10 Forsyth Street
Northeastern University
Boston, MA 02115

October 15th, 2014

Pr. Joshua Hertz
Professor First Year Engineering
367 Snell Engineering Center
Northeastern University
Boston, MA 02115

Dear Professor Hertz,

Our Group, SySTEMs, has been able to collect and conclude the results of the Innovative Methods for Public Awareness of Complex Technical Subjects (IMPACTS) major design project. The written report of this major design project will follow this letter. We were required to create an original method of teaching a specific group of people, of our choosing, one of the STEM topics that we were familiar with. In considering our options, we had to think of cost, feasibility, longevity, impact, and experience. Ideally, a minimal or self-funding cost would yield a practical and long-term system that will continue to impact our intended audience over time.

We thought of multiple ideas and narrowed it down to the three, most unique and effective concepts to choose from. Our three final concepts were as follows, first, an interactive playground that would teach younger children mathematics. Second, a kiosk in the mall that would encourage teens and young adults to learn and improve their skills of solving equations with the incentive of coupons for correct equations. Last, a live educational street performance group located at faneuil hall. After narrowing it down based on our own opinions, peer reviews, and your reviews we were able to decide upon the interactive playground for our final choice.

We think that we successfully met the goals of the project and created a new and unique method of teaching younger children mathematics We think that the children will get much more out of learning mathematics at a playground as opposed to a normal classroom environment. Children will be able to focus on what they are doing much more when it involves hands on activities as opposed to paper and pencil in a classroom. We hope by getting children to work on these hands on activities they will find that math can actually be fun. This helps us accomplish our personal goal of sparking interest in mathematics at a younger age so that children will be encouraged to pursue the field in both education and, in the long term, even their careers. The challenges have varying difficulties so as they improve their skills they can do the more challenging problems and obstacles.

We look forward to your review of our design and results.

Sincerely,
SySTEMs

Michael Scott
Laura O'Donnell
Savannah Page
Jessica Yin

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Needs Assessment

We were given the task of designing a new way of teaching a specific STEM concept to a group of people of our choosing. We had a few specifications to work with, we needed a group of people who wasn’t familiar or needed improvement on the topic we picked. We had to pick Science, Engineering, Mathematics, or Technology topic that we are very familiar with to teach. Aside from this it was also suggested that we consider the cost and funding required to complete the project, as well feasibility, impact, and longevity.

Based on these specifications and requirements we were able to ask ourselves a few questions as a prelude to our actual design plan. The two general questions we asked are as follows:

- “Who would we like to introduce STEM ideas to and who would it have the biggest impact on?”
- “What would we be the most comfortable with teaching from the STEM topics?”

With these general questions we further analysed them and came up with a specific question:

- “What is the best way to apply our knowledge from these fields to designing something that will teach them to children in a new and interesting way to have a lasting impact on them?”

By answering these questions we were able to further expand our ideas into our Why? Why? statement and a problem formulation.

Problem Formulation

The first thing we needed was a problem statement which we were able to create by answering our more general questions. We decided that we wanted to introduce our ideas to children because they are the most open minded and willing to learn. We also chose children because we figured that if a children finds interest at an early age it will have a stronger impact on them so they will be more likely to pursue that subject in school and eventually in their careers. We also found that the two STEM topics we were most comfortable teaching to children were mathematics. Another reason for picking mathematics was the generally disinterest among children, which with the help of a creative tool, we could change. With these answers we were able to form our problem statement:

We need to design an interactive structure that will teach children math, and by doing this they will hopefully find an interest in these fields and later pursue them in school and as a career.

Based on our problem statement and the final question of our needs assessment we began to go more in depth into the problem formulation. We came up with our three best ideas before narrowing it down to one. Our first idea was to design an interactive pathway or playground that would teach children mathematics in a hands on way. Our second idea was an interactive kiosk in a mall that would be used to teach teens mathematics and algebra equations of varying difficulties with the incentive of coupons for correct answers. The third idea was to have college students run an interactive street performance in which they will perform a physics lab in a city location for children to watch and help with. First we ruled out the kiosk based on some helpful peer reviews that stated it might reward those who are naturally smarter instead of actually helping the children learn the topics. Next we got rid of the interactive street performers because it required a lot more maintenance and we didn't think that it would have nearly as big an impact on the children as the playground, Mathways.

Design Goals

Once we picked this we came up with some design goals and specifications that would make it the most feasible and successful design that it could be. We want Mathways to be located by a playground along the Charles River, where many children walk with their families each year. The math problems will be fairly simple so that younger children would be able to solve them. We need to create a way that the children will know how to finish the course based on getting the correct answers to each problem. Also we want children to actually be interested in it so we need to find a way to make the concepts entertaining for them.

Some examples of challenges that we want to design and include in the course are as follows. First we want to have small descriptions or hints before each challenge indicating what the children need to do in order to successfully complete each challenge. One object would be a geometry base puzzle that creates a set of stairs to climb. Another idea is that the children would have to follow a path made of numbers in the fibonacci sequence, the hint would be to add the number you're on with the number that comes before it and follow the path of that number. We want to keep it safe so we plan on having a soft surface and nothing will be built too high incase children fall. We also need to consider how large we will make it because it could be difficult getting a large amount of property from the city.

