EFFICIENT OPERATIONS AND PROCEDURES OF CHILDREN’S MUSEUMS

by

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Executive Summary

Due to the recent economic downturn, the San Luis Obispo Children’s Museum’s budget has been reduced by half. The entrepreneurial Museum Director is searching for ways to cut costs and increase revenue. This project aimed to apply Lean methodologies, traditionally used in manufacturing organizations, to the Museum, a non-profit service organization.

The project objectives were to have an organized storage area using principles of 5S; determine excess inventory; consolidate available exhibit information; create guidelines for exhibit production to ensure high quality exhibits with sufficient user documentation are created; perform a sampling of exhibit use in order to have a list of exhibits ranked by popularity; identify areas of waste and initiate record-keeping in these areas as basis for future projects.

The storage area was organized, but 5S was not fully applied because the labeling and storage containers were not standardized. Before and after photos of the storage area are shown in Figures E2 and E3. Some excess inventory was identified, but more is still likely to be found in the front office and the business offices. Exhibit information was consolidated and the Guidelines for Exhibit Production were completed and implemented. Exhibit sampling was performed, but lacked scope. Further sampling should be performed over a greater number of days.

This project found that applying Lean methodologies in a non-profit, service organization was effective in producing both the quantitative and qualitative benefits typically seen in traditional applications in manufacturing organizations. Yet, these benefits will be short-lived at the Museum if lean thinking is not adopted across the entire organization and the organizational culture is not transformed into a Lean culture. Many more areas of the building would benefit from 5S implementations.

Future Directions include making exhibit improvements; tracking birthday party costs and attendance, and inventory use; determining optimal staffing levels; and locating all inventory in various areas of the building by performing 5S.
Acknowledgements

This Senior Project would not have been possible without the cooperation and support of the San Luis Obispo Children’s Museum. A warm thank you to the following people:

Michelle Jenkins, Executive Director
For giving me license to implement my solution.

Dr. Kathy Chen, Exhibits Committee Chair
For reviewing and giving prompt feedback on exhibit documents.

Sheryl Flores, Floor Manager
For answering all my questions and teaching me the ins and outs of the Museum.

The Museum staff
For answering even more questions and performing the exhibit sampling.

I sincerely hope that I have contributed as much to the Museum as it has to me.
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Introduction

The San Luis Obispo Children’s Museum is a non-profit organization that promotes learning through play. Children interact with various exhibits to learn by doing. In recent years, the museum’s funding has decreased drastically, forcing the organizational structure to be rebuilt essentially from scratch. The Museum has reached out to various Cal Poly departments for help on improving their operations, specifically by reducing costs and increasing the quality of visitors’ experiences.

The working environment at the Museum is chaotic, due primarily to a lack of procedures. Organization is attempted but not sustained. Items are put in cabinets in the front office or in the storage room wherever room can be found. The disorganization of the storage area has made it impossible to properly monitor inventory. Improving these conditions will result in cost savings for the museum.

Exhibit maintenance is also of concern to the Museum because many exhibits, mainly those developed by Cal Poly students, lack the user documentation needed to know how to service the exhibits. It can take months for an exhibit to be repaired. The Museum would like to prevent this problem in the future. Also, the Exhibits Committee would like to identify unpopular exhibits so that they may be replaced with better ones. Addressing these problems will likely improve the visitor experience.

Purpose

The purpose of this project was to assist the Museum Director in improving operations at the Museum by applying industrial engineering skills and lean methodology. Such organizational improvements will save the Museum money and provide a more efficient work environment for staff. This project focused on organizing the storage area; developing Standard Operating Procedures for exhibit maintenance and Cal Poly-developed exhibits; and initiating data collection in key operational areas for future use in improvement projects.
Goals and Objectives

- Have all employees be able to quickly locate inventory and know when new inventory must be ordered.
  - Have an organized storage area.
    - Use principles of 5S.
    - Use Systematic Layout Planning (SLP).
  - Determine excess inventory.
- Enable the Exhibits Committee to improve Museum exhibit offerings.
  - Consolidate available exhibit information.
  - Perform a sampling of exhibit use in order to have a list of exhibits ranked by popularity.
  - Create guidelines for exhibit production to ensure high quality exhibits with sufficient user documentation.
- Lay the groundwork for future projects at the Museum.
  - Identify areas of waste.
  - Initiate records-keeping for these areas.

This report will first give a detailed background on the Museum and the methodologies used, followed by a description of how the solution was designed. Next, the implementation of this solution will be explained and the results will be examined. Finally, the conclusions drawn from this project will be discussed and future directions for Museum projects will be suggested.
Background

The San Luis Obispo Children’s Museum (referred to as the Museum in this document) opened in San Luis Obispo, CA in 1990. It is a non-profit organization whose mission is to inspire learning through play by providing interactive exhibits and programs in the arts, sciences, and humanities. The Museum is geared towards children 10-years-old and younger.

The Museum has three floors of exhibits, as well as an outside play area. Each floor has exhibits targeted for a specific age group, as outlined in the table below.

<table>
<thead>
<tr>
<th>Floor</th>
<th>Age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8-10 years</td>
</tr>
<tr>
<td>2</td>
<td>5-7 years</td>
</tr>
<tr>
<td>3</td>
<td>4 years and younger</td>
</tr>
</tbody>
</table>

Visiting the Museum requires purchase of admission. Patrons also have the option of purchasing various memberships. Membership gives members discounts on birthday parties, reduced admission for guests, and invitations to members-only special events. Some membership options also give members free or reduced admission at over 165 museums in the United States (called “reciprocal museums” because the Museum honors their memberships as well). While at the Museum, visitors can also purchase items from the Museum store, which stocks Museum shirts, educational toys (often themed around a visiting or featured exhibit), children’s books and novelty items.

Another service the Museum offers is hosting birthday parties. Each child attending the birthday party receives a birthday bag, filled with various goodies. Birthday bag fillings depend on whether it is a “Toddler Bag” or a “Child Bag.” The Museum also supplies tables, chairs, plate ware, and balloons for the party.

