The Magic ATM

by

August Brower
Amber Iraeta
Jason Sy

Project Advisor: Dr. Lou Rosenberg

Instructor's Comments:

Instructor's Grade: _____

Date: _____

The Magic ATM

by

August Brower
Amber Iraeta
Jason Sy

Mechanical Engineering Department

California Polytechnic State University

San Luis Obispo

2009

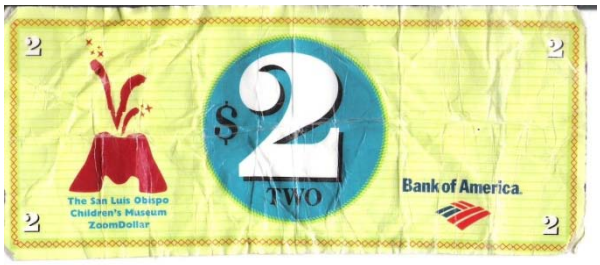
Statement of Disclaimer

Since this project is a result of a class assignment, it has been graded and accepted as fulfillment of the course requirements. Acceptance does not imply technical accuracy or reliability. Any use of information in this report is done at the risk of the user. These risks may include catastrophic failure of the device or infringement of patent or copyright laws. California Polytechnic State University at San Luis Obispo and its staff cannot be held liable for any use or misuse of the project.

Introduction

The SLO Children's Museum is a facility designed and built for children. According to the museum's mission statement, the museum inspires learning through play. One exhibit that inspires learning is the fictional town of Zoomtown. Zoomtown consists of essential town elements such as a doctor's office, diner, farmer's market, and a fire station which encourage children to use their imagination to run the town.

Since goods and services are exchanged in the various establishments, Zoomtown uses a fake currency called the Zoomdollar, which children use with other children throughout Zoomtown. Currently, the Zoomdollars are distributed in the various cash registers throughout the town, but there is no way children can retrieve their own Zoomdollars to spend without finding them in the various cash drawers. The need for an ATM in the town is apparent.



The magic ATM project will serve the vital function of not only distributing money to children, but also to teach children about fiscal responsibility. There are three options for money distribution. One of which consists of individual bills being dispensed by their denomination. The second is to dispense multiple denominations out of one dispenser. The third is to only dispense one denomination like a real ATM. The multiple dispenser option poses the most potential problems. It also will incur the greatest cost due to the fact that the bill dispenser has the highest probability of being the most expensive component.

Providing an ATM for the SLO Children's Museum will boost the realism of Zoomtown allowing children to interact and learn in a playful environment.

Table of Contents

Project Background

The San Luis Children's Museum has received grant money to help kids explore the use of money. Currently the museum uses play money in several locations, including the Farmer's Market and Diner in Zoomtown. While these exhibits allow the children to role play with money, there is nothing to let them explore money management and banking. By installing a kid's ATM, children will be able to integrate these additional building blocks into their dramatic play.

Several other museums have money exhibits, most notably OMSI in Portland, OR. Their Moneyville exhibit goes into more depth than the SLOCM's money play, but it provides a good rubric to base the Magic ATM on. There are some off-the-shelf children's ATM products, but all are modeled as a piggy bank, and will not work for multiple users. Existing ATMs are prohibitively expensive, and would most likely require extensive software modifications to be able to work in a museum environment, as well as not being engaging to the children. The use of an off-the-shelf cash dispenser is an option, but it would have to be "dressed up" to be interesting to children.

The real challenge is designing an extremely durable ATM that is engaging to children from 5-9 years old, which covers a broad developmental range. The problem of making intuitive human interfaces for children has been examined by children's electronics companies, with such products as the LeapPad®. Several studies have been funded by large companies like Toshiba® and Sony®.

Project Objectives

The Magic ATM will be an educational exhibit used by young children aged 5-12. It will be an interactive experience for children visiting the SLO Children's museum. The exhibit will introduce children to the world of banking while providing entertainment and requiring active participation. Below is a list of design objectives by order of importance.

Table 1: Magic ATM Design Objectives

Objective #	Objective
1	Children's Safety
2	Durability
3	Fun for Kids Age 5-12
4	Maintainability
5	Dispenses Money
6	Educational
7	Zoomtown Themed
8	Enticing Visuals
9	Subdued Audio
10	Age appropriate

Design specifications were developed through brainstorming the problem, analyzing the potential user profile, and cross referencing design objectives. Below is a list of the formal design specifications.

Table 2: Magic ATM Formal Engineering Requirements

Spec. #	Parameter Description	Requirement or Target (units)	Tolerance	Risk	Compliance Analysis (A) Test (T) Similarity to Existing Designs (S) Inspection (I) Feedback (F)
1	Error Free Operation	1 Week	Min	H	A, T
2	Fun and Entertainment	yes	Max	H	F
3	Size	43 x 28 in	.5 in	M	I, A, T
4	Emergency Exit Obstruction	none	Min	H	I, A, T
5	Simple User Interface	yes	Max	M	I, T, F
6	Money Dispersion	1 Day	Min	M	I, A, T
7	Video Screen	yes	Max	L	A, S
8	Audio	-40 dB	10 dB	L	T
9	Height	78 in	.5 in	M	A, I
10	Serviceability	yes	Max	M	T, F

11	ADA Accessible	yes	Max	M	A, T
12	Multilingual	maybe	Max	M	T, F

Using a basic quality function development (QFD) methodology to identify the importance of each requirement, we developed a chart outlining how vital each specification is to the project.

Table 3: QFD worksheet

Magic ATM	Engineering Requirements (SPECS)											
Customer Requirements (NEEDS)	ERROR FREE OPERATION	ALLOTTED SPACE	NOT EXIT OBSTRUCTING	SIMPLE USER INTERFACE	HOLD MONEY FOR ENTIRE DAY	VIDEO SCREEN	INCLUDES AUDIO	CORRECT HEIGHT	ADA ACCESSIBLE	UNDERSTANDABLE FOR NON-ENGILSH SPEAKERS		
1. SAFETY	0	5	9	0	0	0	0	5	5	0		
2. DURABILITY	7	4	5	7	8	0	0	9	5	4		
3 FUN FOR KIDS 5-12	9	0	0	8	9	7	7	4	4	7		
4 MAINTAINABILITY	8	1	2	7	9	5	3	2	2	4		
5 DISTRIBUTES MONEY	9	2	3	6	8	0	0	0	0	0		
6 EDUCATIONAL	6	0	0	9	5	8	4	5	5	8		
7 THEMED TO ZOOMTOWN	0	6	0	0	4	5	2	0	0	0		
8 ENTICING VISUALS	0	1	3	8	2	9	0	7	6	2		
9 SUBDUED AUDIO	0	0	0	6	0	0	9	0	0	0		
10 AGE APPROPRIATE	0	0	0	9	8	5	4	8	0	0		
COLOR YOUR STRONGEST CORRELATIONS												
COLOR YOUR MEDIUM CORRELATIONS												
COLOR YOUR WEAKEST CORRELATIONS												

Method of Approach

Combining the expertise of the three team members and the sponsor Roy Mueller, the best ATM design has been reached which satisfies a balance of fun and true-to-life experience. The basic model of the machine has been developed from existing bank ATMs in order to keep ties with the real world model of Zoomtown. The ATM will not be built entirely from scratch.

Extensive research has been made in order to find key components (i.e. bill dispensers, card readers, etc.) Bill dispensers have been looked at from vending machines, current ATMs, and gaming applications such as slot machines that dispense tickets for casinos. Card reader research has come from the gaming industry; casinos use cards to keep track of gamer credits. Additional component information has been found by researching current ATMs.

The primary focus of the design is the kids. The machine has to be durable and easy to maintain, but above all it has to be fun and engaging enough to draw the kids in. With this in mind, kids have had input into the design. By collaborating with schools in the area, kids will be able to see their ideas put into action.

Once the entertainment value of the ATM was established the next focus is durability. Many of the parts of the system will be isolated from museum visitors (items such as computers and cash dispensing mechanisms). The interface devices such as keypads and card readers have been selected for durability and ease of replacement. Wherever possible components will have backups incase one of them fails.

While physical durability is important, the software also has to be robust, stable, and error free. For software testing, the kids will again prove to be an invaluable resource. While the team can do most of the debugging and problem solving, it is ultimately the kids that will use it: if there is a bug, they will find it in short order. By using the same classes that helped with brainstorming and idea development, they not only know how the system should work, but they will use it enthusiastically because it is their own ideas they are playing with.

These components will be implemented into the final design along with a durable fiberglass of similar material housing to make a working ATM. Extensive testing will be executed in order to ensure fully functional operation as well as keeping all design specifications within tolerance.

Important design considerations will be made based upon the use of decision matrices, communication with the Children's Museum, and other decision tools to make the decisions that will best suit both the project and the SLO Children's Museum.

Management Plan

The Magic ATM project is broken into three main phases: Project Design, Fabrication, and Testing. The subtasks are available in Appendix A as a Gantt chart. At this point detailed planning has not been done past the design phase, as tasks for future quarters are unavailable.

Amber Iraeta:

- Serves as primary contact with the children's museum
- Tracks projects progress
- Mechanism Design
- Meeting Agenda and management

August Brower:

- Responsible for fabrication
- Mechanism design
- Mechatronics and Human Interface

Jason Sy:

- Ergonomics and visual design
- Mechatronics and Human Interface
- Prototype testing
- CAD diagrams

Mechanism Design: Responsible for designing all mechanical systems for the project. Proposed systems include bill counter and money delivery

Mechatronics and Human Interface: Responsible for the design and programming of the mechanical and electric systems for the project. The Mechatronics team will design and write code to integrate the input pads, card readers, money dispensing mechanism, and displays.

Ergonomics and Visual Design: Responsible for the outward appearance and aesthetics of the ATM. The Visual Design team will ensure that the project fits the theme of Zoomtown, is visually enticing, accessible to all ages, and meets ADA design requirements.

Experience Design

The magic ATM design consists of four different elements: the Experience, the ATM architecture, the mechanical structure, and the software.

The Experience Design consists of the design of the occurrences from when the children first interact with the ATM to where the money is distributed to be used in Zoomtown.

The experience design will include what is done at the ATM, and how the general functionality of the ATM will be. The magic portions will also be included as well as how the team came to their decisions.

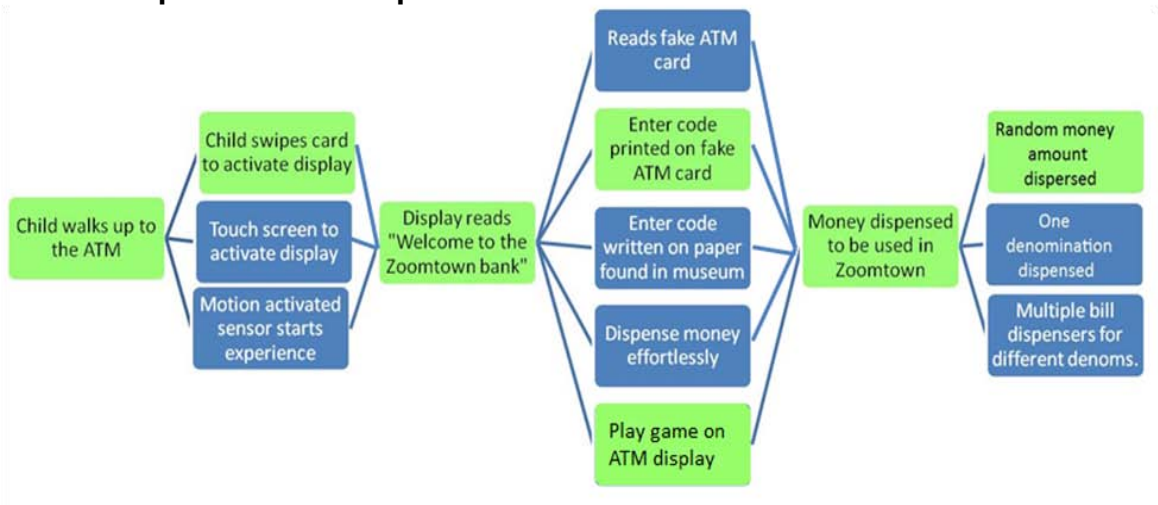
The user interface will also be discussed in this section, since it is a key element to the overall experience a child gains during the ATM use.

Experience Concepts

Below are several flowcharts showing the different user experience possibilities. The path in green is the team's desired path.