Abstraction/Synthesis

Before this final project was disclosed, members of our team were told to rapidly think of groups of people and places we would not associate with learning STEM related topics. We were also asked to quickly list a variety of STEM topics. At a later date, after we were given guidelines for this project, we put these various lists together, mixing and matching different phrases to create scenarios like "chefs" waiting at a "bus stop" observing a "Newton's Laws of Physics" advertisement. Needless to say, some were more practical than others. We chose three options based on their feasibility and expected overall impact: a playground for elementary school age children that incorporates laws of physics, a mall kiosk that gives coupons to shoppers who correctly answer highschool level STEM-related questions, and a physics fair to be held in a public space that showcases experiments to tourists and locals alike.

To further expand upon our ideas, we focused on the target audience groups for each of the projects. We expected children to be disenchanted with a playground that forced physics concepts on them if they could play with each part without learning anything. Thus, we took the activities and located them along a pathway, making it seem like an obstacle course with getting through the all of the challenges as the incentive. Along the way, we also realized math-related topics were more suited for the course. For the kiosk, we wanted to broaden the age range of our audience, as shoppers vary anywhere from 13 to 20+ years old. In doing so, we proposed there be different levels of difficulties, with better coupons rewarded to harder questions. For the final idea, we thought asking local undergraduate/graduate STEM students to volunteer for showcasing their experiments would be a science fair-esque form of public entertainment. We would organize multiple events, such that in each event, all the showcases would be of one topic, therefore exposing passersby to a rather quick and fun way of learning the “STEM topic of the day.”

Analyses of Alternatives

As is stated above, Mathways was not our groups only idea. There were several others which did not make it past the preliminary stages of planning. The basic idea of our street performer plan is a performance in which Northeastern students, preferably in the engineering or sciences department, would lead a street performance which focuses on STEM topics in a hands-on way. Ideally, they would perform in an area such as Quincy market, or somewhere similarly well traveled, where they could easily draw in a crowd. These experiments would be similar to those shown in the popular children's television show, *Zoom*, which incorporates learning with fun and safe ideas that children can often times try again at home after they see the show. This idea did not surpass Mathways in feasibility due to several factors. It was brought to our attention that visibility could be a major issue, as the older children could block the younger and shorter ones, which the show is geared towards, in an outdoor setting. Additionally, finding willing performers would be difficult, and there would have to be some sort of training process incorporating the experiment ideas and showmanship, which is stereotypically difficult for people in the necessary fields of study. Finally, prototyping would have been difficult with this idea, as it is more of a show than a physical object. Overall, the negative points failed to surpass the positive ones, and the idea was scrapped.

The kiosk, with a coupon reward, was to be placed in the Prudential Center and teach STEM topics in exchange for coupons. The main selling point of this idea was that people would be likely to utilize this kiosk due to the promise of a tangible reward. People would answer questions on a screen related to math or science, and if they provide the correct answer, they receive a coupon to a store in the mall. With increasing difficulty levels, the coupons would become higher in value, or could be presented to more in demand stores. If the question is answered incorrectly, a tutorial would play demonstrating the proper way to answer that question and the user could attempt to answer it again with their additional knowledge. Stores would likely contribute coupons for free to increase public relations, which means obtaining the reward would be relatively simple. The concern was raised in our feedback that people could cheat, utilizing other people or technology to obtain the necessary information without actually understanding the content. The most troubling concern, however, was the fact that this type of product would be rewarding those who are naturally smarter, or came from a better schooling background. Those who already knew all the answers could overpower the machines, while the people who have not yet learned these concepts and who the machines are geared towards might sit at the sidelines, too embarrassed to get an answer wrong.

As far as our chosen design, Mathways, we kept it fairly similar from start to finish. One of the major changes was that we decided to make the Mathway into a maze, rather than a normal path, so children would be more inclined to actually solve the problems rather than utilizing a guess and check method. This would also add an element of accomplishment when they reach the reward, a tire swing, at the end, because this means they have successfully completed all the math puzzles. The other major change was the addition of various levels to each obstacle, in an attempt to appeal to and challenge all the ages that are included in the specified audience. We wanted to include a wide enough age range so that many people can get use out of the Mathway, but children on opposite ends of our age spectrum, which is 6-11 year olds, have widely varying degrees of competence in math. For this reason, we implemented levels at every obstacle along the Mathway, providing a challenge for all ages indicated in our audience. The levels either consist of different problems, or a hint for the younger children which the older children do not receive.

Design Description

Mathways will consist of four obstacle or maze type elements followed by a tire swing reward at the finish. Children must utilize math to solve the puzzles and move forward on the Mathway. Instructions will be provided, along with basic explanations of the math principles needed in each obstacle, in plaques on the ground in front of the obstacles.