The Museum’s budget is funded entirely by donations and any income it generates through its operations, such as admissions, memberships, and hosting birthday parties. Due to the recent economic downturn, donations have dropped significantly. The Museum is further hurt by the public’s misconception that the city of San Luis Obispo or other government entities provide
funds to the Museum; this false impression makes people less likely to donate because they believe the Museum will survive using this funding. The decrease in income from donations has cut the annual operating budget essentially in half from $600,000 to $300,481. Because the Museum’s budget has been so negatively affected, the Museum must be even more cost-conscious.
Literature Review

This literature review looks at several topics related to this project. The first topic is museums, specifically children’s museums and recent trends in museum management. Next, lean methodology is discussed. 5S, a tool of lean, is evaluated in terms of application in a service industry. Finally, the use of activity sampling is examined.

Museums

Museums are non-profit organizations. Recently, non-profit organizations are becoming more strategic in order to respond to the rapid change in their environments (Akingbola, 2006). The most common strategy being used is the Analyzer strategy from the Miles and Snow Strategy Typology (Akingbola, 2006). The Analyzer strategy strives to maintain stable operations while pursuing some innovation (Daft, 2010). There has also been a shift in museums from being primarily custodial institutions to being audience-centric (Gilmore, 2002). Two types of museum directors have emerged: custodial and entrepreneurial. The entrepreneurial director focuses on creative programming and generating funds, primarily through efficiency measures (Gilmore, 2002). Michelle Jenkins, Director for the San Luis Obispo Children’s Museum, is an entrepreneurial director.

The Association of Children’s Museums defines a children’s museum as “an institution committed to serving the needs and interests of children by providing exhibits and programs that stimulate curiosity and motivate learning.” (2008). Children’s museums differ from traditional museums in that they emphasize education and use interactive exhibits rather than focusing on preservation or research and having non-tactile exhibits (ACM, 2008). However, children’s museums are still recognized as formal museums by the Institute for Museum and Library Services, the American Association of Museums, and the International Council of Museums (ACM, 2008).

Lean Methodology

Lean methods were developed to eliminate waste associated with the flow of materials and information. Key principles of lean are specifying value (in terms of what customers want) and pursuing perfection (Womack & Jones, 2003). Lean methodology is traditionally applied in the manufacturing sector, but Lean can be applied in every industry (Womack et al., 2007). Recently,
there has been a trend of service organizations, such as hospitals, adopting “lean thinking” principles into their improvement techniques. While these principles must be adapted to the specific needs of the service organization, this is no different than the adjustments that must be made when applying Lean to various manufacturing industries (Ben-Tovim et al., 2008). Thus, Lean methodologies are just as applicable in service industries as they are in manufacturing.

Implementing Lean has both quantitative benefits, such as reduction in cost and time, and qualitative benefits, such as reduced stress in the work environment. Most companies fail to recognize the value of the qualitative improvements, focusing solely on cost reduction (Manos, 2007). It is important to have a holistic approach to Lean.

The benefits of Lean are undisputed; thus, there is some question as to why all organizations are not Lean. Identified difficulties include the counter-intuitiveness of some Lean concepts, limited understanding of existing processes, unclear strategic priorities, and resistance from management or staff (Bagley & Lewis, 2008). Additionally, the Lean management system differs from other attempts to improve business activities (usually short-term programs or initiatives) because it requires a change in culture (Emiliani & Stec, 2004). The subtle difference causes many organizations to fall into “Imitation Lean,” which is where only the tools of lean are used without adopting a Lean mindset. Mixing Lean and non-Lean management practices in this way will result in low improvement rates (Emiliani & Stec, 2004). To successfully implement Lean, it must be remembered that “Lean is not the tools. Lean is in [the] head and heart.” (Manos, 2007).

5S

5S is a Japanese methodology for workplace organization often summarized by the mantra “A place for everything, and everything in its place.” It is a five-step technique for organizing workplaces and getting the entire organization involved in improvements (Sarkar, 2006). The five steps for 5S are based on Japanese acronyms; these steps, with their Japanese names and their English equivalents are shown in the table below (EPA, 2011).
Table 2: Steps of 5S and their definitions

<table>
<thead>
<tr>
<th>Japanese</th>
<th>English</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seiri</td>
<td>Sort</td>
<td>Eliminate unnecessary items</td>
</tr>
<tr>
<td>Seiton</td>
<td>Set in Order</td>
<td>Create an organization system</td>
</tr>
<tr>
<td>Seiso</td>
<td>Shine</td>
<td>Clean area</td>
</tr>
<tr>
<td>Seiketsu</td>
<td>Standardize</td>
<td>Use the same set-up in all similar areas</td>
</tr>
<tr>
<td>Shitsuke</td>
<td>Sustain</td>
<td>Maintain the system</td>
</tr>
</tbody>
</table>

The 5S process is a cyclical methodology, as shown in Figure 2. Following this cycle leads to continuous improvement. Kaizen is the Japanese word meaning continuous improvement. It refers to subtle, gradual improvements made over time (Manos).

![Figure 2: Cyclic process of 5S (Source: Environmental Protection Agency)](image)

In the Western world, 5S is often considered “housekeeping,” but the true practice of 5S (as it is used by the Japanese) strives to ingrain the values of organization, neatness, cleaning, standardization, and discipline into the workplace (Gapp et al., 2008). For this reason and because 5S is relatively easy to implement, 5S is often the first step in a Lean implementation. Other Lean tools are ineffective if a robust 5S system is not in place (Chapman, 2005).

The 5S tool is traditionally applied in manufacturing sectors, but several applications in service organizations have been successfully implemented (Sarkar, 2006). Implementing 5S in a service company can help develop an inventory management system, change the mindset of employees to one of problem prevention and continuous improvement, and create a strong foundation for
future work (Sarkar, 2006). While 5S is beginning to be applied in the service industry, this project is unique because it applies 5S to a non-profit organization where the motivation to eliminate waste is survival rather than profit.