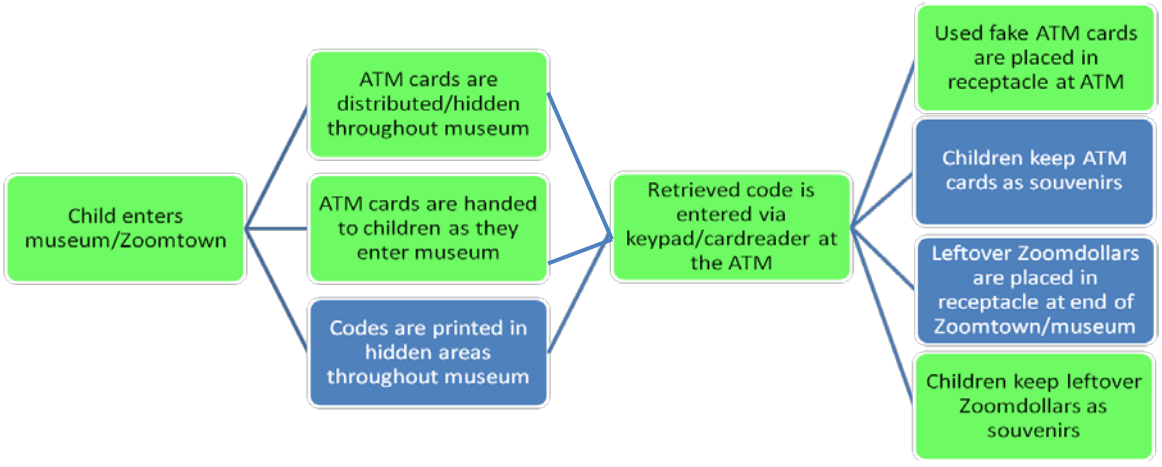
The first flowchart shows the overall experience the child will have when they approach the ATM. The preferred method allows children to search for fake ATM cards with codes printed on them that are hidden throughout the museum. The will then use the codes to be able to extract money from the ATM.

Overall Experience Concepts



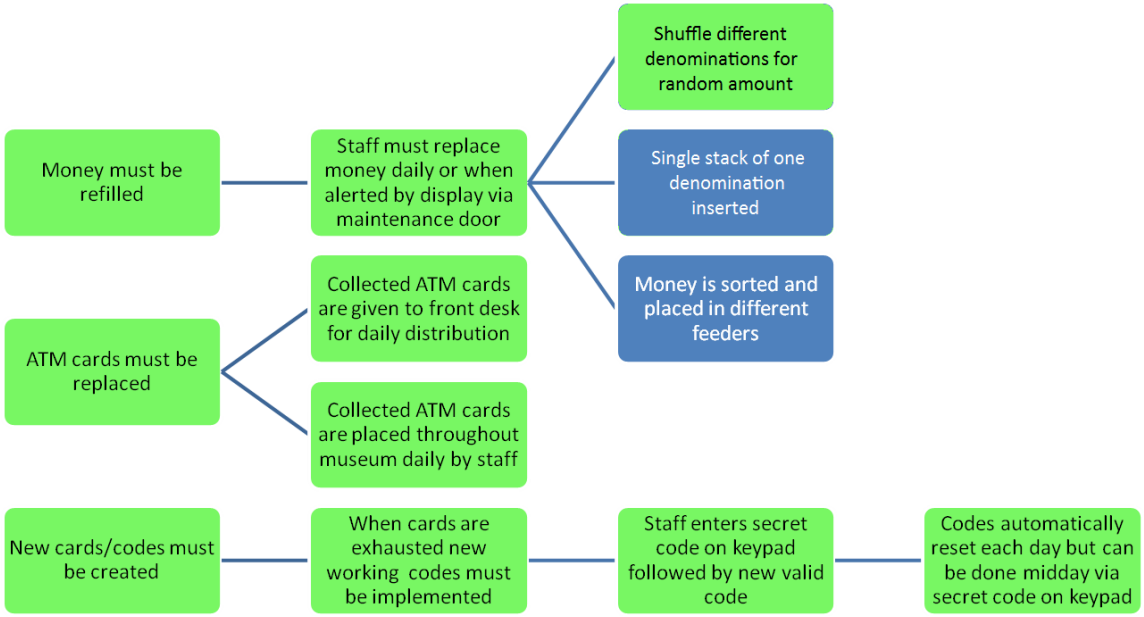
The second flowchart showcases how the children will retrieve the codes in the museum.

Child Receiving ATM Code Options



The last flowchart shows what maintenance and upkeep will be required on a daily basis and what the staff should be expected to complete to keep the ATM functioning properly.

ATM Maintainability Concepts



The above flowchart focuses on decreasing staff workload and increasing maintainability of the system. By lowering the amount of work necessary to maintain a successful exhibit many of the design objectives are met: less downtime leads to increased fun and more educational opportunities; simpler systems deal to increased durability and maintainability.

The Game

Children using the ATM will be playing a game as part of the overall experience. The thought that the game should tie into surrounding Zoomtown gave the team the perfect idea for the game.

The game is titled: Around Zoomtown. The children will be presented a screen with buildings that are already present in the museum and they will automatically advance to each building and answer a trivia question that relates to that particular location.

For example, one building may be the movie theater. The question may read similar to the following:

You want to see a movie today, but you don't know if you have enough for a movie ticket. If a movie ticket costs 8 dollars and you have a 5 dollar bill and 4 one dollar bills, do you have enough to see the movie?

The answer would be yes, and the next screen will help the child either figure out the problem if they didn't answer correctly, or would congratulate them on getting the problem correct.

At the end of the game, regardless if the child has answered any or all of the questions correctly, they will receive the money from the ATM.

Experience Decision Process

Preliminary decision matrices were utilized to help identify the top solutions in three areas: Attracting kids to the ATM, how the kids interact with the ATM, and how the money is distributed.

Table 4. Decision Matrix Attracting Kids to ATM

Concept / Criteria	Flashing Light	Sounds	Video	Human Clown	Scrolling Marquee	Mechanical Motions
Safe	+	+	+	-	+	+
Maintainability	S	+	+	-	S	S
Durable	S	S	S	-	S	S
Fun	+	S	+	s	-	+
Attention Grabbing	+	+	S	+	S	S
Subtle	S	-	-	-	+	+
(+)	3	3	3	1	2	3
(-)	0	1	1	4	1	0
total	3	2	2	-3	1	3

The first decision matrix shows that either flashing lights or mechanical motions would be a good way to attract kids to the ATM. Yet, most of the concept ideas, with the exception of the human clown, are shown to also be reasonable choices. A combination of the ideas is now being considered to be used. While the decision matrix is used to aid in the decision process, it is not the ultimate decision factor.

Table 5. Interacting with the ATM

Concept / Criteria	Codes	Games	Fake ATM cards	Just get $	Working	Tokens
Safety	S	S	+	S	S	S
Durability	-	-	+	S	S	-
Fun	+	S	S	-	-	S
Maintainability	+	-	+	S	-	+
Educational	+	S	-	+	-	+
Σ+	3	0	3	1	0	2
Σ-	1	2	1	1	3	1
Total	2	-2	2	0	-3	1

Interacting with the ATM is a hard decision to make. There are several ways that the kids can use the ATM, from just getting money to having to work and somehow earn their paycheck. The whole precept of the museum is to learn while having fun, therefore only working for money seems too much like work, and just getting money is not providing a learning element. The decision matrix reflected our original notions and the main idea in order to gain money from the ATM is now to use codes printed on fake ATM cards.

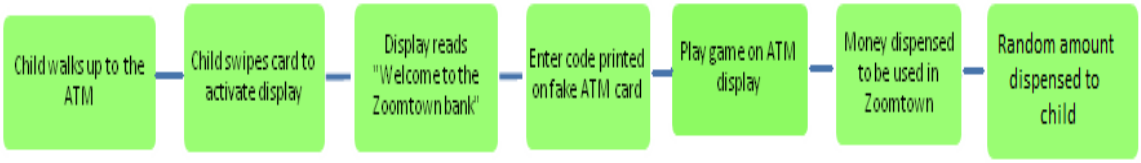
Finally, in order to reaffirm the choices that will be integrated in the final design, a local 5th grade class from Teach elementary was interviewed. A brainstorming session was held and each student was given a blank sheet of paper to capture any ideas that come to mind and to sketch what the “ideal” ATM looked like. Some of the ideas that were the most popular among the students as a whole were:

- A clear housing in order to see the mechanics of the bill dispenser
- Utilizing a fake ATM card and fake dollar bills
- English and Spanish words on screen
- Lights and sounds
- On screen games
- Wheelchair accessible

All of these ideas were implemented into the final design.

Experience Final Design

Using input from the sponsor and other methods the following final experience design was agreed upon:



Final Experience Flow Chart

The child will walk up to the ATM after obtaining an ATM card from the museum staff.

The child will swipe their ATM card, containing a unique PIN number at the ATM. The ATM will then greet the child and ask for that PIN number. The PIN number is to prevent the same ATM card from being used over and over and to also prevent the child from withdrawing as much money as they want from the ATM.

Audio and video cues will be able to assist children in using the ATM. Also, lights on the ATM will light up the part that requires child interaction on the ATM. This will further assist the child in being able to have a great ATM experience.

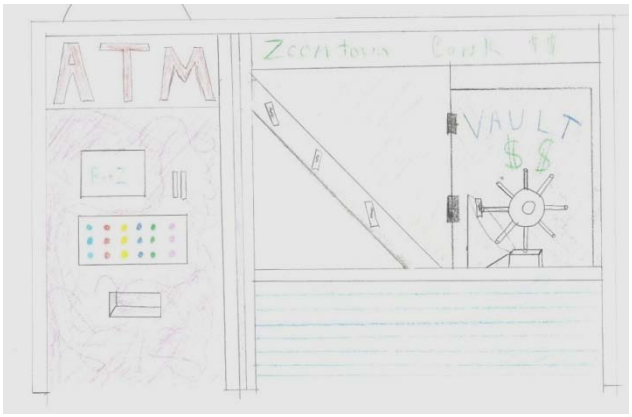
After the PIN number is entered, a trivia game will be played with the child. The game will have five questions that are centered in 5 different buildings throughout Zoomtown. The child will be able to visit each of the 5 buildings and answer questions that may require children to do simple addition or subtraction. For example, if a child were visiting the movie theater then the question might be along the lines of figuring out the change you get when you buy a movie ticket or some popcorn.

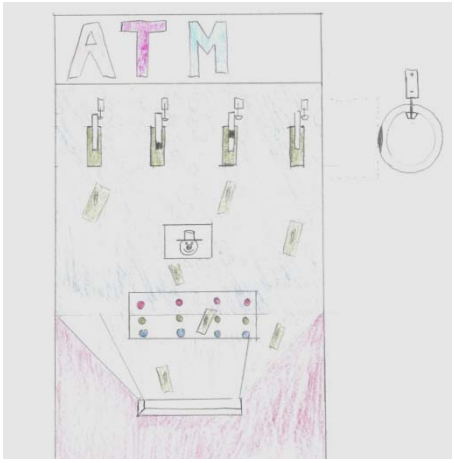
The children will be able to see if their answer was correct for the game and then five random bills will be dispensed to the children. Additional lighting features on the ATM will cause LEDs to twinkle and light up when money is distributed and also during the game.

User Interface

Concept sketches were created to give a general feel of what the user interface would be. They are important in giving the team and sponsor possible ideas for how the ATM will be presented to the children and how they will interact with it. This was important in understanding what components were needed, and also where the components would be placed.

The concept sketches give possible visual experiences, as well as showing the possible integration of fanciful cash dispensers in the visual experience. In all the concepts, the focus is on safety, durability and education. For all of the concepts, mechanisms are kept visible but separated to prevent injury. The interfaces are simple and use durable off-the shelf components, while maintaining a sense of realism. With all of the components, ease of repair or replacement using off-the-shelf components is very important.





Teach Elementary User Interfaces

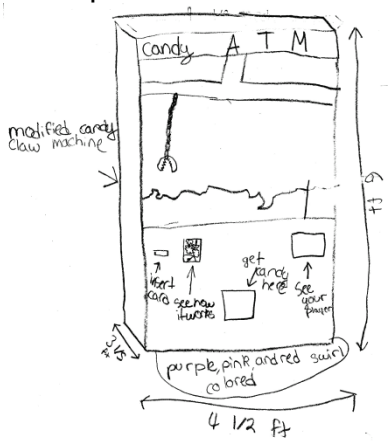
In addition to the teams own concept user interfaces, a local elementary school, Teach Elementary, was visited in order to gain insight into what a child would want in a magic ATM.

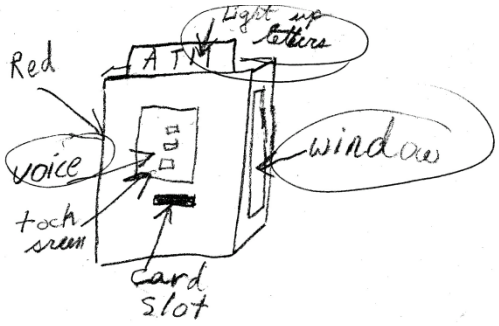
A brainstorming session with fifth graders resulted in thirty unique ideas for ATM user interfaces. Some focused on the practical, while many more gave us fanciful ideas of a whimsical ATM that dispenses everything from soda to stickers.

There were a few ideas that were universal to several of the papers. One idea was the ability to look inside and see the ATM and see how the components operate. This was thought about by the team earlier in the design, but was ruled out because the team thought there would not be much to see due to the covers on the bill dispenser.

After the session with the fifth graders, this decision was relooked at. The team noticed that changing a metal panel out on the bill dispenser with a clear panel would enable the operation of the dispenser to be seen. A portion of the ATM façade will be clear scratch resistant acrylic in order for this operation to be viewed by the kids.

