method that may be used when the objects go out on loan. In these instances it is important for the receivers of a loan to be aware of the condition as it comes into their location and as it leaves, denoting any change during the time at a given location.

Within the museum field there is specific terminology used in condition reports.[26] The reports themselves may vary some between the different museum types (i.e. art, science, history). However, the general sense of condition applies throughout and often is seen as the most formulated examples of critical condition descriptions offered. "The form guarantees a standardization of information and observation guidelines."[27] Since the Physics Circus is not a 501 (c)(3) non-profit working as a museum but rather a production studio and traveling exhibit, the stringent detailing of the reports that might accompany a traveling exhibit of renaissance artwork will not be necessary, though some standardization is helpful.

The creation of the condition report came in two portions. The first was a Microsoft Word document that could be used as the paper version, which would also serve as the model for the other. The second would be the electronic copy that would

[26] Buck and Gilmore. *The New Museum Registration Methods* (Washington D.C., American Association of Museums 1998)
[27] Paul MacFarland. *Preparing Condition Reports*. Picture Framing Magazine January 2003

coincide with the FileMaker database. The e-copy will be constructed in the same principle as the main database but will remain separate. As a separate information set, the condition reports will be connected into the main database through an input script which with one click will open the individual data entry associated by object. This choice, rather than having a more elaborate collections database allows for a simplification of the project whereas it could otherwise develop into an overly complex and unusable program.

Object Information Reasoning

Since this project centers around the creation of an information system that will be useful for the Physics Circus team, as well allow for future development, explaining why certain pieces of the information are included in the database is important. Explaining the aspects of inclusion will also show the tailored specifics included in the database making it unique for the needs of the Circus. Using FileMaker Pro the options were allowed to be manipulated. The newest version of the software, v11, is built upon fifteen years of programming for database use, creation, and maintenance. The objective is the building of the database for the objects while at the same time developing additional framework, which could allow further development in the future.

Objects Tab

TEKS

The TEKS and their presentation that can accompany the objects are important for justifying their use. The state standards of education have become one of the all important factors for museum education projects. One reason for this is that teachers themselves are being required to further justify all of the trips and activities that they might use in the classroom. By providing the TEKS with each object, the teachers can choose which of the objects might be the most useful for each lesson.

Space Needed

Not all of the objects are a simple small thing. Some of the technologically developed objects such as the spark gap generator and the Tesla coil have high voltage or amperage which could prove dangerous to human life. Not only that but the energy discharge from the Tesla coil can travel towards the closest attractor, which could be a light bulb, electrical socket, etc. In this case the energy discharge could blow the electrical circuits of the room's power if not the larger circuits.

Dimensions

Always a needed piece of information, the dimensions of the object is directly tied to its potential use. If an individual determines to use an object yet has no space in which to display it then something unfortunate has occurred.

Support Needed

As some of the technologies have potential danger, these might need a person to be responsible for the classroom use. The teachers themselves could be in charge but would need to be cleared for the use. The graduate assistants for the Physics Circus would be the optimal choice for the assistants, allowing the teacher to focus on the students as the graduate assistant focuses on the lesson and science. For those objects which need no extra support this is able to indicate something as appropriate for teacher or substitute lead use.

Storage Location

Knowing how and where the objects are currently stored allows an understanding of how long the life expectancy might be. The posters which are part of the central use of the objects for instance should not be left in a non-ventilated inadequately climate-controlled area. If left in such a place the humid, hot Texas summers would warp and discolor them making their use less likely as well as limiting the time frame that they could be used. In a similar thought, not all objects need to be kept in climate controlled conditions thus increasing the possible number of locations in which objects may be stored. So long as the objects are evaluated often when not in use, the regulation of their condition can be monitored for whether the location is acceptable or not.

Current Condition

Obviously knowing the current state of the objects allows knowledge of whether or not something can be useful. There will be several grades of condition from New to Replace/Repair.

Limitations

Some of this information will be repeated in some of the other sections presented. One factor that may limit an objects use is knowing whether or not an object is recommended for use in the classroom without supervision by Physics Circus staff. This is more of an internal evaluative measure as there might be many factors that can influence this decision based separately at times.

Teachers

As part of the database is dedicated to the storage of teacher information, it is only justifiable that there is some way to determine what information is necessary to be a part of their tab. At the Physics Circus there are often only a few individuals who have detailed knowledge of an individual teacher. Contact to the individual teachers might be centered in messages through a single intermediate source such as the department head of the sciences, principal, or simply the school secretary. All of this creates a barrier between the organizations.