**Activity Sampling**

Activity sampling is a method of using statistical sampling and random observations to determine the percent occurrence of an activity. It is used to gain an accurate representation of operational activities in a cost-effective way (Kanawaty, 1992). Traditionally activity sampling is used to track a machine (or an operator) in a manufacturing facility to determine what percentage of that machine’s time is allotted to various activities, such as working or stopped. This technique can also be used to monitor multiple machines to determine the average percentage of machines working and the average percentage of machines stopped (Kanawaty, 1992).

Productivity is an important factor to consider when managing programs and determining allocation of resources. Lack of productivity data can lead to poor decisions that cause negative results (Urden & Roode, 1997). Activity sampling is an effective way to measure the productivity of manufacturing and service organizations.

**Literature Review Summary**

The literature review suggests that as museum directors adjust to the changing environment, cost-reducing methods for operational costs should be employed and a greater emphasis should be placed on audience experience. Lean methodology is an effective way to reduce waste in any type of organization; 5S is an appropriate first step in applying lean methodology in a service organization, such as a children’s museum. Using 5S at the Museum will lay the foundation for future projects, such as inventory management. Choices on how to allocate resources to improve visitors’ experiences should be based on data. Activity sampling will quantify the current state of visitors’ experiences, specifically the use of exhibits.
Design

This section will discuss the evaluation of the problems discussed earlier and the design of solutions to them. Before beginning any design work, a thorough study of the Museum’s operations was conducted. Extensive interviews with the Museum Director, Store Manager, and five of the seven staff members were performed in order to determine the challenges, wants, and needs for museum operations.

Exhibits Solution Design

While generous donations from companies and individuals are still a major source of income for the Museum, much is also generated from admissions and memberships. One way to increase income would be to increase the volume of people attending the Museum. The best way for the Museum to attract more visitors is to improve the quality of its exhibits.

Several solutions were designed to help the Museum improve its exhibits. These solutions fall into the following categories: exhibit sampling, exhibit production, and exhibit maintenance. Also, all of the existing exhibit manuals were converted into digital format and consolidated to allow easy accessibility to the Exhibits Committee.

Exhibit Sampling Plan

The limited budget prevents how much can be invested into new exhibits. The budget currently allows only $8,500 for exhibits. Exhibits are managed by the Exhibits Committee. Because the budget is so small, the Committee wants to be sure that money is invested where it will be most effective, namely replacing unpopular exhibits with new ones.

In order to determine exhibit popularity, an exhibit sampling plan was developed using work sampling techniques. First, a list of all of the exhibits was created, grouped by the floor where they are located. Next, a sampling sheet was created (see Appendix B); each sheet is for use on one day of operation and includes columns for five samples. The exhibit sampling would be conducted at random times throughout the day by museum staff while they perform their regular supervisory duties. Only the number of children playing with each exhibit will be tallied; adults will not be counted. After a sample is taken, that sample column is highlighted with a marker to prevent future samples from being recorded in the wrong column.
A sampling plan of 30 days with five observations per day will give a total of 150 samples. Sampling will be performed by Museum staff members so that the samples will be randomly spread throughout the day. Sampling by the author would skew the data because the author’s schedule would only have allowed for afternoon sampling.

**Exhibit Production, Standard Operating Procedures**

Many of the exhibits were designed and produced by Cal Poly students, usually as part of multidisciplinary senior projects. The Museum often experiences maintenance or functionality problems with these exhibits, but the Museum staff does not know how to address these problems. The main source of this knowledge deficit is insufficient user documentation to allow Museum staff to service the exhibits. Also, because the exhibit producers were students, the majority of them no longer live in San Luis Obispo so the Museum cannot call them for help with the exhibit problems.

In order to prevent this information gap from occurring in the future, standard guidelines for exhibit production needed to be established. A copy of this document will be given to any individual or group who wishes to develop an exhibit for the Museum. In order to determine the content of the guidelines, interviews were conducted and the existing exhibit manuals were reviewed. Additionally, a senior Cal Poly student in the Child Development department was consulted in order to gain basic information regarding the cognitive and physical capabilities of the different age groups of the Museum’s audience.

Interviews about the exhibit guideline needs were conducted with the Museum Director, the Store Manager, and staff. The Store Manager pointed out that she never refers to the current exhibit manuals because she essentially has them memorized from looking at them so much due to frequent exhibit breakdowns. She added that the manuals themselves were not very useful because they did not address operating glitches of the exhibits which are the most common issue, and that most of her intimate knowledge of the exhibits came from hands-on, trial-and-error. The extensive time needed to perform experimental methods when no directions exist in the manuals was cited as an influencing factor on the huge wait times for repairing exhibits.

Next, all of the exhibit manuals on file were read and analyzed to determine where they were lacking. The two main areas of need were in content and professionalism. It was determined that the following content areas should be included in all user documentation:
• Start-up and Shut-down procedures
• Set-up instructions
• Maintenance instructions
• Troubleshooting guide
• Contact information
• Company information and parts numbers for reorder

While some manuals included one or two of these content areas, no manuals included all of this information.

From the above research, a standard procedure document for producing exhibits was created, called the *Guidelines for Exhibit Production* (Appendix D). These guidelines provide specific requirements on user documentation to facilitate easier use, such as color pictures and major content areas. Also, producers will be required to submit the user documentation three weeks prior to exhibit delivery so that the Museum can review the documentation to be sure it will be sufficient to support the use and maintenance of the exhibit once the producers are gone.

Another important requirement is that user documentation must include all company contact information and parts numbers necessary for reordering parts. This was highly desirable by all Museum staff, as well as the Exhibits Committee because missing this type of information is a common source of problems for maintaining current exhibits.