Garnering suggestions from kids was an excellent step in the user interface concept design. It enabled the team to have confidence that the design decisions made were in line to what the users wanted, and also realigned some concept ideas, such as the viewing window, to what the users desired.



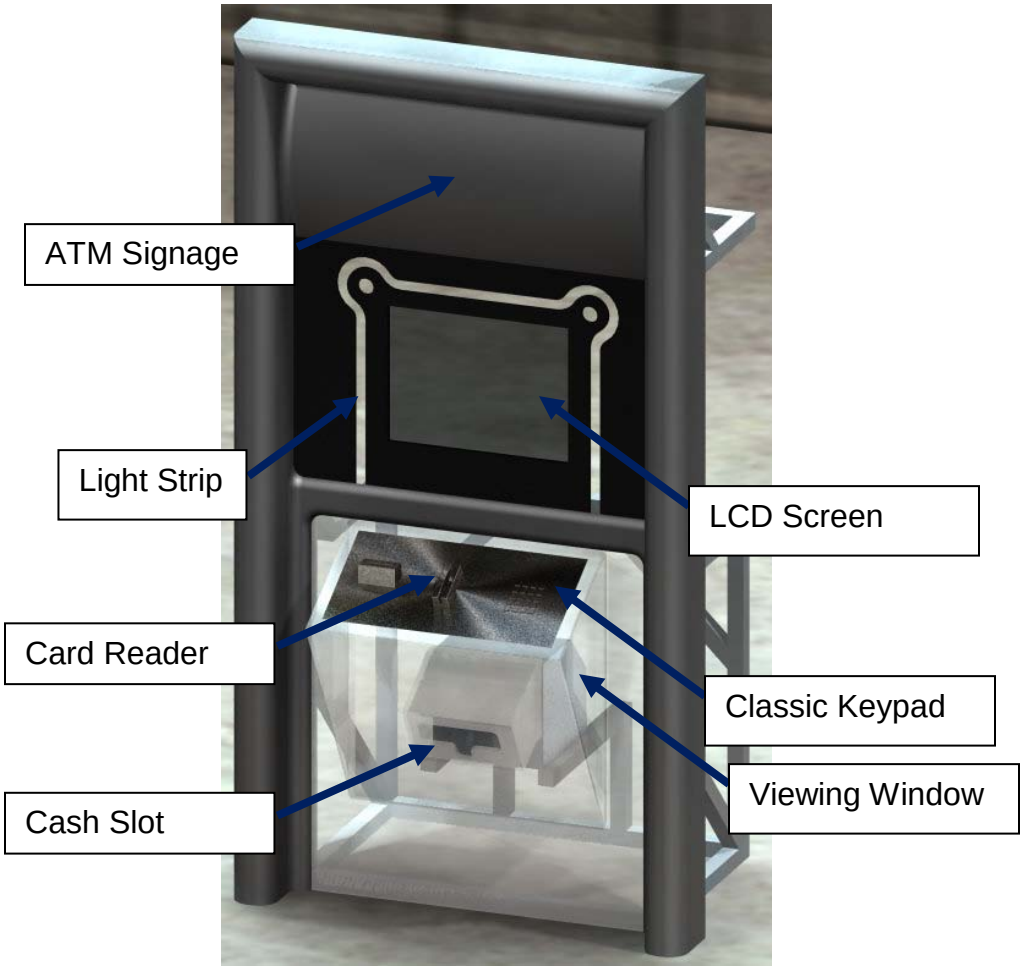


Final User Interface Design

The final decision for the overall ATM user interface came from applying various different sources to create an appropriate design. The sources included the surrounding buildings of Zoomtown, the overall feel of the town, what the museum desired, existing bank ATMs throughout San Luis Obispo, regulations for accessibility, and the input from the children at Teach elementary.

The final design was found to need what is called 'hidden magic.' While this is a fun and interactive ATM, due to the realistic feel of surrounding Zoomtown, and the desire to give the children using the ATM a fun but enriching experience, the exterior of the ATM had to look more or less like an ATM that you would encounter at any bank.

The result was a realistic feeling ATM that would be able to hide the magic elements desired for fun interaction.



Architecture Section

The architecture portion of the report shows the various components that are needed to create a working ATM. Examples include the Computer, cash dispenser, and the keypad.

The architecture section also details how the different components interact with each other.

Architecture Concepts

The architecture components came about in the experience design phase. In order to have an ATM experience there were a few key components that would be essential to the experience.

One was the how the Zoomdollars would be dispensed from the ATM. Several fun ideas for cash dispensing were formulated for the ATM, some included vacuum tubes and money falling from the sky.

Another conflict that came about was how the kids would interact with the ATM. Several methods were thought of, everything from cranking gears to getting money out to manipulating a game using a joystick. Many of these concepts went hand-in-hand on how the money would be dispensed.

The last big part of the architecture design was a place that would allow the children to interact with a game or somehow learn about money.

Cash Dispenser Decision Process

Several concepts for money distribution were considered for the ATM. The following decision matrix was utilized in making the decision process.

Table 5. Money Delivery

Concept / Criteria	Raining money	Single premade dispenser	Multiple premade dispensers	Kid cranked	Pneumatic	Vacuum tubes
durability	S	+	+	-	+	+
building cost	+	-	-	+	+	S
engaging	+	-	-	+	+	S
fun	S	-	-	+	S	+
Maintenance (period)	-	S	S	+	-	S
Maintenance (cost)	S	-	-	S	+	+
Loading	S	+	-	S	+	S
(+)	2	2	1	4	5	3
(-)	1	4	5	1	1	0
total	1	-2	-4	3	4	3

The money delivery method is the heart of the ATM. It must be durable, as well as easy to maintain and visually stimulating. Many of the elements can be combined if desired—pneumatic pads can be used to take money from a stack and then the money can be transported through vacuum tubes, for example. The premade dispensers received low marks because they are not visually stimulating, expensive to buy, and may require factory maintenance if they break down.

Due to the nature of the bill dispenser and the desire of the sponsor, the team decided to select an off the shelf dispenser to have a more realistic ATM and a reliable product.

Vendor information for the cash dispenser can be found in Appendix B

ATM Interaction

The final decision for how the kids would interact with the ATM was decided based on four different criteria: Durability, Realism, Fun, and Maintainability.

The four final concepts were matched up against each other in a decision matrix that showcased whether a touch screen, buttons, keypad, or joystick would be best for the ATM.

Table 5: User interface

Concept / Criteria	Joystick	Keypad	Buttons	Touch Screen
Durability	-	+	S	S
Realism	-	+	+	S
Fun	S	S	S	+
Maintenance (period)	-	S	S	-
(+)	0	2	1	1
(-)	3	0	0	1
total	-3	2	1	0

As indicated in the decision matrix, the keypad is the best all around for the realism and durability of the atm. This decision matrix helped in the selection of our final user interface, which does include a keypad.

Vendor information for the keypad can be found in Appendix C

Game Interaction Decision

One of the main features of the ATM is a game that allows the children to learn about money while they are playing. The game was decided early that it would be software based. This would allow the team to integrate the game with the money distribution.

Since the game would be software based, the display for the game is essentially limited to a computer screen. And, since the touch screen was dismissed in previous decisions for the keypad, the decision was fairly simple. The LCD screen that came with the computer was determined to be an acceptable way to display the game.

The computer selection came from the price. No operating system was really required for the programming of either the game or bill dispenser, so the computer was easily selected from Dell, which from team experience, is a reliable computer company.

The I/O board was selected based on the previous decision to use lights that are timed with the child's interaction with the ATM. An I/O board allows for the control of the different elements in the ATM, such as the keyboard and the lights.

The specification sheet for the computer and I/O board can be found in Appendix D and E, respectively

Magic Components Selection

The fun elements of the ATM were decided in the experience portion of the design.

The flashing lights and mechanical motions were determined to be the most feasible for the ATM. The mechanical motions will be covered in the mechanical design portion of this report. The flashing lights however will be discussed in this section.

Table 6: Magic Lights

Concept / Criteria	LEDs	Scrolling Marquee	Incandecent Bulbs
Durability	+	+	S
Hidden	+	S	-
Fun	+	+	-
Reliable	+	+	S
(+)	4	3	0
(-)	0	0	2
total	4	3	-2

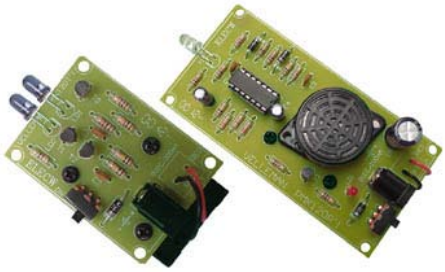
The LEDs were found to be the best decision based on the four criterions stated. The hidden criteria was found to be an essential element to correspond with the teams desire to disguise the fun elements of the ATM.

The scrolling marquee was also found to be an acceptable alternative to the LEDs. Since the marquee could also function as an ATM advertisement, the team has decided that, with time permitting, it can be added to the ATM after initial fabrication and programming has been completed.

Final Architecture Design

The final design is centralized around a PC that controls the system. The PC (Dell Inspiron 530n) will talk to and receive input from the bill dispenser, optical switch, and keypad. The computer was selected based on price.

The display will be activated when an ATM card is swiped and triggers the optical switch.

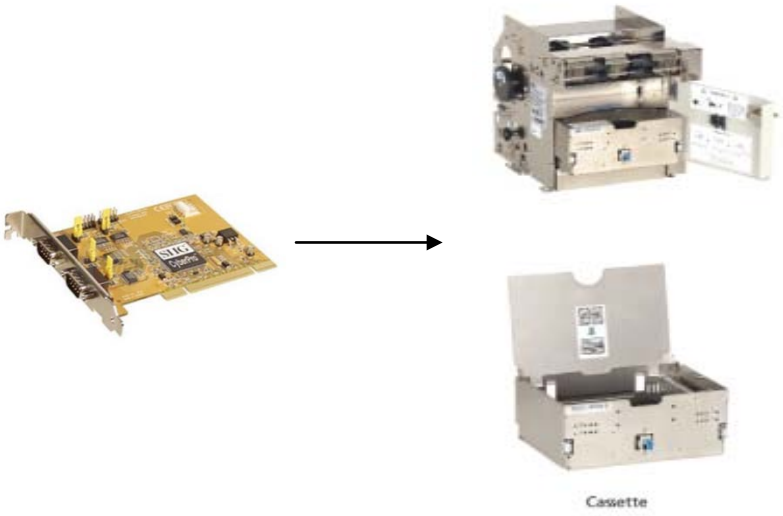


The optical switch will feed into the I/O board, which will provide the direct communication to the computer.

The keypad is a very rugged model that will sustain significant wear and tear. The bill dispenser is an economical, easily maintainable and highly reliable model from HWI.

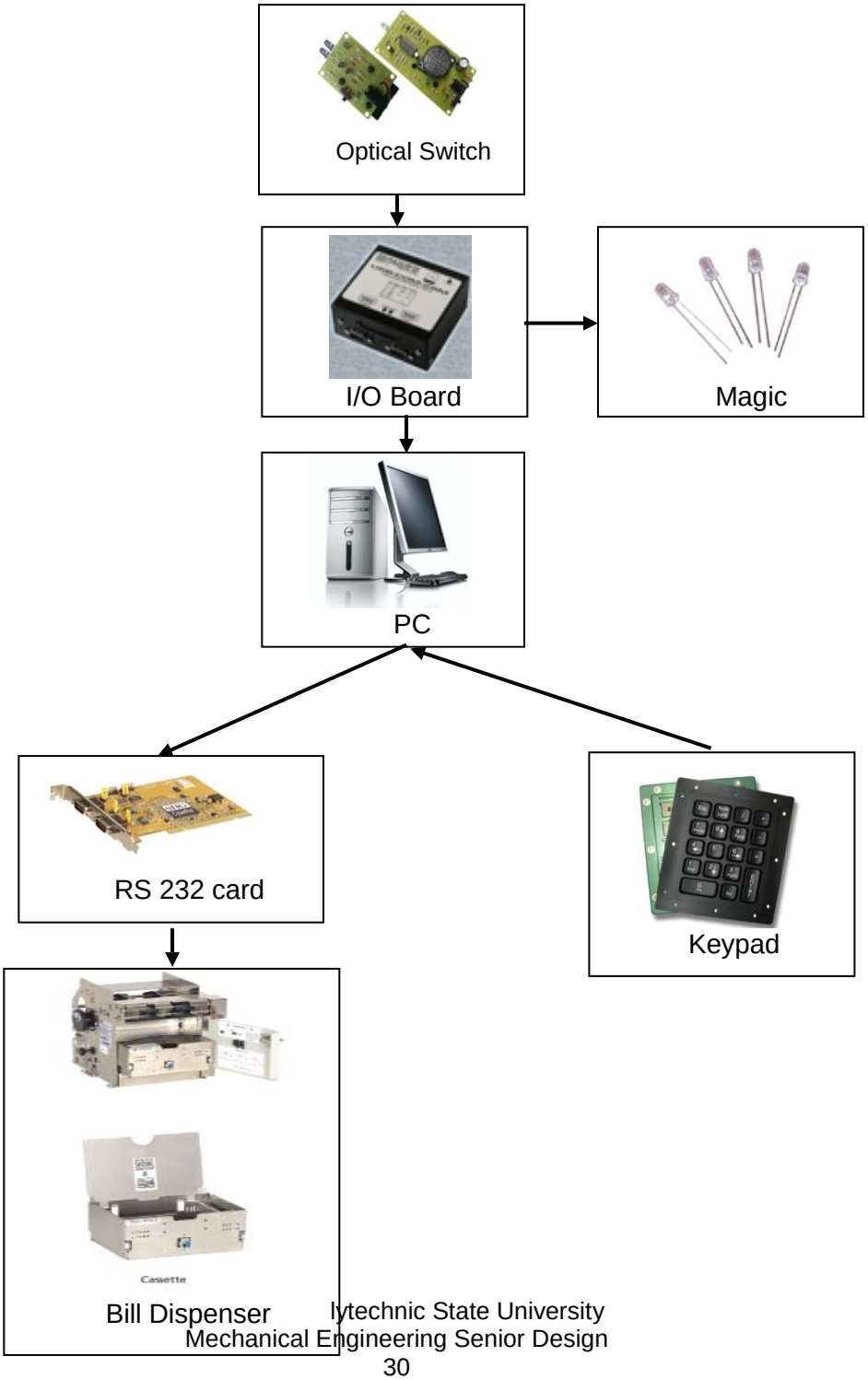
The magic elements of the ATM will consist mainly of LED lights that will be imbedded in the ATM housing. The LEDs will be timed by the I/O board and will be able to interface with the system software and enable the LEDs to flash at different points in the ATM experience.