The first obstacle is a wall the child needs to traverse in order to move further in the course. To do this, they must assemble a small staircase from several three dimensional geometric blocks. After they successfully complete the stair jumble, they must reset the stage, which will hopefully teach them about cleaning up after themselves.

The children then move on to the part of the maze entitled “Figure Out the Mattern”. This is a mat with many colorful squares, each containing a number which children can stand on. To move on, they must discover that the pattern they should follow is the Fibonacci sequence and then follow that from 1 to 21. In the easier version, the children are told what the pattern is, and must focus on addition as opposed to pattern solving, as they are not yet skilled enough at math to determine patterns with very little initial information.

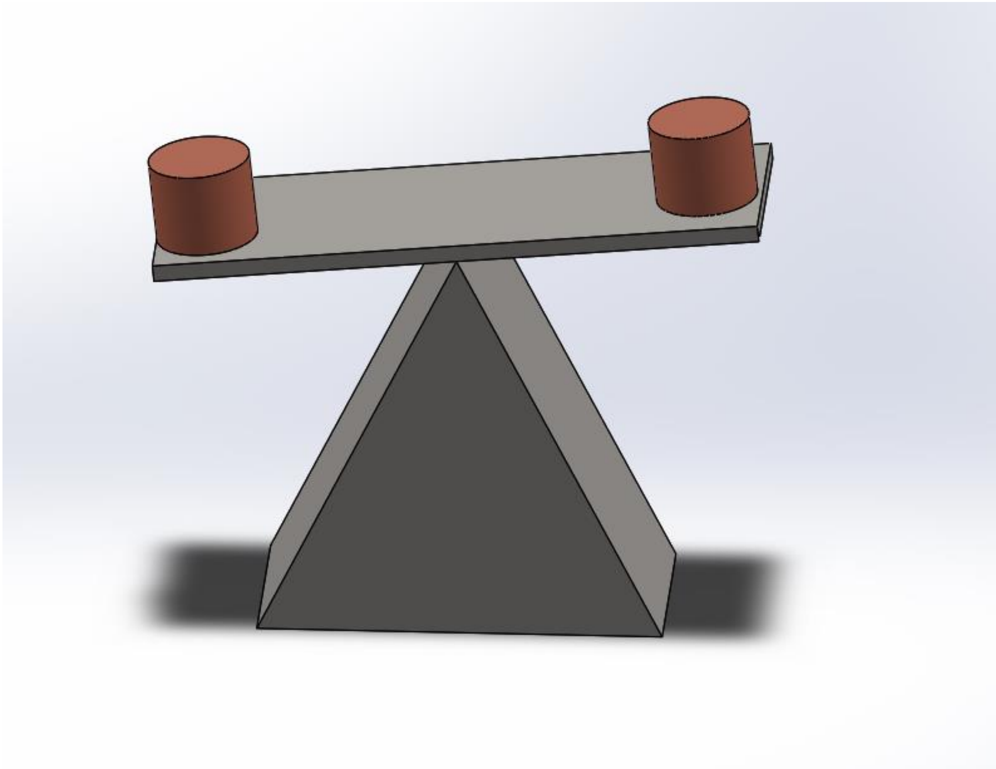
Following “Figure Out the Mattern” is another maze element. This is play structure in which there are several points of divergence. At these point, the children must choose either to go up or down based on the solution to a math equation which will be placed throughout the course at points where the path splits. If the answer is an odd number, the child will go up, and if the answer is even they must go down. If the get the answer incorrect, then they will reach the end of a blocked off tube and must retreat and retry the problem. We took into account the wide range of mathematical abilities in the age range specified, and therefore created three difficulties of math problems. The easiest will consist of very basic addition functions, the middle will also incorporate multiplication and division, and the hardest will combine multiple functions and order of operations topics in one equation. This climbing obstacle will consist of platforms, ramps, tubes to climb through, and slides, which will keep the children entertained through the entire obstacle. The thought of making their way through without mistakes will also encourage them to solve out the math equations.