Professionalism was also needed in these manuals. Lack of clarity was the primary offense with acronyms and abbreviations left undefined, and with inconsistencies in part names and labeling. Several manuals seemed unedited and a few used personal pronouns. Communication in a technical document, such as a manual, must be unambiguous and direct; this ambiguity was likely a source of problem for the Museum staff because it made it difficult to understand and use the information provided in the document. Thus, professionalism specifications were included in the *Guidelines for Exhibit Production*.

The *Guidelines for Exhibit Production* were then reviewed by the head of the Exhibits Committee and the Museum Director. Both offered their feedback and adjustments to the guidelines were made as needed.
Exhibit Maintenance Tracking

Exhibit problems are not currently tracked in the Museum. There are no records of when an exhibit needs attention, how long it takes for the exhibit to be repaired, and the cost of this work. Currently there is much variability in how long it takes for an exhibit to be serviced. Exhibits with high visibility may be repaired in a week, while less visible exhibits may be out of service for months. An Exhibit Maintenance Form (see Appendix C) will be developed to track the time and money it takes to repair exhibits. The short period of time for this project did not allow for sufficient data to be collected and analyzed to determine which exhibits break down the most, the average time it takes to have exhibits repaired and how to decrease this time, the cost of repairs, and methods to improve the maintenance process. However, this records-keeping will lay the foundation for future project work.
Storage Area Organization Design

To begin the organization process, measurements of the storage room were taken and a layout diagram was created. Interviews were conducted with the Store Manager and other staff members to determine the contents of the storage room (in general terms because there many of the items are hidden in the disorganization).

![Diagram of original storage area layout](image)

Figure 3: Diagram of original storage area layout

5S Design

The steps of 5S are:

- Sort
- Set in Order
- Shine
- Standardize
- Sustain

The first step in the 5S implementation is “Sort.” Because the storage room was so overcrowded with objects, “Sort” was divided into two phases.
Phase one is a preliminary sort to eliminate trash and other easily removed items, such as lost-and-found items (which are donated to charity if they are unclaimed after a month). During this phase, similar items will be grouped together so that the overall space requirements for different item categories can be determined. The space requirements will be used in the Systematic Layout Planning (SLP), which is a process to determine the best locations for the items. The SLP will develop the system to be used in the second step of 5S, “Set in Order.”

Phase two of “Sort” will occur simultaneously with steps “Set in Order” and “Shine.” In this phase, the Museum Director, the Store manager, a staff member, and the author will take out most of the items from the Storage Area in order to rearrange the shelving as determined with SLP (see next section). Items will be sorted as they are removed from the storage area. While the Storage Area is relatively clear of items, it will be cleaned as part of “Shine.” Using the layout from SLP and putting items on the appropriate shelving will be step “Set in Order.”

Next will be “Standardize.” Clear plastic bins will be purchased for storing items so that everything will be easily identifiable. Labeling will be applied throughout the Storage Area. High visibility will prevent losing items and overstocking inventory.

The final step, “Sustain,” will be ongoing. The main test for the Museum will be whether or not staff puts items back where they belong.

**Systematic Layout Planning**

Using information from interviews, it was determined how frequently different items in the storage room were accessed. The layout diagram was then color coded to visualize frequency of use. The color code is shown in Table 3.

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Daily</td>
</tr>
<tr>
<td>Yellow</td>
<td>Weekly</td>
</tr>
<tr>
<td>Dark yellow</td>
<td>Varies, approximately weekly</td>
</tr>
<tr>
<td>Red</td>
<td>Rarely</td>
</tr>
<tr>
<td>Dark red</td>
<td>Never</td>
</tr>
</tbody>
</table>

Figure 4 shows the diagram of the original storage area layout with the color-coding applied.
The color-coding shows that there are several rarely used items blocking access to more frequently used items.

In order to generate alternative layouts for the storage area, a relationship chart was used. This chart is used to determine the necessity of having different items co-located. Each level of need is represented by a symbol, as shown in Table 4.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Need of co-location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Absolutely necessary</td>
</tr>
<tr>
<td>E</td>
<td>Especially necessary</td>
</tr>
<tr>
<td>I</td>
<td>Important</td>
</tr>
<tr>
<td>O</td>
<td>Ordinarily important</td>
</tr>
<tr>
<td>U</td>
<td>Unimportant</td>
</tr>
<tr>
<td>X</td>
<td>Undesirable</td>
</tr>
</tbody>
</table>

The relationship chart is shown in Figure 5, below.
Most relationships were scored as “unimportant,” so these items have no restrictions or preferences for their location in relation to certain items. Relationships other than “unimportant” are highlighted in the figure in red. The key relationships taken from this chart are:

- It is “absolutely necessary” to have the helium tank and birthday supplies (balloon and ribbon, pre-made birthday bags, and birthday bag supplies) co-located.
- Due to safety concerns, it is “undesirable” to have the helium tank, exhibit technology, and the cleaning supplies near each other.
- It is “ordinarily important” to have store inventory and holiday decorations co-located.

An additional restriction is that the exhibit technology, stored on the shelving behind the door (colored dark red in the color-coded diagram), cannot be moved because it must be connected to the patch panel on the wall.

After taking space requirements for the storage items into account in addition to the frequency of use and relationships of the items, two alternatives were generated. These alternatives are shown in Figures 6 and 7.
In both alternatives the “store roll-away” has been removed from the storage area. The store rollaway is a low cabinet on wheels which is usually used in the Museum store to display
merchandise on top and store inventory in the locked cabinet. Because the store does not need another roll-away, it had been put in the storage room. However, the Museum found another use for the roll-away in the Museum, so the design assumed the removal of this piece.

The safe and file cabinet remain in place because they are accessed frequently and are located near the door. The shelving unit containing store and exhibit supplies (shown in red in the diagram) has been moved next to the birthday supply shelving unit. Moving the shelving unit allows for easier access to large items that are moved frequently, namely the tables and chairs.