In order to interface from the pc to the bill dispenser a RS232 card will be used.



Operational Flow Chart

The operational flowchart shows a comprehensive view of how the different ATM components will interface with each other.



Mechanical Section

The mechanical design portion will cover the frame design for the ATM, accessibility and the component placement, outside ATM housing, staff access, and safety.

The frame design consists of the material choice and overall structure of the frame.

The component placement correlates closely with accessibility as outlined in the ADA guidelines. Both will be discussed in their entirety.

The outside ATM housing will be discussed in how it related to the aesthetic aspect of the design and the material choice for it.

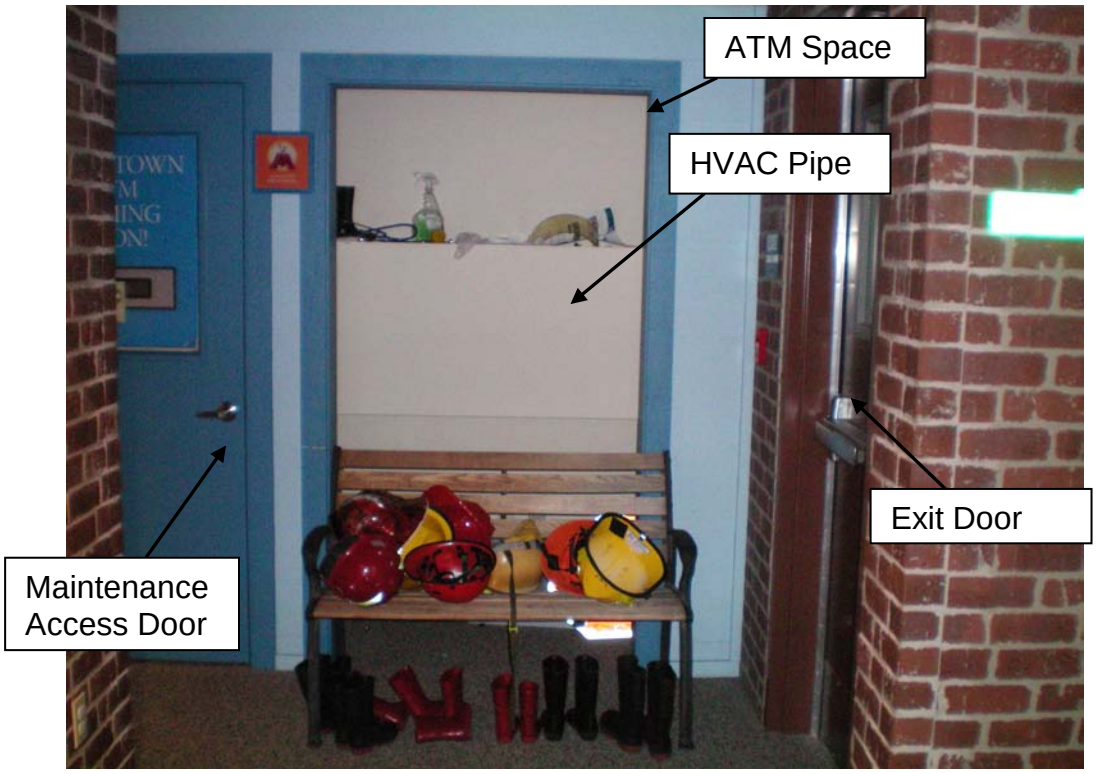
The staff will need to access the interior of the ATM in order to refill the money cartridge; this section will cover how that will take place.

The ATM cards will also need to be retrieved from the children. The details of the ATM card disposal slot will be covered.

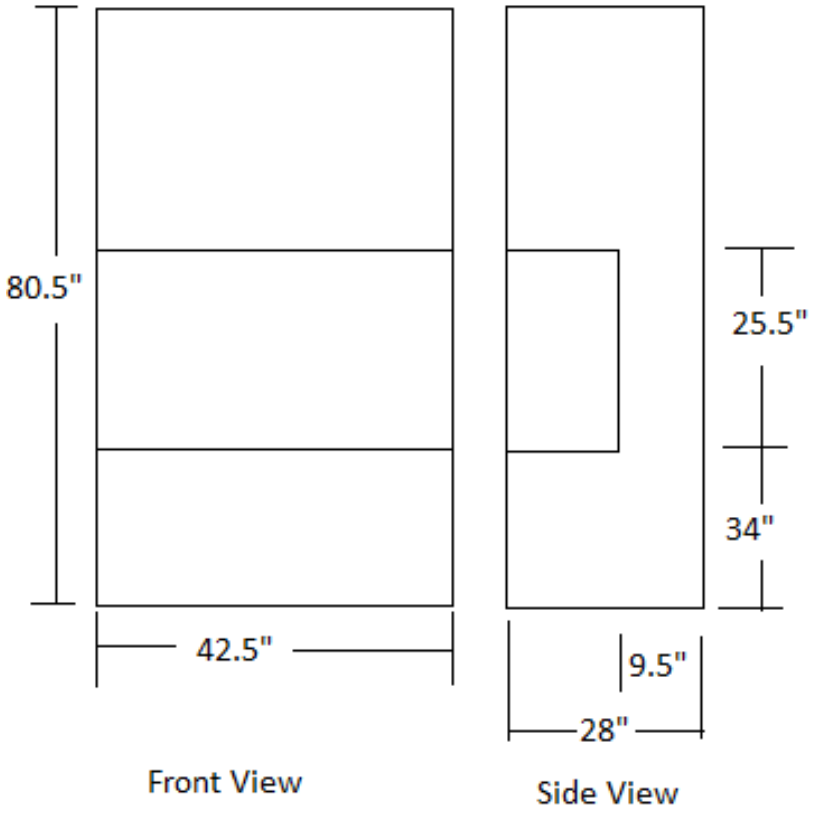
One main concern for the ATM is safety for both the children using the ATM and also for the staff who have to access the ATM. This will be discussed in the final part of this section.

Frame Design

The frame has to be designed around the space that exists at the SLO children's museum. The space currently contains an immovable HVAC pipe that sticks out of the wall.

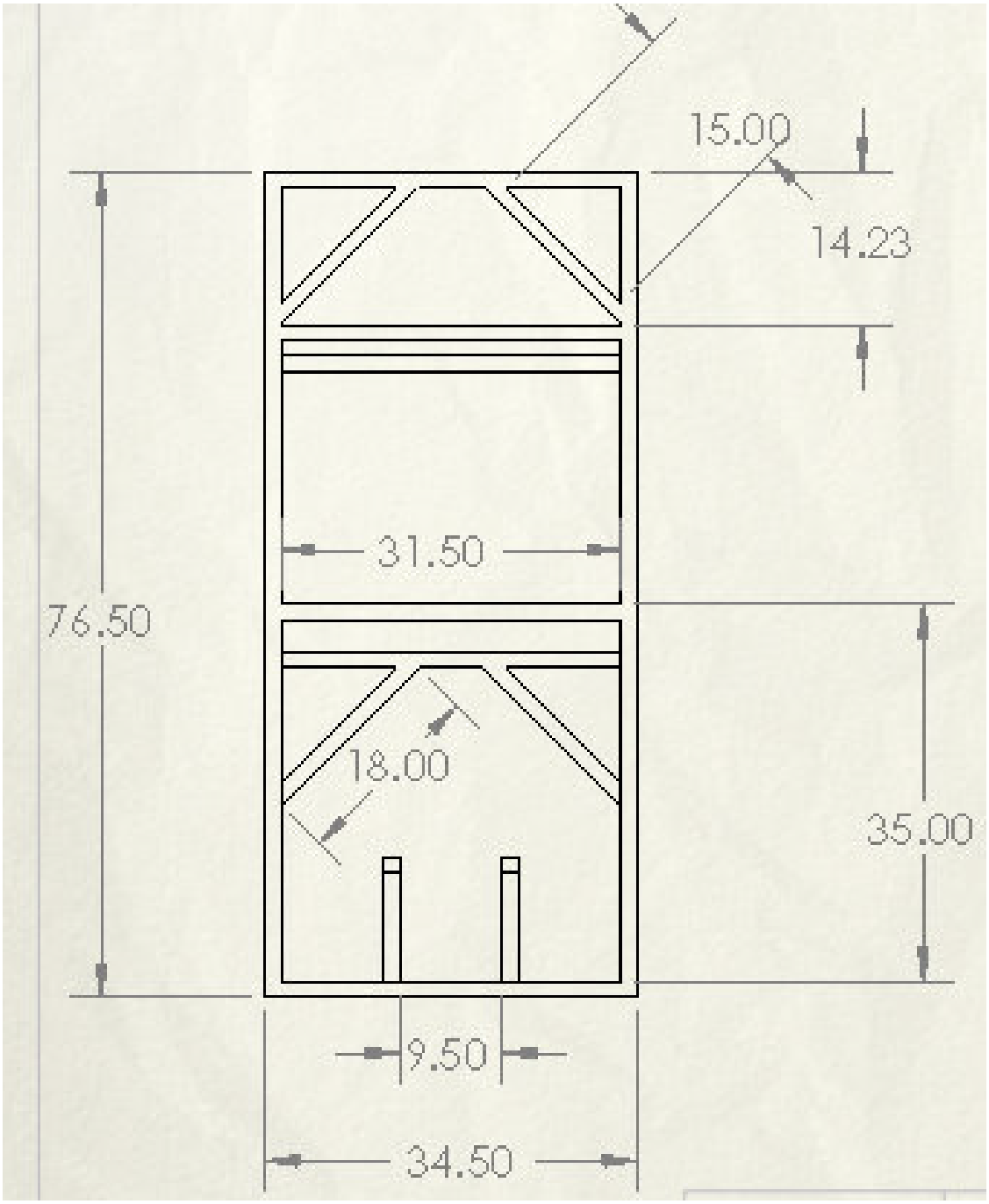


The space for the ATM measures as follows:



The ATM has to also not interfere with the Emergency Exit Door that is located to the right of the ATM. This requires that the ATM not stick out from the actual designated ATM cubby-hole any more than is required.

Therefore the entire structure was designed to look like the following:



The material for the frame was a bigger choice. The frame material has to rigid, durable, and easy to machine. The following decision matrix shows the three different materials considered in the design process:

Table 7: Material Choice

Concept / Criteria	Aluminum 2024	Steel	T-Slot 80-20
Rigid	+	+	+
Durability	+	+	+
Machinability	S	+	S
Weight	+	-	+
Ease of Assembly	S	S	+
(+)	3	3	4
(-)	0	1	0
total	3	2	4

According to the original decision matrix, T-slot 80-20 was found to be the best choice for the ATM. T-slot aluminum is lightweight without sacrificing rigidity, strength and durability. The structure comes pre-cut according to the design specifications therefore there will be no need to source other frame parts.

One consideration that was not originally considered during the material selection was price. T-slot Aluminum is prohibitively more expensive compared to aluminum or steel. While it is a very convenient material to utilize on this project, upon closer examination, the cost to convenience ratio for the T-slot 80-20 was found to be extremely high, with a quote from the manufacturer coming to a total of $650.00.

Another criterion that was further decided by the team as unnecessary was the weight of the material. There is not a lot of material needed to build the frame, so the difference between building the frame out of steel or aluminum is minimal. The biggest deciding factor came once again to cost.