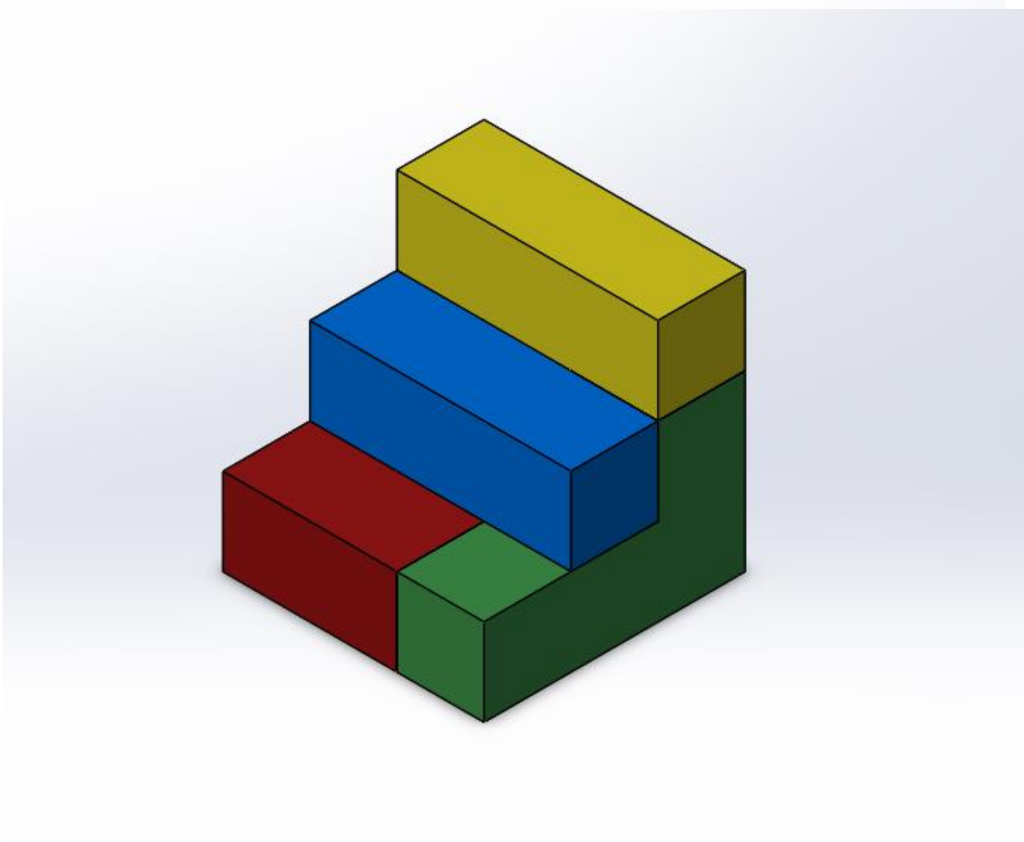
The final element of our Mathway is called “Scale Skills”. This is a cause and effect based obstacle which aims to show inequalities to children in an interactive way. There will be three scales in this section, with weights that can be placed on the scales. The goal is to balance all three scales, which requires additional skills as well as the ability to set equations equal to each other. For the younger children, the first scale will only have integers. Following this scale, there is an increase in difficulty as the weights are then marked with fractions and on the final scale, decimals. This element is designed in a way in which the more difficult scales can be skipped if the children do not yet have a working understanding of fractions or decimals. Additionally, due to the multitude of scales, children can race each other in an attempt to balance their scale more quickly than their friends or siblings, adding the fun of competition to the mix.

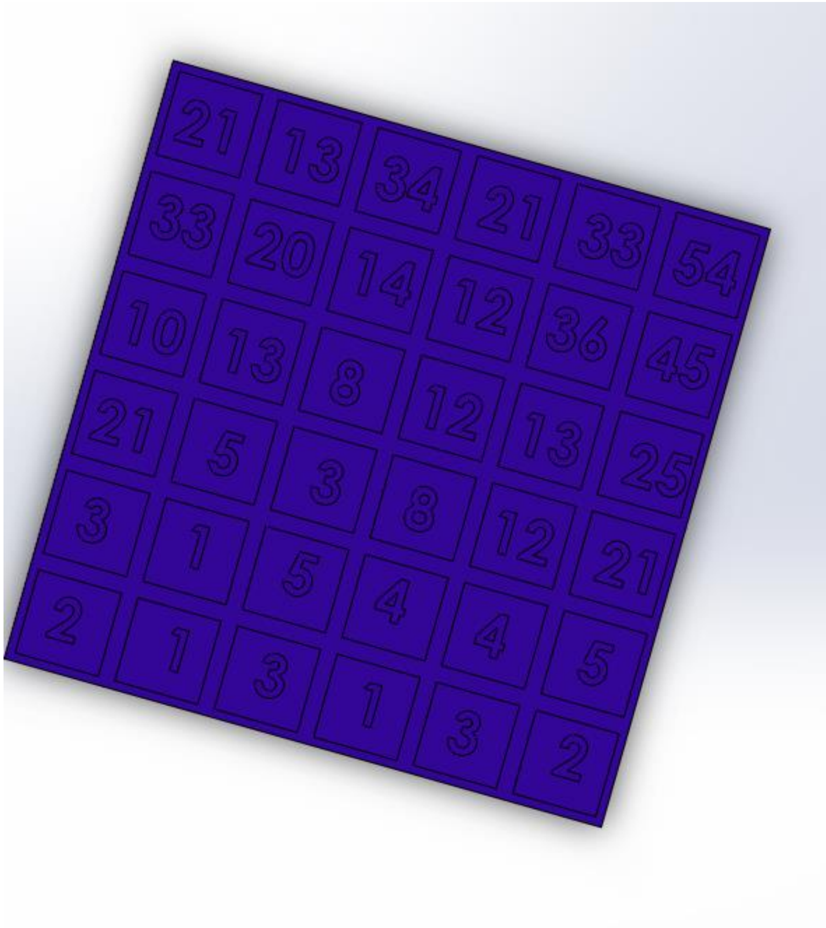
At the close of the course, following the successful completion of the four obstacles, the children are treated to a playground structure widely regarded as superior to most others: The tire swing. This tire swing will also have a simple math element, although it will not involve any sort of solving or active learning. Still, the tire swing does have a math feature to it, as there will be circles drawn on a mat underneath the tire swing, which will have measurements to show the circumference, radians, and area of the circles which the children will swing around. This is another attempt at teaching children geometry, and teaching through cause and event. The children will learn that a harder push off will lead to a larger circumference and area. This marks the end of the Mathway.