The major difference between the two alternatives is the location of the tables and chairs. In Alternative 1, the distance from the door to the tables and chairs is minimized, which will save time when these items must be pulled out for birthday parties. However, the chairs are somewhat difficult to access because they are located in a corner. More ergonomic access to the chairs and tables is provided in Alternative 2, but they are farther from the door.

Alternative 2 was selected because placing the chairs in the nook prevents other items from being placed back in there.
Implementation

An exciting aspect of this project is that portions of the solution were actually implemented at the Museum. The implemented solutions were the exhibit sampling, the *Guidelines for Exhibit Production*, and the organization of the storage area. These solution implementations are discussed in detail in this chapter.

Exhibits Sampling

The staff was enthusiastic about performing the sampling. How to use the sampling sheet was explained to staff members and they confirmed they understood. Their understanding was confirmed when the first exhibit sampling sheet was properly used. However, a major difficulty was encountered with executing the exhibit sampling.

The sampling clipboard, which had all the blank sampling sheets on it, was frequently lost. Upon every visit of the author to the Museum, the clipboard would have to be found and put out in view. When the clipboard was found, the sampling would be executed by staff for a day, but then the clipboard would be lost again. Because sampling was not a routine activity, most staff members suffered from an “out of sight, out of mind” mentality. Some staff members attempted to locate the clipboard but to no avail. Invariably, the clipboard would remain lost until the author visited and found it again.

The author visited the Museum weekly, sometimes biweekly. The Museum is open six days a week which means four to five opportunities for sampling were missed every week. Furthermore, it appeared that on a few days the clipboard was lost midday because the sampling sheet was not filled out in its entirety.

These unfortunate circumstances not only highlighted the chaotic working environment, but also resulted in far fewer samples being taken than originally intended. Only 13 samples were collected instead of 150.
Exhibit Production Guidelines Implementation

The Guidelines for Exhibit Production were put into use. Following her approval of the guidelines, the document was given to the head of the Exhibits Committee for distribution to a Mechanical Engineering group that is creating an exhibit for the Museum.

Storage Area Organization Implementation

Phase one of “Sort” took far more time than expected due to the amount of items in the storage area, as demonstrated by Figures 8 and 9. A significant amount of trash (such as deflated balloons from past birthday parties) and miscellaneous items were purged. Several bags of lost-and-found items were found as well; these items are supposed to be donated to charity every month, but they had been forgotten because they were lost in the storage area. All of these bags were collected and taken to a donation location. Removing the trash, unneeded objects, and the lost-and-found items helped to create more space.

Figure 8: Initial state of storage area, view 1
Figure 9: Initial state of storage area, view 2

Another helpful step in Phase one was reducing packaging. Many large boxes were only partially filled with items and some were empty. Condensing items into smaller containers and stacking empty containers helped to gain space.
Out-of-season holiday décor was moved from the storage area to an off-site storage unit the Museum rents. Only the current season’s décor will be kept on-site in the storage area in order to have sufficient room to store other items that are accessed more frequently.

The state of the storage area after Phase 1 is shown in Figures 10 and 11. The preliminary sort has taken place, leaving a cleaner, more accessible area. The storage area is ready to be rearranged based on the layout developed with SLP.

Phase two was performed after-hours with significant help from the Store Manager and the staff. This employee assistance was arranged by the Museum Director, who is enthusiastic about purging unnecessary items from the Museum. The Director also came and helped for part of the time. Her presence was invaluable for several reasons:

- Demonstrated upper management support of the implementation.
- Allowed workers to receive immediate feedback on decisions needing the Director’s approval (such as whether or not to purge an item).
- Encouraged workers with her enthusiasm.

Many items sorted during this phase were removed from the storage room to more appropriate locations. The large quantity of items that fell into this category highlighted how the storage area had become a dumping ground for anything and everything.
During the implementation, workers began to take ownership of the project. All expressed excitement when they saw how much space the storage area offered and how organized the items were.

The results of the implementation are discussed in the Results section.
Results

The results of the solution implementations are limited because the outcomes could not be observed for the necessary amount of time after the implementation. However, some initial conclusions can be drawn from the exhibit sampling and the organization of the storage area.

Exhibit Sampling Results

The conclusions that can be drawn from results of the exhibit sampling are limited by the small sample size of 13. However, because each sample observed multiple children, a total of 425 counts were observed. Another limiting factor is the presence of a travelling exhibit, a Space Station. This exhibit temporarily displaced permanent exhibits, such as the Giant Bubble. According to interviews and news publications, the Giant Bubble is a popular exhibit. Once the Space Station exhibit leaves, exhibit sampling should be repeated to quantify the Giant Bubble’s popularity and to rank it amongst the rest of the Museum’s permanent exhibits.

A Pareto Chart of the data for all the exhibits was created, shown in Figure 12. This chart is useful because it essentially ranks all the exhibits from most to least popular.

![Pareto Chart of Exhibit Use](image-url)
However, because the exhibits cater to different age groups, it is useful to stratify the data by floor. Figures 13, 14, 15, and 16 show the Pareto Charts for each of the floors.

![Pareto Chart of Exhibit Use, Floor 1 exhibits](image)

Figure 13 shows that the Space Station was the most popular exhibit on the first floor. However, as mentioned previously, the Space Station is a travelling exhibit. Perhaps its popularity was based purely on novelty, but there it could be because of the exhibit content. If the latter is true, the Museum could consider a installing a permanent space exhibit. The most popular permanent exhibit on the first floor is the Dinosaur Dig Site.

The least popular exhibits on the first floor are not listed on the chart, but fall into the “Other” category. These exhibits are the Gravity Weigh Station and the Magnetic Board; they should be the first exhibits the Exhibits Committee should consider for elimination on the first floor.