That is why the frame was determined to be best made out of steel. Steel is a cheaper widely available material that will suit the ATM needs fine. In fact, steel

is an easier material to work with than aluminum. Overall steel comes out on top as a more economical and feasible material choice, which is why it was selected for the frame.

Detailed drawings of the frame are available in Appendix F.

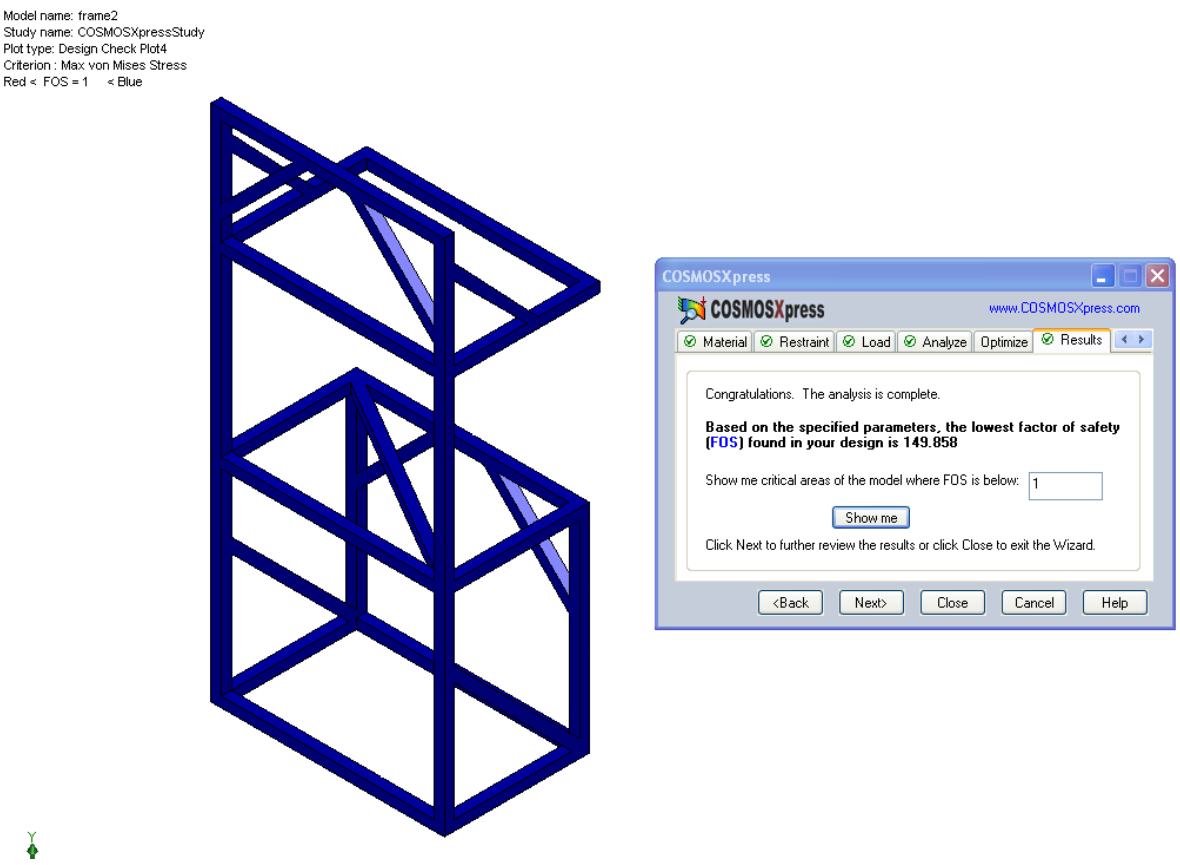
Frame Analysis

The analysis that was required was to estimate the loads on the steel frame and to ensure that the frame could support these loads. This analysis was performed using SolidWorks. Loads were estimated as follows:

Weight of CPU on upper bracket: 10 lbs
Weight of wood panel and monitor assemble on the upper bracket: 10 lbs
Weight of Acrylic assembly on the front face: 10 lbs
Weight of bill dispenser assembly: 15 lbs

The built-in COSMOSX press software was used to determine if any of the steel structure would fail under the given loads. The frame was assumed to be restrained parallel to the ground. The material was steel and the dimensions for the frame were those listed in the Frame Drawing.

For these given conditions, the minimum safety of factor was ≈ 150, showing that our frame design will hold up the CPU and monitor more than adequately. This is shown in the screenshot on the following page.

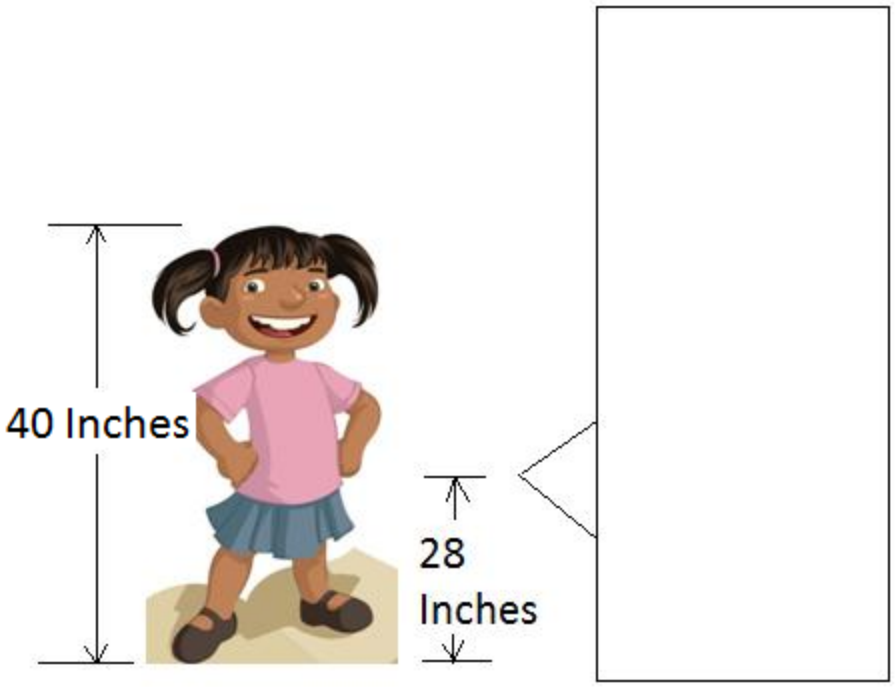


Accessibility

The ATM is required to follow ADA guidelines in terms of accessibility. ADA guidelines state that the height of a table needs to have a minimum height of 28 inches above the ground.

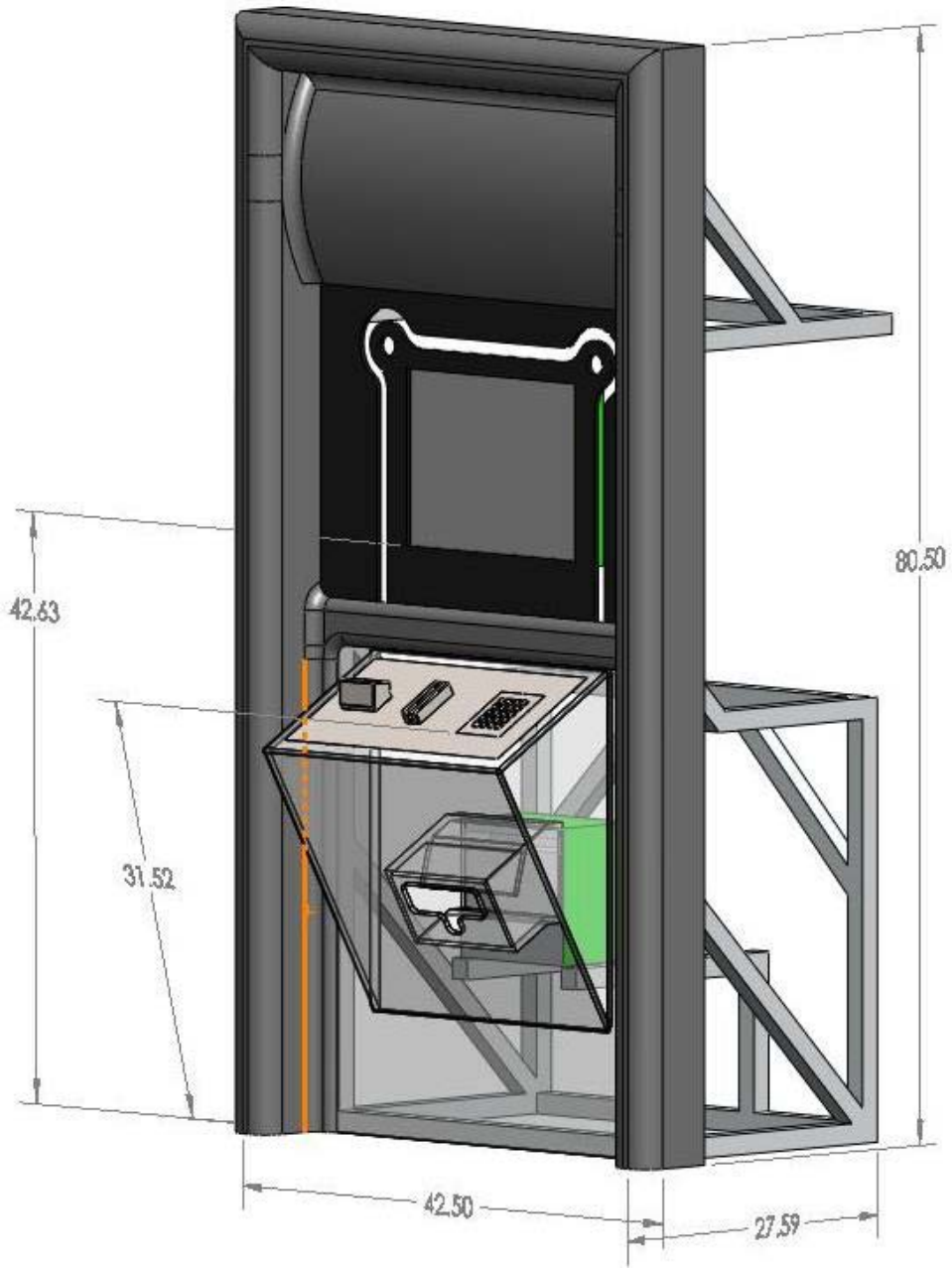
Since the ATM is made for 5-9 year olds, their height requirements also have to be taken into consideration.

The average height of a five year old is 40 inches. The height of the keypad will reach 28 inches, in order for it to be both accessible for a smaller child, as well as be ADA compliant.



Component Placement

Now that the interior frame of the ATM is designed and accessibility issues have been discussed, the components can now be reasonably placed inside the ATM frame.



This is a diagram of the placement of the components inside the ATM, and the height of each component

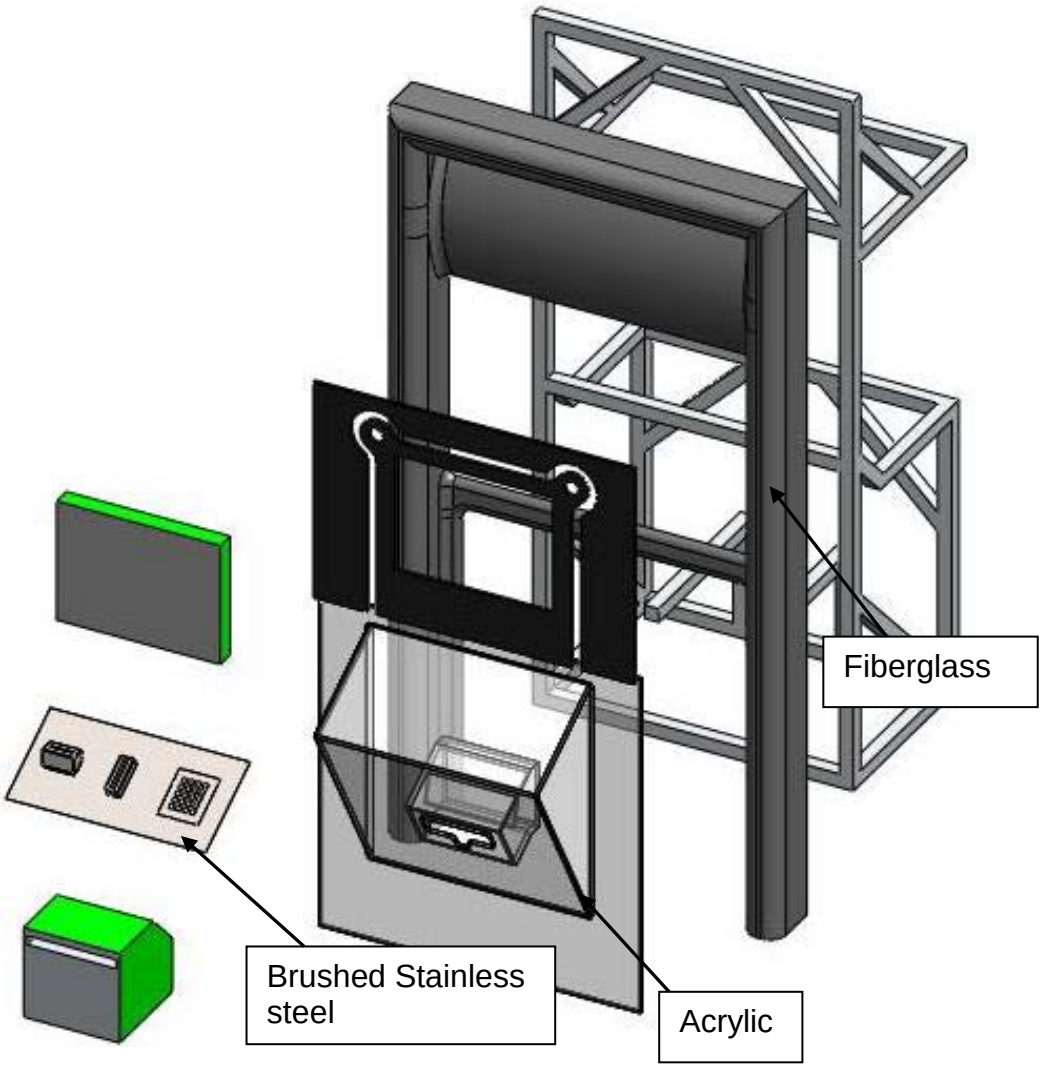
ATM Housing

The housing of the ATM will be made out of gel coat fiberglass and scratch resistant polycarbonate.