SolidWorks

The interactive features as well as the Mathway itself have been created on SolidWorks. Each structure and component has been constructed to the proper size. Each feature also has been constructed out of the proper material, described in the budgeting portion of this report. The following are screenshots of the interactive pieces of the Mathway. The number of the features shown in SolidWorks varies from our Mathway slightly, for example the shown ArithMAZING structure will actually be doubled in our design. The SolidWorks Assemblies will be submitted with this report in the form of zip files on blackboard.



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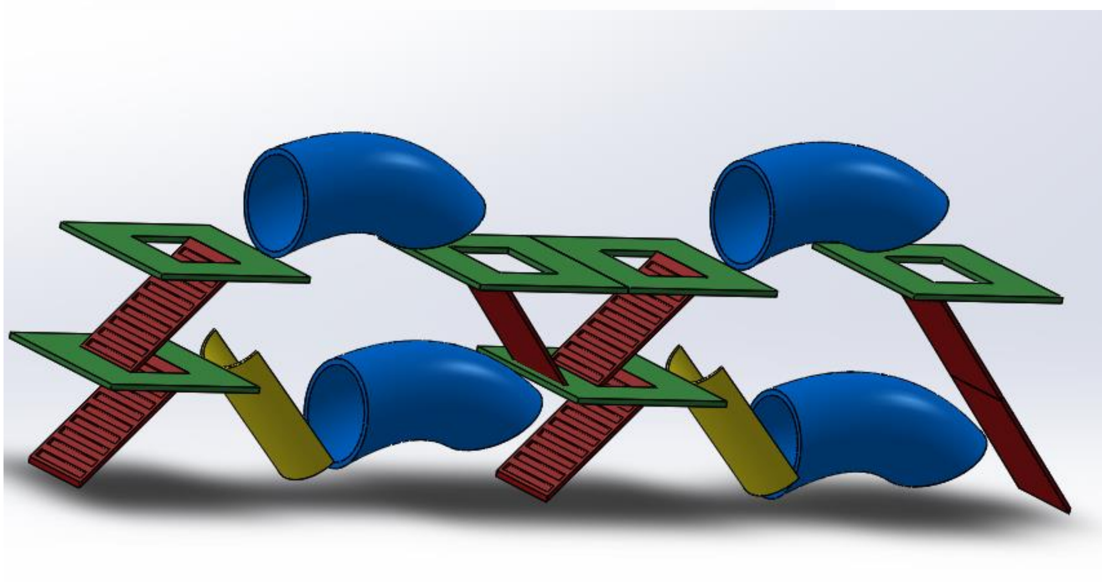
10 13 8 12 13 25
21 5 3 8 12 21
3 1 5 4 4 5
2 1 3 1 3 2



Testing and Selection

While reading our peers' feedback, one of the major concerns we encountered was safety. We invested a lot of time in finding an ideal plastic to use for our playground materials, and discovered low-density polyethylene (LDPE) plastic. In comparison to high density polyethylene (HDPE) plastic at $58 per 24"x48"x1/2" sheet, and polyethylene terephthalate (PET) at $110 per 24"x48"x.236" sheet, which are two plastics most commonly involved with food packaging, LDPE was the safest and most cost-effective option. Although upgrading plastics to either HDPE or PET is an option, it is unnecessary because children will not be consuming things that have come into contact with the playground equipment in quantities that could harm them. LDPE has also been proven safe and does not leach any carcinogens or hormone-disrupting chemicals. It is durable, but also breakable. Hence, we sought to use ½ inch thick sheets all around to prevent any breakages that could lead to falls and cuts.

Our other major safety precaution was rubber mulch. We did some research to figure out the boundary that had to be set around obstacles in order to meet safety standards, and found out that loose filling compresses by 25% in height over time due to weathering and usage, with rubber mulch as the only exception. Due to this durability, we decided rubber mulch was the best option, as woodchips could lead to splinters as young children fall quite often and quite hard, and rubber mats were too hard a surface to fall on. We also wanted to minimize upkeeping fees associated with the park, as we already require one supervisor to make sure all loose pieces are locked up at night and restored in the morning. We then calculated our projected mulch requirement on the assumption that we would extend 2 feet outwards from any equipment/material, with the exception of the tire swing which has an even wider boundary, to provide ample space for tripping.

With safety as our primary goal, SySTEMs made every effort in selecting high quality materials to provide the community's children.