An interesting finding was made with this sampling. In several of the interviews with Museum staff, the Energy of Motion exhibit was considered the least popular exhibit. However, from Figure 13, it is evident that while Energy of Motion is low-ranking, it is not the lowest ranking. In fact, it constitutes 6% of children’s exhibit use. The quantitative data from sampling can validate or invalidate staff perceptions. In either case, the Exhibits Committee will benefit from this unbiased approach.
Next, the exhibits on floor two are examined. Top ranking exhibits include Cosmic Café, the Performance Stage, and Farmers’ Market. All of these exhibits are “role-playing” exhibits. Role-playing is considered an integral learning method for children ages 5 to 7 years, which is the target range of this floor. These exhibits seem to be meeting the needs of their audience.

Aside from the three leaders, most of the exhibits account for similar percentages of children’s use, between 3% and 8%. More data should be collected to better differentiate these exhibits’ percentage of use from one another.
Figure 15 shows that the Play Area on floor three is the most popular. Also, most of the exhibits have substantial percentages of use of 13% or more, whereas the Velcro Wall falls under 5%, indicating it is an unpopular exhibit on that floor.
Outdoors, all exhibits had significant percentages of use with no exhibit contributing less than 17%. Of note, the Playground contributes to almost half of all outdoor exhibit usage.

The results of this exhibit sampling give some interesting insight into exhibit popularity at the museum. However, it is still highly recommended that more data be collected to increase the accuracy of the study and to reflect the changes in exhibits.

**Storage Area Organization Results**

A major observation during Phase one was that there were many things put in the storage area that should not be kept there. For example, broken exhibits or exhibit pieces were put wherever room could be found. By giving everything a place, the amount of random items placed in the Storage Area should decrease.

Phase one also uncovered a lot of hidden inventory. In some cases, the item had just been reordered because it appeared that the inventory levels were low, when in fact there was a substantial stock of the item. One example was white curling ribbon used for birthday balloons. Nine spools of ribbon had just been uncovered in the storage area when a box arrived containing four spools of ribbon which had been ordered because ribbon levels were perceived...
Results

as low. At $3.50 per spool (not including shipping), the Museum now has almost $50 in ribbon inventory.

Phase two resulted in a storage area where there is a place for everything. In doing this, no room has been left for items that do not belong in the storage area. There are no longer places to stack items; items must be returned to the shelving units or their appropriate home. To some degree this design will self-enforce the maintenance of the area.

Implementation time was limited to two hours, so not everything was able to be sorted. Particularly, the exhibit technology could not be touched or tidied because the staff member with exhibit technology knowledge was not present. Overall, more work must be done, but staff members are now aware of these tasks.

Figure 17 demonstrates the amount of floor space uncovered by Phase 2 and the easy access to the folding chairs. Figure 18 shows the access to the folding chairs, as well as the tent and easels. The tent and easels must be quickly accessed because they are used for events the Museum hosts and attends.

Figure 17: State of storage area after Phase 2, view 1
Figure 18: State of storage area after Phase 2, view 2
The new location of the second shelving unit is shown in Figure 19. There is little to no space on the shelving units for stacking items that do not belong.

Consistent labeling still needs to be applied to standardize the system.
Conclusion

Due to the recent economic downturn, the Museum’s budget has been significantly reduced. The entrepreneurial Museum Director is searching for ways to cut costs and increase revenue.

The project objectives were:

- Have an organized storage area using principles of 5S.
- Determine excess inventory.
- Consolidate available exhibit information.
- Create guidelines for exhibit production to ensure high quality exhibits with sufficient user documentation.
- Perform a sampling of exhibit use in order to have a list of exhibits ranked by popularity.
- Identify areas of waste and initiate record-keeping in these areas as basis for future projects.

Some objectives were fully met while others were partially met.

- The storage area was organized, but 5S was not fully applied because the labeling and storage containers were not standardized.
- Some excess inventory was identified, but more is still likely to be found in the front office and the business offices.
- Exhibit information was consolidated and the Guidelines for Exhibit Production were completed and implemented.
- Exhibit sampling was performed, but lacked scope. Further sampling should be performed over a greater number of days.
- Certain areas of waste were identified, such as exhibit maintenance and cleaning methods. However, records-keeping was only initiated for exhibit maintenance.

This project found that applying Lean methodologies in a non-profit, service organization was effective in producing both the quantitative and qualitative benefits typically seen in traditional applications in manufacturing organizations. Yet, these benefits will be short-lived at the Museum if lean thinking is not adopted across the entire organization. Many more areas of the building would benefit from 5S implementations.
The most challenging part of this project was attempting to convert the Museum’s culture to a Lean culture. Despite staff and upper management’s involvement in the organization in the storage area, the prevailing perspective was that this was a project being done for the Museum rather than a movement that would be continued once this project is finished. But, it must be noted that the Director is committed to the continuous improvement of the Museum and will no doubt support having more projects of this nature completed by Cal Poly students. The following Future Directions section gives some suggestions of future projects the Museum can pursue.
Future Directions

This project has laid the groundwork for several future projects.

Exhibits

The *Guidelines for Exhibit Production* have already been distributed to a Cal Poly project team currently working on an exhibit for the Museum. After this exhibit is completed, the effectiveness of the Guidelines should be evaluated.

The Exhibit Maintenance Form will be used to track the time and money it takes to repair exhibits. Once sufficient data has been collected, the forms should be analyzed to determine which exhibits break down the most, the average time it takes to have exhibits repaired, the cost of repairs, and methods to improve the maintenance process. Improvements would be preventing breakdowns from occurring and decreasing the time to repair them.

The ranked list of exhibits produced by the exhibit sampling will allow the Exhibits Committee to make data-supported decisions when replacing and developing exhibits. Exhibit sampling should be repeated whenever the exhibits change, such as a new exhibit is added.

Birthdays

The price for birthday parties was recently decreased, resulting in an increase in birthday party frequency. The cost of putting on a birthday party (such as staffing, birthday bags, and decorations) should be calculated out to determine if the price is correctly set.

Most of the inventory held in the storage room is for birthday supplies. A log of birthday information (such as date and number of adults, children, and toddlers in attendance) should be collected. This data can then be analyzed to determine recommended inventory levels for birthday supplies.