Fiberglass is a durable material and is seen elsewhere in the museum, for example the clay volcano, and has shown that it is able to withstand the stress that results from daily usage by kids.

To showcase the inner workings of the ATM a scratch resistant acrylic sheet will be applied under the keypad and the bottom portion of the ATM. On top of the Acrylic, on the corners, a rubber pad will be applied. This is to ensure that if a child were to run into the corner the impact would be mild.

Underneath the keypad a brushed stainless steel is going to be used in order to also prevent wear and tear on the ATM.

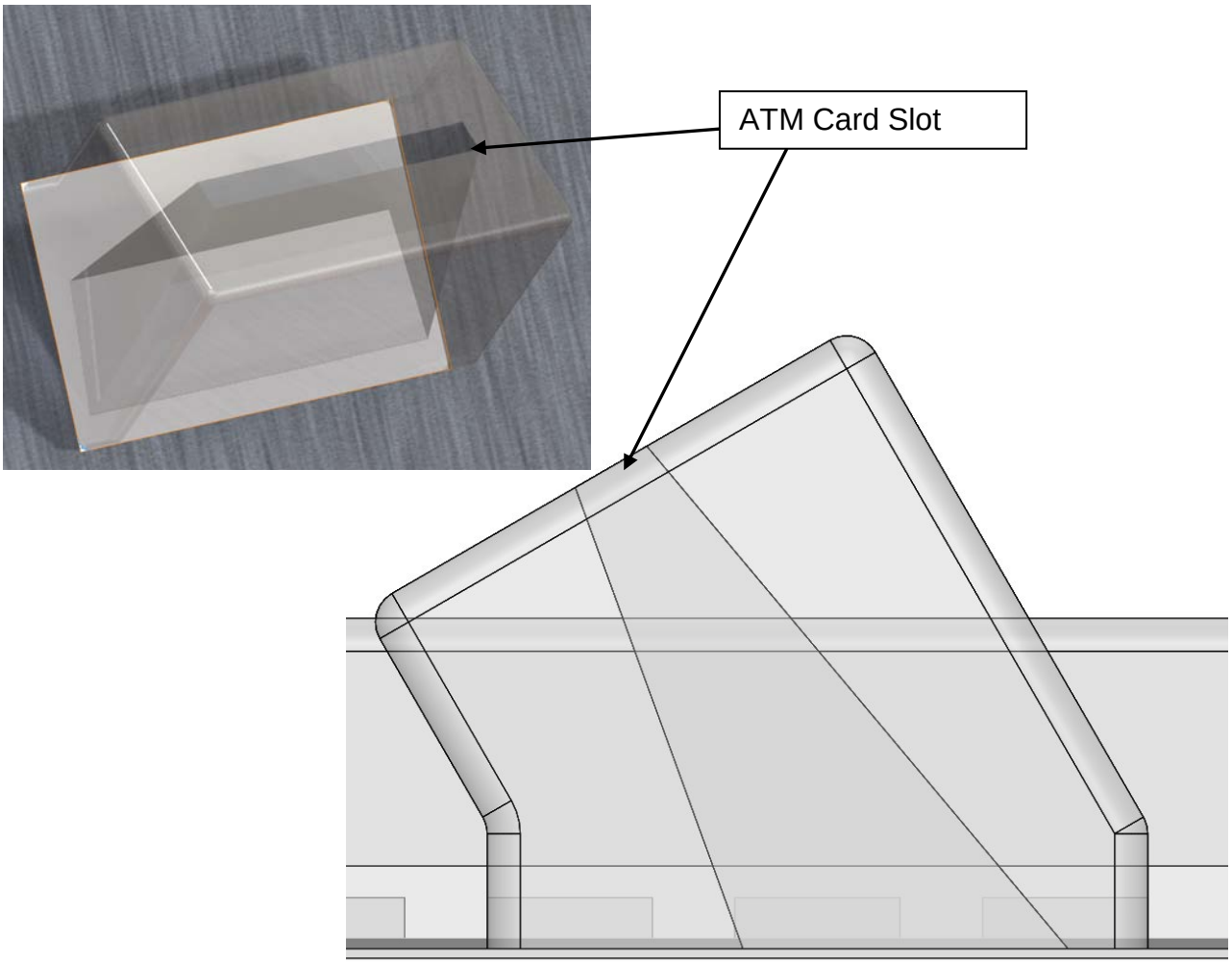

Fiberglass
Brushed Stainless steel
Acrylic

ATM Card Disposal Slot

The disposal slot will be a fun and interactive place for the children to dispose of their ATM cards after they have used them.

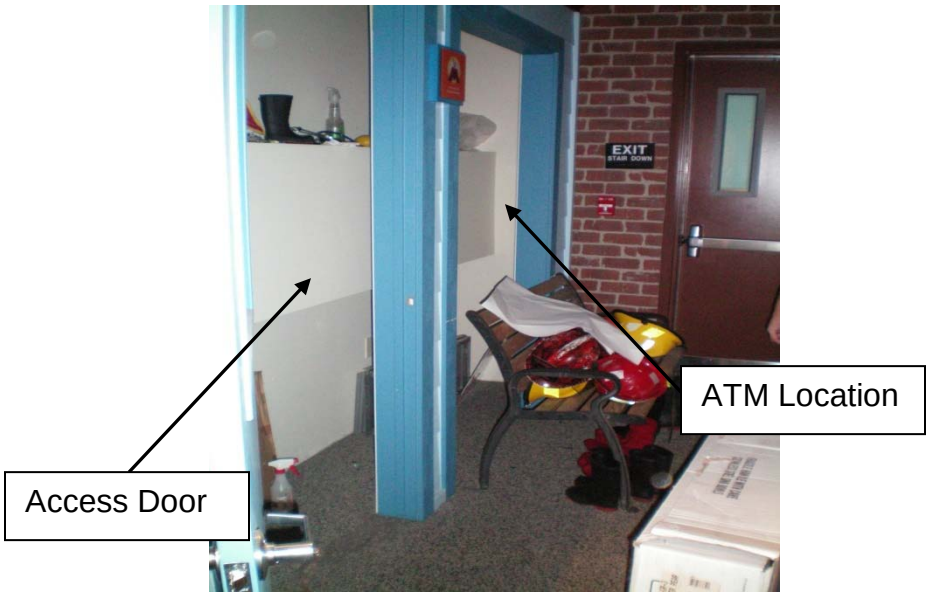
The slot is designed so the top portion of the slot is the skinniest part of the entire collection system. If an item that is not an ATM card were to be inserted into the slot the item could be easily pushed down into the card bin and then removed by staff.

Below is a close up of the ATM card disposal slot:



Refilling ATM Money

The museum staff will be able to easily access the ATM via a side access door that is already present in the museum.



The ATM will not have siding on that side so when money needs to be refilled the staff will open the door, then be able to slide and swivel the cash dispenser in order fill it.

The cash dispenser will be mounted on a slide and swivel that will then lock into place when the ATM is in use. This will enable museum staff to load the cash dispenser from the front and not have to reach awkwardly into the ATM.

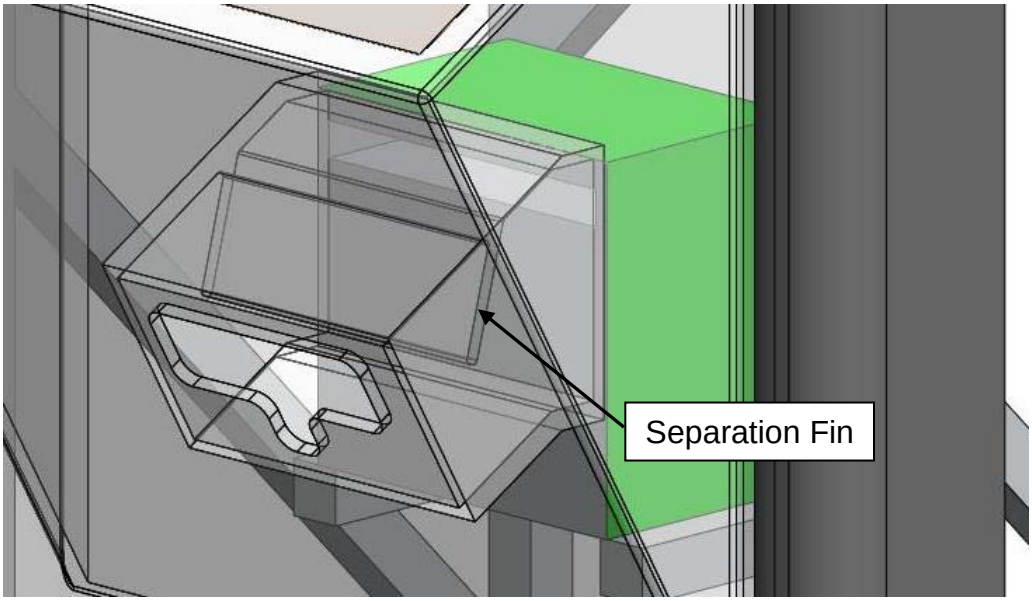
Safety

The magic ATM has been designed from the beginning with safety being paramount in the design process.

Moving parts of the ATM will be separated from the ATM users. This is especially important, since the primary user of the ATM will be children. Moving parts will be set back into the ATM, behind a themed plastic molded cover, with the parts being triggered by either optical sensors, or the PC.

The main concern is the money distribution slot. A custom chute has been designed that is similar to those found in vending machines to prevent customers from reaching up into the machine to grasp the items being sold. A plastic fin will be utilized to create a buffer that will prevent a child reaching up and into the cash dispenser.

While this in no way means a child could not reach into the slot, the fin's main purpose is to prevent any contact with the moving mechanism of the cash dispenser.



Other safety concerns include the refilling the money by the staff. The money cartridge will be made so that it is easily accessible using a swivel and a linear slide so that the machine is easily and comfortably refillable.

Software Section

The software portion of the report will detail the software that will be used to control the ATM.

Also detailed is why the particular software will be used and how it will be programmed and integrated with the various components.

Software Concepts

To decide on the software language and layout, the functional requirements for the software were examined. The program needs to be able to:

- Output graphics to a display
- Play a simple, fun game
- Communicate to the cash dispenser via RS232
- Take inputs from a USB keypad
- Handle multiple sensor inputs
- Control several banks of LED lights
- Be easy to maintain

Because of the software functional requirements and team member experience, the only viable options were assembly language and C++. While assembly code does have some advantages in program speed, it takes much longer to write and is very difficult to program for graphic output. Because the ATM uses a computer processor with a high clock speed, the small speed benefits are greatly outweighed by the added functionality and programming simplicity of C++

With C++ all of the functional requirements are met. While still not easy, the graphics are easy to manage and reliable. By creating arrays of key codes that are easy to change, the program will be easy to maintain. The key codes are the only portion of the code that museum staff may have to interact with.

The program is structured using object oriented programming. This creates a modular program that is easy to manage, and easy to add components to if needed. Through the use of inheritance, adding additional sensors, lighting arrays, or even displays should be quite easy. In order to ensure that all of the tasks are monitored sufficiently, cooperative multitasking will be used. Because of the high clock speed of the processor (2.16 GHz), more elaborate methods such as timeslicing or using hardware interrupts are not necessary.

The game incorporated into the ATM will be a simple question and answer game. The screen background is a skyline of Zoomtown. Each of the buildings acts as a question station (5 in all). An animated player walks between the stations, answering one question at each station. The player moves to the next station after the question is answered, regardless of the answer's correctness. In order to provide and experience which changes with each use, a bank of questions will be used for each station. By programming 5 questions into each of the 5 locations, 3125 individual experiences are possible.