One of the benefits of allowing information on the teachers to be included in this project is to familiarize the Physics Circus workers with the individuals in charge of the students. Creating relationships between these two groups of people will have the benefit of increasing the liaison and drive to participate from both ends. As the Physics Circus works to be more in the classroom, and offers more teacher training, better relationship will allow for creating improvements in the abilities of both groups with respect to the science education brought to the students. With information on each teacher in the database the Physics Circus can look up information on each teacher associated and determine what strategies might be more effective for each teacher or school group. There is also the ability to ascertain which teachers are more willing for the material offered by the Physics Circus, showing also who would benefit more from continuing associations.

Contact Information

These fields would include the teacher's name, phone number or extension at the school, and school email. This information is important for many reasons. Throughout the year it is necessary to interact with the teachers and to receive information from them relating to their classes and students. In the past, this information was mainly known to the director of the Physics Circus who served as the primary contact for all aspects of inter-relation. Having this information in the database would allow employees to make the contacts on their own when necessary, ideally leaving less work for the director.

Professional Information

This area would include which school the teacher currently teaches at, the number of years teaching, which subjects are taught by the teacher, and their participation in teacher education sessions that are hosted by CASPER and the Physics Circus.

Comments

Always an important section is one where any specific notations about a teacher can be made. There may be any number of reasons for unique pieces of information to be noted. The teacher may mention willingness to do more work with the Circus, or it could be that a teacher is soon to retire.

Schools

The importance of being able to have each of the schools who make up the target cohort be part of the database is shown in part by the participation of the individuals from the schools. Rather than relying upon the internet for all queries, this system would put the information needed straight into the hands of those who would use it.

School Data

Within these fields is found the information about the school that is related to the general contact information and the statistics of importance. Examples of important statistics would be number of students or teachers.

Comments

Any extra comments that might be necessary to relate to each campus. Notes could be on anything from construction issues with roadways near the school, specific concerns about teachers/students, or unique factors that affect the schools students and performance.

Future Use and Development

This project has not simply been the creation of an objects database but has also provided a location for information about other important aspects of Physics Circus programming. FileMaker Pro remains a flexible and easily manipulative system through which the database may be managed and developed in the future. By creating a framework through which this further development can be implemented, this project works to assure a continued viability of database use after the completion of this project.

Following the idea that there will be further use of this project after its completion there are also ideas that may direct this development. By involving the creative team during future developments this process can be done during and allow for educators to use objects for preparation of the show rather than just as part of the show.

Linking the database to the Physics Circus website would allow for use beyond the initial target group. The website is often changed as the performance and the information needed to be supplied to the public changes. The introduction of a link to the database which could be either downloaded via a pdf or accessed as a webpage listing is optional. By opening up the listing to teachers and educators in the area, as well including the safety and specifications of the requirements of the Physics Circus allows an expansion of its current mission into something that the public can make use of on their own.

Another designed feature where this can be effective is the development of the Physics Circus as a program that can be used in a larger area than just the local target audience. There are many ideas of the future use of the filming that accompanies the show. Since the show is an important introduction to the information that accompanies the posters and objects the ability to relate the film of the show and the objects together would increase the success of each piece. As well this allows future use of what has been done already while not changing the next years development.

Conclusion

The current implementation of this project is designed for the use by Physics Circus staff and educators in understanding the value, condition, and potential of educational objects. Arranging these objects as a collection managed according to museum standards encourages a continuation of value and an understanding that the care of these objects is an important aspect of the Physics Circus. Establishing this project from the perspective of the museum community allows for addressing potential concerns with knowledge and efficiency as many issues have already been addressed.

The exploration of various historical developments and individuals efforts were looked to for their influence upon the modern actions of museums, science centers, and education programs. With an understanding of the legacy through which this project is established, one can see the importance that past efforts to improve science education have taken in utilizing object-centered experiential education efforts.

The database in its live form is a system that enables a simplification of the current methods of information storage that is in use by the Physics Circus. As well, the creation of condition reporting allows for a continual quality assurance of the objects, allowing over time the ability to evaluate many aspects of their storage and long term use. The other aspects of the database are developed for future use attempting to create a useful set of information where there is not currently one.

In summation, the role of a database is storing important information which can prove useful for evaluation and planning. Museums have long used systems of information collection, allowing for the database to be grounded in a legacy that continues to devote care to objects and their use.

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