Inventory

The rest of the Museum should be organized according to 5S principles. Doing so will allow all inventory to be located. The rate of inventory use should be tracked; from this, inventory reorder points can be established.
Staffing

According to some interviews with staff and from observations, it appears the Museum may be overstaffed. However, additional observations revealed that the majority of the work is performed by the Store Manager, which may be giving the illusion that there is not enough for the rest of the staff to do. A project could be done to try and evenly distribute the workload. Once this is done, it can truly be determined whether or not the Museum is overstaffed.
References and Bibliography


Appendices

Appendix A: List of Exhibits
Appendix B: Exhibit Sampling Form
Appendix C: Exhibit Maintenance Form
Appendix D: Guidelines for Exhibit Production
## Appendix A: List of Exhibits

### Exhibit List

<table>
<thead>
<tr>
<th>Floor 1</th>
<th>Floor 2</th>
<th>Floor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mock Elevator</td>
<td>Pendulum Swing</td>
<td>Velcro wall</td>
</tr>
<tr>
<td>Crystal Cave</td>
<td>Climbing Area</td>
<td>Ball drop</td>
</tr>
<tr>
<td>Earth Organ</td>
<td>Gears</td>
<td>Train set</td>
</tr>
<tr>
<td>Energy of Motion</td>
<td>Cosmic Café</td>
<td>Big Train</td>
</tr>
<tr>
<td>Claymation</td>
<td>Dalmatian Station-Fire</td>
<td>Play Area</td>
</tr>
<tr>
<td>Dinosaur Dig Site</td>
<td>Zoom Town ATM</td>
<td>Reading Nook</td>
</tr>
<tr>
<td>Magnetic Board</td>
<td>Bubble Gum Alley</td>
<td>Outside</td>
</tr>
<tr>
<td>“Shake It Up”</td>
<td>Shadow Wall</td>
<td>- Pool</td>
</tr>
<tr>
<td>PlayMotion</td>
<td>Post Office</td>
<td>- Shuric and Archimedes Screw</td>
</tr>
<tr>
<td>Giant Bubble</td>
<td>Doctor’s Office</td>
<td>- Hippo</td>
</tr>
<tr>
<td>Art Area</td>
<td>Election Booth/Ballot Box</td>
<td>- Playground</td>
</tr>
<tr>
<td>Gravity Weigh Station</td>
<td>Trolley</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Performance Stage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rocking Horse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farmers Market</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Funhouse mirror</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Police Motorcycle</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 17: List of Exhibits**
## Appendix B: Exhibit Sampling Sheet

![Exhibit Sampling Sheet](image)

**Exhibit Sampling**

<table>
<thead>
<tr>
<th>Date:</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time:</td>
<td>Time:</td>
<td>Time:</td>
<td>Time:</td>
<td>Time:</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Exhibit</th>
<th>Tally number of CHILDREN at each exhibit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mock Elevator</td>
<td></td>
</tr>
<tr>
<td>Crystal Cave</td>
<td></td>
</tr>
<tr>
<td>Energy of Motion</td>
<td></td>
</tr>
<tr>
<td>Claymation Volcano</td>
<td></td>
</tr>
<tr>
<td>Dinosaur Dig Site</td>
<td></td>
</tr>
<tr>
<td>Magnetic Board</td>
<td></td>
</tr>
<tr>
<td>Space Station</td>
<td></td>
</tr>
<tr>
<td>&quot;Shake It Up&quot; Table</td>
<td></td>
</tr>
<tr>
<td>Earth Organ</td>
<td></td>
</tr>
<tr>
<td>Gravity Weight Station</td>
<td></td>
</tr>
<tr>
<td>Pendulum Swing</td>
<td></td>
</tr>
<tr>
<td>Climbing Area</td>
<td></td>
</tr>
<tr>
<td>Comet Coaster (ball drop)</td>
<td></td>
</tr>
<tr>
<td>Gears</td>
<td></td>
</tr>
<tr>
<td>Cosmic Cafe</td>
<td></td>
</tr>
<tr>
<td>Dalmation Station</td>
<td></td>
</tr>
<tr>
<td>Zoom Town ATM</td>
<td></td>
</tr>
<tr>
<td>Bubble Gum Alley</td>
<td></td>
</tr>
<tr>
<td>Shadow Wall</td>
<td></td>
</tr>
<tr>
<td>Post Office</td>
<td></td>
</tr>
<tr>
<td>Doctor's Office</td>
<td></td>
</tr>
<tr>
<td>Election Booth/Ballot Box</td>
<td></td>
</tr>
<tr>
<td>Trolley</td>
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</tr>
<tr>
<td>Performance Stage</td>
<td></td>
</tr>
<tr>
<td>Rocking Horse</td>
<td></td>
</tr>
<tr>
<td>Farmers Market</td>
<td></td>
</tr>
<tr>
<td>Funhouse mirror</td>
<td></td>
</tr>
<tr>
<td>Police Motorcycle</td>
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</tr>
<tr>
<td>Velcro wall</td>
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</tr>
<tr>
<td>Ball drop</td>
<td></td>
</tr>
<tr>
<td>Train set</td>
<td></td>
</tr>
<tr>
<td>Big Train</td>
<td></td>
</tr>
<tr>
<td>Play area</td>
<td></td>
</tr>
<tr>
<td>Reading nook</td>
<td></td>
</tr>
<tr>
<td>Pool</td>
<td></td>
</tr>
<tr>
<td>Slinky &amp; Archimedes Screw</td>
<td></td>
</tr>
<tr>
<td>Hippo</td>
<td></td>
</tr>
<tr>
<td>Playground</td>
<td></td>
</tr>
</tbody>
</table>

**Once a sample is completed:**

Highlight the column for that sample so it isn't accidentally filled in when the next sample is taken.