Components & Materials

The product list was compiled using retail prices from online vendors. Several items may be available for discounted prices (such as educational discount), or available locally to save on shipping costs. Price includes shipping costs wherever possible. Prices were rounded up to the nearest dollar to provide for small variations in cost. Since the design is not completely finalized at this time, miscellaneous costs were added to the total project cost to account for small design additions and variations, as well as to cover unforeseen costs.

Item	Part Number	Vendor	Remaining Cost (Projected)	Final Cost (Total)
Dell inspiron 530n	inspiron530n	Dell.com		$ 534.02
Cash Dispenser	ezcd1000-1	Hwiglobal.com		$ 1,005.00
RS 232 Card	N82E16815150006	Newegg.com		$ 36.05
Ruggedized Keypad	OEM-18-KYB-PS/2	Ruggedkeyboard.com		$ 197.00
Digital I/O Board	USB-I2CIO	Acces I/0		$ 192.10
Misc. Electronics		Digikey.com	$ 242.93	$ 257.07
Steel Frame			$ 500.00	
Frame Covering		Various	$ 1000.00	
Misc. Mechanical			$ 200.00	
		Projected Remaining Costs:	$ 1,942.93	
		Cost of Ordered Parts:	$ 2,221.24	
		Projected Total Cost:	**$ 4,164.17**	

ATM Build

The method of assembly, as a whole, consisted of an approach where the most essential parts were created first, and the least important elements created last.

The most essential piece of the ATM is the steel structure. The analysis that was done was focused on creating a steel framework that would support the necessary loads indefinitely.

The pieces of steel were purchased and cut to appropriate lengths using a steel band saw. Some of the ends of the beams were cut to 45 degrees in order to ensure smooth joint connections.

The beams were then welded together using a MIG welder and flux cored wire.

Assembly was continued in this manner until the frame was complete.
A coat of black spray paint was applied before moving on.

Next, the largest issue to conquer was the façade of the ATM. The goal was to use something very durable, yet would sand down smooth and would look very much like existing ATM's. It was also important to keep cost and weight down.

The final design implemented was a polyurethane foam core covered in fiberglass that was subsequently sanded and painted.

The first task was to build wood mold to pour the foam into. It was important to make the mold as accurately as possible as this would cut down on filling and sanding later.

The foam to be used was a two-part liquid that, when combined, rapidly expanded and hardened. In order to expedite the process of popping the foam core out of the wood mold, we lined the wood with duct tape to act as a quick release agent.

Finally, the mold was filled with the foam and was placed in a heated environment to allow the foam to fully cure.

Once the foam was full removed from the mold and some cursory sanding was done, the façade core was taken to the SLO Children's Museum for a test fit. The results were pleasing.

Special sanding tools were used to shape the foam into the desired layout. Before the fiberglass process began, all holes in the foam were filled with spot filler foam.

The foam was then prepped for the fiberglass cloth by being coated with polyester resin. After the cloth was laid, more resin was used to fully bond the fiberglass. The process was repeated for many layers.

Next began the long and arduous process of filling and sanding. Using Bondo fiberglass filler, all pinholes left behind were filled. Many hours were spent sanding, using both power and hand tools, the entire foam body and achieving a finish that was a smooth as possible. Finally after more coats of resin, red paint, and clear gloss finish, the façade was complete.

All that was left to create were the other, smaller components that attach to the frame. A panel was made out of wood and painted blue to complement the red color of the façade to replicate a Bank of America ATM. The panel is to be used as a holder for the computer monitor.

Also, as part of the magical experience, over 50 color-changing LED's were installed in a gap inside the panel providing a dazzling light display. The lights were held in place in an acrylic plate using epoxy and mounted to the back of the panel. The LED's wire wired in parallel and can be plugged direct into a wall socket.

In order for the children to enjoy the exhibit better, the lower portion of the ATM was made of see-through acrylic. This way, the children could actually see the bill dispenser and watch it dispense the bills. The acrylic pieces were ordered cut-to-size and were assembled using a very strong adhesive. A slot was cut in the front panel for bill removal and the entire casing was flame polished to provide smoothness and to dull the edges.

The façade and acrylic front were bolted to the frame and another test fit was done in the museum.

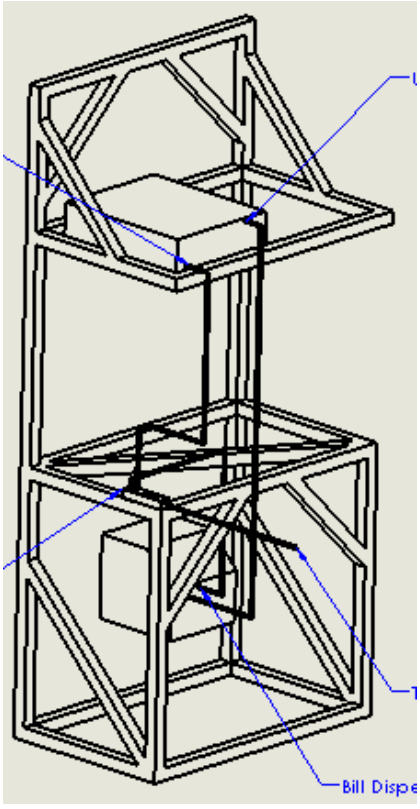
Other small pieces of the puzzle were assembled last. The card reader and slot were made out of a casting resin that was poured into a wooden mold. The stainless steel instrument panel to hold the card reader, slot, and keypad was bolted to the acrylic. Finally, the bill dispenser was mounted onto a metal slider and the CPU was mounted on the upper part of the structure.

Testing

Testing was done during the assembly of the ATM. Critical key components of the ATM were tested as they were manufactured. The first and most crucial testing feature was based on the stability of the ATM structure.

It was important that the ATM was not too top heavy. We would not like the ATM to fall over in the event of an earthquake. After the frame was manufactured and the fiberglass façade was attached to the front of the frame it was observed that it could be possible in a moderate earthquake that the ATM could tilt forward.

This was a concern for us, and when the ATM was put into the museum, testing was again done to see if the tilting problem would occur and it was found that the ATM would not become dislodged from its holding place due to the upper shelf of the ATM from hooking underneath the door.



It was also found that there would be no way in which a child could dislodge the ATM from the wall because the façade was amply situated in the frame. Due to the additional weight of the computer components that were not taken into account when initial tilt tests were done. The computer weight lowered the center of gravity and significantly increased the stability of the structure.

Concern was expressed about the bill dispenser and the possibility that a child could reach into the moving machinery if they wanted to. A guard was designed to keep hands out of the bill dispenser. The placement was determined to be extremely important. It had to be placed so that a child would not reach under it into the machinery, and also it had to allow the money from the bill dispenser to slide into the money slot properly.

We had a child reach into the money slot various different ways to find out how they would twist their arm to get to the bill dispenser. The original position was found to be a little too low. A child could reach over the bill dispenser. When the guard was moved down and angled out towards the bill dispenser opening the guard proved to be more effective in preventing a child from reaching up into the bill dispenser and also from a child from reaching under the guard, except to grab the money.

The fun features of the ATM were also tested for maximum effectiveness. Originally, the color changing LEDs were going to be placed along a clear plate of Plexiglas. During our initial mockup of the LEDs it was found that the effect was not able to be seen since there was no surface for light diffraction on the Plexiglas.

It was quickly found that scratching the Plexiglas would be the best solution to the problem, since the scratching would prove to be an effective surface to bounce light off of.

Ethical Considerations

One of the chief design objectives of the Magic ATM is to provide an educational experience. The biggest ethical concern of this project is how the criterion is satisfied. It is essential that the ATM instills positive financial values yet is fun enough to be used over and over again.

The conveyance of information is via the game experience (see page 13). The ethical issue of the project lies in the specific questions that are asked of the children. Each trivia question will be carefully crafted to be challenging and yet not be frustrating. When a question is answered incorrectly, the correct answer will be displayed clearly reinforcing positive financial habits. Each question will be formulated to relate to the child's surroundings (ie. purchasing a movie ticket) and also simulate resolving an issue with money (ie. making change).

The overall experience adds to the educational component (see page 16). The exhibit will model real-life transactions like swiping a debit card, entering a PIN via a keypad, and removing cash from the associated compartment. The money can also be used in various play stations throughout Zoomtown. Ethically, this instills positive money handling techniques in children. These faux experiences in dealing with money prepare the children for real-life situations later in life.

However, if these issues are dealt with carelessly, the exhibit loses its effectiveness and value. An exhibit in a children's museum need to teach children about life and its challenges. Parents need to be able to trust that the museum is doing this in an ethical manner, or else the museum loses its credibility in the community.

The Magic ATM, however, will be a great learning tool for children of all ages. Every effort will be given to ensure a positive learning experience. After interaction with the exhibit, each child will walk away with money in- hand as reward for learning some basic monetary principles.

Final Concept

The proposed final design is powered by an off-the-shelf Dell Inspiron 530n PC. This allows much more flexibility with graphics than a microprocessor. The Dell PC is supplied with a 17 inch monitor.

The cash dispenser is an HWI ezCD1000-1. This bill dispenser has a capacity of 800 notes, which will supply 160 children with 5 notes apiece. The bill dispenser communicates with the PC via an RS232 card.

The machine is activated by infra red switches. To provide more reliability two identical switches are used, with either switch triggering the machine. The switches and any lighting or visual cues are handled through a digital I/O board connected through the PC's USB ports.

The ATM frame is constructed out of steel. It is designed with wheels for easy movement and access, as well as a swivel/sliding mechanism for easy access to the cash dispenser.

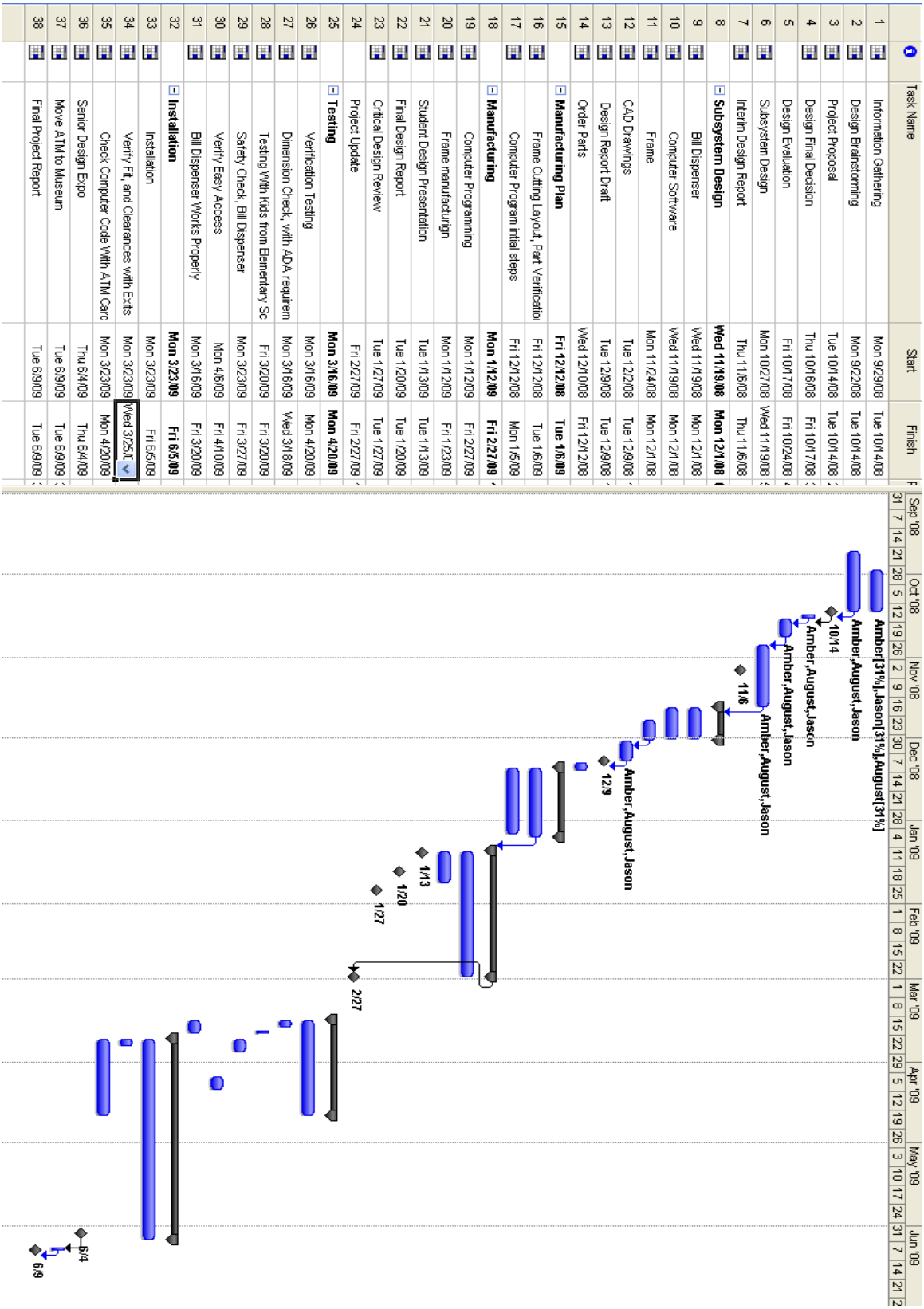
The housing of the ATM is made out of clear gel coat fiberglass, with the bottom portion being fabricated out of scratch resistant acrylic.