Operational Description

If implemented in real life Mathway would be approved by the city and construction would begin in the early spring, weather permitting. While being constructed we would reach out to organizations like the Children's Museum and Math Works Boston for donations to offset the costs, as well as to advertise the park. Once construction is complete, Mathway will be openned to the public, ready to teach the children of Boston.

The participants of Mathway will begin their experience a few hundred feet from a parking lot, thereby providing easy access to the activities. Children would be encouraged to travel along the path with parental supervision, allowing the adults to enjoy a walk along the river during and after the time their children complete the activities. Families that have headed to the Charles to exercise will still be able to do so while having a new attraction for children. The Mathway will draw the attention of the children and lead them through the mathematical principles in a fun way. The pathway will be able to successfully teach math skills to the children who would not generally be exposed to them through a concept familiar to nearly all children; fun. Users of the Mathway will leave satisfied with new found knowledge to implement. The park will gain popularity as parents and children share it with their friends and families.

In the first few months of operation we will ask for feedback from parents and children to see what can be approved upon. We will also reach out to local elementary schools to see if the Mathway has sparked any interest amongst the students. When winter rolls around and the Mathway use slows down, we will hold a redesign session in which we review the feedback and work on improving the path. We have already considered some possible improvements for the Mathway. Some activities only have one set of equipment. If there are multiple people at one station, teamwork is encouraged. For activities in which limited equipment could cause crowding issues, such as the Mattern, we could lay out a few different mats, thereby not only allowing for more simultaneous traffic, but also for more experiences for one child if he or she were to go through the Mathway multiple times. Also if a child visits the Mathway multiple times we want them to continue learning as opposed to simply memorizing how to successfully navigate it. To prevent this we could change the equations or instructions every month or so to keep the regulars interested and challenged. These are hopefully just some of many design improvements that we can make in the early spring of 2016 to make the Mathway as fun and educational as possible.

As for the daily use of the Mathway, we suspect heavy traffic on weekdays after school around 2PM to about 6 or 8PM, depending on the season. After 8PM, as most children of our target audience will be at home by that hour, there will be one park supervisor who is in charge of taking loose pieces (blocks of Jumbled, weights for Scale Skills, ie) and lock them up in an on-site shed. They will also be responsible for checking for any damages. If damages are found the park attendant will contact the SySTEMs office to report what has gone wrong. We will send a maintenance worker out immediately to repair the Mathway. We will also send a worker out every month to inspect the safety of the structures. In the morning the park supervisor will put the pieces back out onto their respective areas for the use of the children.

If implemented correctly, of Mathway will achieve our goal of teaching children math concepts through an interactive playground. We will have sparked an interest in mathematics where it typically is not found, hopefully created a bright future for the elementary students of Boston. If our Mathway is successful, we will hopefully see an increase in math scores and classes throughout the city. We will then consider expanding, to create more Mathways across the city or possibly state. With the success and popularity of our initial Mathway we will receive much more funding to provide even more learning opportunities. In the future the SySTEMs team could be able to teach other STEM topics through fun. We hope our will teach many the subjects that are so under-available to the general public and impact many.

Budget

In order to create our Mathway we would need to buy the proper materials as well as pay for construction. For this we created a budget to account for all possible spending including preparation, materials, and labor. The first thing to consider in a budget would be for the land being used. Since we have chosen a walkway along the Charles River as our location it fall into the jurisdiction of Boston Public Works. There is an application process to construct in, on, or above a public walk way, as shown in the application below. This would require a small fee, which varies depending on the project, and we would not have to purchase the land it’s being built on, saving a great deal of money. The next step would be to prepare the land for construction through clearing and grading the park. This process costs roughly $1,800 per acre. Our total area that needs to be cleared comes up to less than a tenth of an acre. We rounded to a fifth of an acre, leaving us with roughly $360 of work. The cost for foundation is roughly $2.35 per square yard. Our Mathway requires roughly 82 square yards of foundation, making the cost $193.

The next portion of our budget is the cost of materials. In order to find the proper materials to use, we researched the various structures and components commonly used in playgrounds. The most common material in play structures today is a particular plastic, low density polyethylene. It is sturdy, weather resistant and comes in a variety of colors. The average price for such plastic is $3-8, depending on the color, when bought in quantities of 500 kilograms. 500 kilograms of low density polyethylene equals roughly .53 cubic meters. This plastic will be used for the ArithMAZING structure as well as for the Jumbled Up stair puzzle pieces, which comes out to 3.5 square meters. This requires 7 quantities of 500 Kilograms of polyethylene, for a total of between $10500 and $28000 depending on the colors chosen. To ensure the safety of those using our Mathway we plan to surround the structures with a cushioning material typically used in playgrounds, rubber mulch. This would also be used in our Fibonnaci mat. Rubber Mulch is a soft material made primarily from recycled tires, priced at $5.49 per square foot. With roughly 740 square feet that needs to be covered, the price would be $4,100. The Scales Skills component would require 3 large balance scales with sets of weights made from aluminum. Needing only 13 square feet of aluminum, the total price would be $70 plus roughly $500 for the specialized construction of the scales. For support in our structures we would need 276 feet of 3 inch diameter steel bars. Since these pipes are typically sold in 20 foot long sections, our ArielthMAZING structure would require 14 20 foot pipes. The pricing for 14 sections of this pipe would come out to $1,940. In order to store all of the removable parts, such as the stair pieces and the weights, we would need a small shed shed. An 8 by 3 foot shed that would work for such storage would only cost $410. The final component we would need in our Mathway is the tire swing which comes pre made at $3,000 dollars.