Figure 18: Exhibit sampling sheet
Appendix C: Exhibit Maintenance Form

Exhibit Maintenance Form

Date: ____________ Reporting staff member ________________________

Exhibit: ________________________________________________________

Urgency Level (circle one)

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Several months</td>
<td>Less than one month</td>
<td>Less than one week</td>
</tr>
</tbody>
</table>

Describe maintenance issue:
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Did you repair the exhibit? □ Yes □ No
If no, can you repair the exhibit? □ Yes □ No

If exhibit is not repaired and staff cannot repair, refer maintenance to:
____________________________________________________________________

Additional actions to be taken (such as closing the exhibit):
____________________________________________________________________
____________________________________________________________________

Date Fixed: ____________
Cost to Museum: ____________

Figure 19: Exhibit Maintenance Form
Appendix D: *Guidelines for Exhibit Production*
# Table of Contents

<table>
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<th>Page</th>
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<tr>
<td>Exhibit</td>
<td>2</td>
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<tr>
<td>Design for age group</td>
<td>2</td>
</tr>
<tr>
<td>Delivery</td>
<td>3</td>
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<td>Documentation</td>
<td>4</td>
</tr>
<tr>
<td>Content</td>
<td>4</td>
</tr>
<tr>
<td>Professionalism</td>
<td>4</td>
</tr>
</tbody>
</table>
Introduction and Purpose

Thank you for your interest in producing an exhibit for the San Luis Obispo Children’s Museum. The Museum is a non-profit organization. Its mission is to inspire learning through play by providing a rich environment of exhibits and programs in the arts, sciences, and humanities.

This document is intended to give exhibit creators direction in their efforts and to ensure that the Museum receives what it needs to successfully use the exhibit. In addition to following these guidelines, exhibit developers should be in constant contact with the Museum managers and the Exhibits Committee of the Board of Directors.
Exhibit

This section addresses two area of consideration for the exhibit to be created. Further requirements will be specified by the Exhibits Committee.

Design for Age Group

The Museum caters to children ages 0 to 10 years old. Each floor of the Museum is intended for different age groups.

Floor 1: 8-10 years
Floor 2: 5-7 years
Floor 3: 4 years and younger

Depending on the intended location of the exhibit being developed, it must be designed to properly cater to the physical and cognitive abilities of the floor’s age group. Below is some general information regarding the capabilities of different age groups of children.

**Age group 0-2:** Limited physical capabilities, limited cognitive capabilities. They learn more about sensation and stimulation rather than learning. They need to be able to touch, hear, taste and smell, and stimulate the senses to learn through experience.

**Age group 2-4:** More cognitive capabilities should be focused on the basics, such as colors, numbers, and letters. Can do more physically at this age. Need parental supervision (this is a major concept for ZPD*). Sounds and language acquisition are important at this age. Have trouble remembering situations that they have previously learned.

*Zone of proximal development (ZPD):* the gap between what children can accomplish independently and what they can accomplish when interacting with others who are more competent. Think of this as scaffolding—the more competent acts as a scaffold to help the child get to the next level.

**Age group 4-6:** Can do more physically but are still egocentric and will not understand more complex exhibits. Appropriate to have physical exhibits, as well as practical life skills, such as the doctor’s office or grocery store so they can create schemas (a cognitive system which helps us organize and make sense of information). Have trouble remembering situations that they have previously learned.

**Age group 7-10:** More physically and cognitively advanced. Exhibits can be more academic, but still need to be exciting. They are able to problem solve at this age and are beginning to think more abstractly. It is appropriate to have more advanced exhibits to encourage parent interaction, but it is important to make the child feel smart and that they can figure things out on their own.

The above information is just a starting point; it is recommended that a person with child psychology expertise be consulted as well.
**Delivery**

All equipment used to run the exhibit (computer monitors, wires, etc.) must be contained in a single packaged unit. All items must be clearly and consistently labeled. Two printed copies of all user documentation must be included, as well a digital copy. For complete guidelines on user documents, see the following section (Documentation).

Upon delivery of the exhibit, a hands-on tutorial of how to work the exhibit must be demonstrated to the store manager and two other floor employees. Note that this orientation is meant to *supplement* the user documentation, not replace it.
Documentation

The user documentation that will be delivered with the exhibit is crucial because it is what Museum personnel will refer to when the exhibit creators are no longer available. Thus, it must be as complete and thorough as possible. This section will give requirements and guidance on creating these documents.

User documentation must be submitted to the Museum staff **3 weeks prior to exhibit delivery** so that it may be reviewed and checked for completeness. The documents will be returned in one week with comments and questions; this will allow two weeks for any necessary edits to be made.

Content

The following sections must be included:

- **Set-up Instructions.** Although the exhibit developers will perform the initial installation, the Museum staff needs to know how to set-up the exhibit in case the exhibit ever needs to be moved.
- **Start-up Instructions.** How to turn on the exhibit.
- **Shut-down Instructions.** How to turn off the exhibit.
- **Maintenance Instructions.** Explain which parts of the exhibit must be serviced, how to do so, and how frequently the service must be done. Think long-term because the Museum will (hopefully) be using the exhibit for many years.
- **Troubleshooting.** Identify any possible problems or “quirks” of the exhibit and how to fix them.

All directions should include visual aids to provide clarity. Photographs and diagrams should be clear; the document should be printed in **color.** The digital copy should be in Portable Document Format (PDF).

The following items should also be included:

- **Table of Contents.** The Museum staff members should be able to quickly and easy find the information they need.
- **Contact Information.** Contact information for all contributors (including companies who may have donated product) should be included so that the Museum knows whom to contact in the event of a problem that is not addressed in the user documentation.
- **Reorder Information.** Parts numbers and company contact information should be provided to allow the Museum to order replacement parts as necessary.

Professionalism

As a professional document, user documentation should not use personal pronouns. All acronyms and abbreviations should be clearly defined either in-text or in a glossary. Finally, be consistent in names and labels; when referring to items on exhibit equipment, use the same terminology as what is labeled on the equipment (see Delivery).