Next we have to consider construction costs and maintenance of the path way. Because the Mathway would be located in Herter Park, a public park in Boston, any everyday maintenance, such as locking up and checking for damages, can be included in the park attendants duties. Should there be any major damage the attendant should contact SySTEMs managers to get the proper repairs in order. For the construction of the Mathway itself we plan to hire a team of 5 construction workers. The project would take an estimated 2 weeks to finish with 8 hour work shifts per day per 5 day work week. The average wage for a construction worker is currently $15. This leaves the total cost of labor at $6,000 for the project. The complete budget including the preparation, materials and labor could range depending on the materials chosen from $28,100 to $46,000.

Results and Reflections

Looking back at our project, we would do several things differently if we had additional time. Considering we did not have to create a prototype and therefore had nothing to build, idea production would have been where our changes would be made. We like our idea as a whole, but there are so many small details, some of which we did not have time to address. One of these details we would have liked to refine is the scale obstacle. We could not figure out how to make it an effective way where it would utilize the maze concept. Currently, there is nothing stopping children from passing through this obstacle completely. The hope is the shiny weights will attract the children and encourage them to complete the scale portion of the Mathway before moving onto the tire swing.

Another portion of the Mathway which we did not have time or means to completely think through was the blocked off tubes in the climbing structure. Right now, we only have a sign with instructions indicating that only one child should be on each platform at a time, but we still run the risk of multiple children being in a blocked off tube at once, which could potentially be unsafe. We were hoping to include some sort of opening on the side of the low to the ground tubes, which would be right after the slide, meaning children would more likely enter the tube at an overly fast speed.The upper tube would be a pretty simple turn around and children would not get hurt on this upper ground. We did not have time to complete a Solidworks drawing including ways to escape the tubes, but even if we did we feel there is a more efficient way to keep the children safe.

Finally, making instructions for each obstacle is something we did not remember to do before the presentation. It would not have been very beneficial, but it may have made the project a little clearer to those we were presenting to. Also, a lot of small details, such as instructions to clean up after the children do their work, were to be included in the instructions. It would have been more convenient to have all those small details in one place, but again, this was not essential.

Other than these small points, our group is pleased with our design idea. We created a good learning environment for children in a relatively wide age range, especially in terms of how much math they have learned in school. Besides this, we learned exactly what goes into the making of a playground, and sorted through many failed obstacle ideas, discovering the importance of brainstorming and the constant possibility of failure and need for iteration. We believe the Mathway is innovative and will be widely used due to its entertaining nature. We also believe we combined three important areas of life for every child of this age: learning, fun, and being active. Our Mathway has many different individual parts to it, ensuring multiple challenges for the children and a lot of fun to be had. The Mathway would be an excellent community project which would educate children about and reinforce the basic principles of math.

Calculations - Preparation + Labor

Clearing: $1,800 per Acre

Area: $105{,}712 in^2 \cdot \frac{1 in}{12 ft} \cdot \frac{1 in}{12 ft} = 734 ft^2 = 740 ft^2$

$740 ft^2 \cdot \frac{1 acre}{43560 ft^2} = .02 acre < 1/10 acre$

Round to 1/5 for addition clearing

$1800 · 1/5 acre = **$360**

Foundation: $2.35 perd yd^2

Area = $740 ft^2 \cdot \frac{1 yd}{3 ft} \cdot \frac{1 yd}{3 ft} \approx 82 yd^2$

$82 yd^2 \cdot 2.35\ \$/yd^2$ = **$193**

Labor: $17 per hour

Workers needed: 5

Work days: 2 weeks = 10 work days

8 hr/shift · 10 shifts = 80 hours

80 hr/worker · 5 workers =

400 hr · 17 $/hr = **$6,000**

Calculations - Materials

Low Density Polyethylene: \$3-8 per Kg
Buy in quantities of 500 kg.
How many cubic meters per 500 kg?

mass: 500 kg $\cdot \frac{1000g}{1kg}$ = 500,000 g
$\rho = mv$ $\rho = .94\ g/cm^3$
$.94 = 500{,}000g / x\ cm^3$ $x = 531{,}914\ cm$
volume = $531{,}914\ cm^3 \cdot \frac{1m}{100cm}\frac{1m}{100cm}\frac{1m}{100cm}$ = $.532\ m^3$ in 500 kg

Ammount need for project: $2 \cdot 100{,}932\ in^3 \cdot \frac{1\ m^3}{1.638 \cdot 10^5\ in^3}$ =
$2 \cdot 1.65\ m^3 = 3.3\ m^3$ $3.3 / .532 = 6.6$ quantities of 500 kg rounded to 7
7 units $\cdot$ 500 kg/unit $\cdot$ \$3 per kg
7 units $\cdot$ 500 kg/unit $\cdot$ 8 \$/kg

\$10,500 - \$28,000

Rubber Mulch: \$5.49 per square foot

SolidWork are = $106560\ in^2 \cdot \frac{1ft}{12in} \frac{1ft}{12in} = 740 ft^2$

$740 \cdot \$5.49$ = **\$4100**

Steel: \$138.50 per 20 ft by 3in pipe.
Solid Works amount: 276 ft
$276 ft \cdot \frac{1 unit}{20 ft}$ = 14 units

14 units $\cdot$ 138.50 = **\$4,100**

Aluminum: \$5.35 per ft^2
13 ft $\cdot$ 5.35 \$/ft = \$70
\$70 + \$500 Labor = **\$570**

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"Sheds." *Arrow 8ft. W X 35in. D Steel Tool Shed*. Web. 6 Dec. 2014. <http://www.wayfair.com/Arrow-8ft.-W-x-35in.-D-Steel-Tool-Shed-GS83-L510-K~NK1065.html?refid=GX50899360500-NK1065&device=c&ptid=75696421620&gclid=CNW6lfyPsMICFSdn7Aodc1UAPQ>.

City of Boston

Public Works Department
Permits Division
Room 714 Boston City Hall
Boston MA, 02201
(617) 635-4910

Application for Projection Permit, In, On, or Over the Public Way

Date: 12/4/14

The Commissioner of Public Works:

The undersigned hereby applies for a permit to erect, replace or alter the following structure.

- ☐ Illuminated Sign
- ☐ Plain Sign
- ☐ Awning
- ☐ Reflectors
- ☐ Marquee
- ☐ Permanent Awning
- ☐ Canopy
- ☐ Barrier
- ☒ Miscellaneous

1. Location of Projection: Herter Park
2. Applicant's Name: SySTEMs
3. Name of Contractor: Build It Address: Huntington Ave
4. Name of Property Owner: City of Boston Address: ______
5. ☒ To Erect ☐ To Replace ☐ Other Changes
6. Size

Projection 3ft	Horizontal 3ft	Vertical 3ft	HLP ______
Projection 6ft	Horizontal 6ft	Vertical 1/6 ft	HLP ______
Projection 7ft	Horizontal 60 [illegible] ft	Vertical 8ft	HLP ______

6. Size: Projection ______ Horizontal ______ Vertical ______ H.I.P ______
7. Material of Sign: Frame Steele Face LDPE Supports ______
8. Are there any other encroachments on this property? ☐Yes ☒No If so, how many ______
9. Existing encroachment to be removed? ☐ Yes ☒ No When? ______
10. Colors of Sign: Primary Colors
11. Wording on Sign: Mathways

Submit with application: (1.) Photograph (2.) Appropriate Sketch in duplicate (8.5 x 11)

Note: all encroachments will be considered temporary and will be removed when ordered to do so by this Department. No work to be started until permit is obtained.

It is expressly understood that should the city cutback the sidewalks, all projections will have to be remodeled to conform to the regulation requiring that no projection shall extend to a point less than 18 inches from the face of the curb.

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Property owner's signature

[signature]

Home address

10 Forsyth St. Boston MA 02115

I hereby certify that the dimensions an other information on this application and plans or sketch submitted herewith are correct, and that all provisions of the laws of the state, and the ordinances of the City of Boston will be complied with.

Approved:

Fee $ 50.00

Signed [signature]

Home Address 10 Forsyth St. Boston MA

Chairman: Public Improvement Commission

Group Memebrs	Mike	Jess	Laura	Savannah
Brainstroming	0.5	0.5	0.5	0.5
Project Proposal	0.25		0.25	0.5
Preliminary Report: Names	0.05			
Preliminary Report: Introduction		0.25		
Preliminary Report: Needs assessment	0.75			
Preliminary Report: Analysis			1	1
Preliminary Report: Gantt Chart		0.75		
Preliminary Presentation			1	1
Final Report: Cover Letter & Table of Contents	0.75			
Final Report: Needs Assesment	0.5			
Final Report: Problem Formulation	1			
Final Report: Abstraction/ Synthesis		0.5		
Final Report: Analyses of Alternatives			2	
Final Report: Design Description			1.5	
Final Report: SolidWorks Drawings				4
Final Report: Testing and Selection		0.75		
Final Report: Operational Description		0.25		0.75
Final Report: Budget				1.75
Final Report: Results and Reflections			0.5	
Final Report: Calculations				0.25
Final Report: Works Cited				0.25
Final Report: Appendices				0.25
Final Report: Editting	0.25	0.25		0.25
Final Presentation	3	3	3	1.5
Total Time Spent in Hours	7.05	6.25	9.75	12