The total projected cost at this time is $4164.17. This includes all of the major components as well as allowances for additions such as lighting and sound and an additional $500.00 built into the budget under frame covering for graphic design.

Item	Part Number	Vendor	Remaining Cost (Projected)	Final Cost (Total)
Dell inspiron 530n	inspiron530n	Dell.com		$ 534.02
Cash Dispenser	ezcd1000-1	Hwiglobal.com		$ 1,005.00
RS 232 Card	N82E16815150006	Newegg.com		$ 36.05
Ruggedized Keypad	OEM-18-KYB-PS/2	Ruggedkeyboard.com		$ 197.00
Digital I/O Board	USB-I2CIO	Acces I/0		$ 192.10
Misc. Electronics		Digikey.com	$ 242.93	$ 257.07
Steel Frame			$ 500.00	
Frame Covering		Various	$ 1000.00	
Misc. Mechanical			$ 200.00	

Projected Remaining Costs:	$ 1,942.93
Cost of Ordered Parts:	$ 2,221.24
Projected Total Cost:	**$ 4,164.17**

Appendix A: Project Gantt Chart



	Task Name	Start	Finish
1	Information Gathering	Mon 9/29/08	Tue 10/14/08
2	Design Brainstorming	Mon 9/22/08	Tue 10/14/08
3	Project Proposal	Tue 10/14/08	Tue 10/14/08
4	Design Final Decision	Thu 10/16/08	Fri 10/17/08
5	Design Evaluation	Fri 10/17/08	Fri 10/24/08
6	Subsystem Design	Mon 10/27/08	Wed 11/19/08
7	Interim Design Report	Thu 11/6/08	Thu 11/6/08
8	**Subsystem Design**	**Wed 11/19/08**	**Mon 12/1/08**
9	Bill Dispenser	Wed 11/19/08	Mon 12/1/08
10	Computer Software	Wed 11/19/08	Mon 12/1/08
11	Frame	Mon 11/24/08	Mon 12/1/08
12	CAD Drawings	Tue 12/2/08	Tue 12/9/08
13	Design Report Draft	Tue 12/9/08	Tue 12/9/08
14	Order Parts	Wed 12/10/08	Fri 12/12/08
15	**Manufacturing Plan**	**Fri 12/12/08**	**Tue 1/6/09**
16	Frame Cutting Layout, Part Verificatio	Fri 12/12/08	Tue 1/6/09
17	Computer Program initial steps	Fri 12/12/08	Mon 1/5/09
18	**Manufacturing**	**Mon 1/12/09**	**Fri 2/27/09**
19	Computer Programming	Mon 1/12/09	Fri 2/27/09
20	Frame manufacturign	Mon 1/12/09	Fri 1/23/09
21	Student Design Presentation	Tue 1/13/09	Tue 1/13/09
22	Final Design Report	Tue 1/20/09	Tue 1/20/09
23	Critical Design Review	Tue 1/27/09	Tue 1/27/09
24	Project Update	Fri 2/27/09	Fri 2/27/09
25	**Testing**	**Mon 3/16/09**	**Mon 4/20/09**
26	Verification Testing	Mon 3/16/09	Mon 4/20/09
27	Dimension Check, with ADA requirem	Mon 3/16/09	Wed 3/18/09
28	Testing With Kids from Elementary Sc	Fri 3/20/09	Fri 3/20/09
29	Safety Check, Bill Dispenser	Mon 3/23/09	Fri 3/27/09
30	Verify Easy Access	Mon 4/6/09	Fri 4/10/09
31	Bill Dispenser Works Properly	Mon 3/16/09	Fri 3/20/09
32	**Installation**	**Mon 3/23/09**	**Fri 6/5/09**
33	Installation	Mon 3/23/09	Fri 6/5/09
34	Verify Fit, and Clearances with Exits	Mon 3/23/09	Wed 3/25/0
35	Check Computer Code With ATM Carc	Mon 3/23/09	Mon 4/20/09
36	Senior Design Expo	Thu 6/4/09	Thu 6/4/09
37	Move ATM to Museum	Tue 6/9/09	Tue 6/9/09
38	Final Project Report	Tue 6/9/09	Tue 6/9/09

Appendix B: Cash Dispenser Information

Make IT Easy

The best choice for self-service automation

ezCDM1000

The low price & ultra compact CDM for retail ATM

LG Cash Dispensing Module

- ezCDM 1000 is an extremely compact cash dispensing module, which is developed focusing on worldwide retail ATM market.
- ezCDM 1000 makes it ideal for retail and off-premise market with its low-end, low-transaction features.
- ezCDM 1000 provides the full benefits of cash dispensing modules with reliability and high performance.

LG N-Sys

The best choice for self-service automation

ezCDM1000

The low price & ultra compact CDM for retail ATM

Features

- Low-price & ultra compact size for low transaction environment
- Field expandable structure up to 3 denomination
- Front access service for easy management
- Double detect facility for determination of notes singularity
- Auto Jam recovery algorithm
- Mechanical key door lock to protect any illegal access to stored notes
- Easy setup, plus highly reliable operation
- Ability to handle worldwide notes and a wide range of media size
- RoHS compliant

Cassette

Specification

Denomination	1~3 Denomination	
Cassette Capacity	128mm	
	Old(750 notes) / New(900 notes)	
Reject Cassette Capacity	About 100 notes (Remove Type)	
Media Capacity	Width	60 ~ 85mm
	Length	120 ~ 175mm
	Thickness	0.07 ~ 0.25mm
Dispensing Speed	2~3 notes / sec	
Replacement	Front	
Dimension(H x W x D)	1 Denomination	250 x 263 x 273
	2 Denomination	406 x 263 x 273
	3 Denomination	562 x 263 x 273
Weight	1 Denomination	7.5Kg
	2 Denomination	11.5Kg
	3 Denomination	15.5Kg
Interface	RS-232C	
Power Requirement	AC 90~240V 53W	
Environment	Temperature Operation	5 ~ 40℃
	Storage	-5 ~ 40℃
	Humidity Operation	30 ~ 85%
	Storage	10 ~ 90%

LG N-Sys

Global Distributors

Hemisphere West International

North/South America,
Australia, East Asia
Hemisphere West International, Inc.
Phone: +1-702-364-4936
Fax: +1-702-364-9915
email: sales@hwiglobal.com

Europe/Middle East, Africa
Hemisphere West Europe Ltd.
Phone: +44 (0) 1239 654157
email: sales@hwieurope.com

1-1. Performance and function 1)

Denomination

US$ (1$, 5$,10$, 20$, 50$) Width : 160mm, Height : 60mm

* **M**ulti **C**urrency **S**ize Application Width : 120mm ~ 178mm Height : 60mm ~ 80mm

But) **If you want to use other notes except US$, you must obtain our approval.**

2) Cassette Capacity

850 (approx) New Notes 700 (approx) Used Notes

3) Cassette Type

-Front Access Type -Mechanical Key Security [Module Door Lock Type]
* Option : Knob Type -Push Plate Locking / Automatic Unlocking [Link Lock Design]

4) Dispensing Speed

3.0 sheets per second ± 10% [Based on 1Denomination]

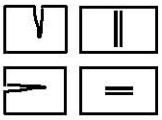
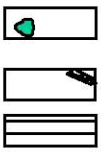
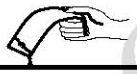
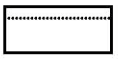
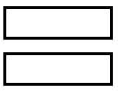
5) Note Detection Function

Delivery Detection
1) Detect whether dispensing note delivered or not completely. 2) Count the number of delivered notes.

Double Detection
1) Detect the poor operation of delivered module, like double/overlapping transference of note. 2) After Detecting, double/overlapping note fills in Reject Box

Confirmation
1) Detect note of Reject Box. 2) Count the number of rejected notes.

6) Usage Note

NO	Abnormal Notes Spec	Result	Remarks
1	[Tear Notes]  • Shape : Inner / Outer • Width : Over 2mm • Length : Over 2mm	Remove	
2	[Damage Notes]  • Hole : Over Φ1mm • Damage : Over 2×2mm	Remove	
3	[Dirty Notes]  • Pollution Thickness Over 0.2mm • Tape Notes • There is a pollution in the middle point	Remove	
4	[Wet Notes] 	Remove	
5	[Skew]  • Angle : Over 12°	Check Reject	
6	[Length]  • Length : Except 37 ~ 62 Slit (52 ~ 87 mm)	Check Reject	
7	[Distance]  • Length : Below 47 Slit 이하 (66mm)	Check Reject	
8	[Overlap 2 Notes]  • Overlap by pollution	Check Reject	

Appendix C: Ruggedized Keypad Datasheet

Datasheet
Models: OEM-18-KYB-PS/2
(OEM/Open-Frame NEMA 4, 4X, 12 Numeric Keypad)

The Ruggedkeyboard.com model OEM-18-KYB-PS/2 provides a full numeric keypad that is easily integrated into any system. Each kit is comprised of an industrial silicone keypad, switch matrix board, keyboard controller, and cables.

Product Photo	Keyboard Features
	NEMA 4, 4X, 12 ABS-Polycarbonate Sealed Plastic Case 18 key numeric layout with Enter, Escape, and Arrow (numlock) key functionality. 10 Million cycles expected life Ideal for Kiosk Applications Includes 6' cable w/ 5-pin DIN, 9-pin serial connectors, PS/2 cables Dimensions: 4.38"W x 5.13"D x 0.75"H **Other Available Models:** *Panelmount: 18-PM-PS/2, 18-PM-HP-PS/2* *Desktop: 18-DT-PS/2*

Technical Specifications

Industrial Approvals
Nema 4, 4X
UL-1950, CE, FCC Class 15, Part B

Key Switch
Material: Industrial Silicone Rubber
Life: Greater than 10 million cycles
Travel: 0.060" (1.5mm)
Actuation Force: 5oz (130g)
Feedback: Tactile with mechanical snap

Power
Keyboard: 5V@10ma (from

Vibration
Power Special Density: 0.04g/Hz
Frequency Range: 20Hz-2kHz
Duration of Test per Axis: 3 hours

Dimensions
(W-H-D) 4.38" x 5.13" x 0.75"
111.3mm x 130.3mm x 19.1mm

Cable
Length: 10 feet (3.94 meters)
Design: "Y" PS2 pr AT/serial Cable (providing separate keyboard and mouse connections),

Compatibility
PS/2 Keyboard:

CPU Port)

Temperature Range
-40F to +194F (-40C to +90C)

Humidity
100%

Shock
3x11 ms pulses of 50g on each of 3 axes

Flammability
Printed Circuit Board: 94 VO
Silicone Overlay: 94 HB
Interface Cable: 94 VO

Compatible with all Windows Operating Systems

Warranty:
1 Year Limited Warranty

Appendix D: Dell Inspiron 530n Information

Order Details

Order Number: 607108887 **Estimated Ship Date:** 01/26/2009

Item Number	Quantity	Item Description
467-9294	1	Inspiron 530,Intel Pentium Conroe Dual Core Processor E5200(2.5GHz,800FSB) with 2MB cache
311-7244	1	2GB DDR2 SDRAM at 800MHz
330-0916	1	Dell USB Optical Mouse
330-3666	1	Dell USB Keyboard Black
320-5489	1	Dell 19 inch E198WFP Flat Panel Analog and Digital
320-5878	1	Integrated Intel Graphics Media Accelerator 3100
341-4809	1	250GB SATA II Hard Drive (7200RPM)
341-5008	1	No Floppy Drive or Media Card Reader
420-9155	1	Ubuntu 8.04 with DVD Playback
310-1966	1	Mouse included with Keyboard purchase
430-0412	1	Integrated NIC card
313-3137	1	No modem requested for Dell Dimension
313-5270	1	16X DVD+/-RW Drive
313-2758	1	Integrated Audio
313-2198	1	No Speaker Requested
461-8389	1	No Virus Protection Requested
412-1397	1	No Productivity Software requested
987-3137	1	Dell Hardware Warranty PlusOnsite Service, Initial Year
982-4310	1	Type 3- Third Party At Home Service, 24x7 Technical Support, Initial Year
987-6238	1	No Warranty, Year 2 and 3
960-3249	1	Banctec Service Agreement
983-3680	1	Warranty Support,Initial Year
990-8029	1	1 Year Limited Warranty and Next Business Day,Desktop
466-7653	1	Thank you for choosing Dell
600-0040	1	State Environmental Fee for display 15 inches, less than 35 inches
*		-DISCOUNT/COUPON APPLIED

Subtotal:	**$448.00**
Shipping and Handling:	$35.00
Environmental Disposal Fee:	$16.00
Sales Tax:	$35.02
Total:	**$534.02**

Appendix E: I/O Card Information

Product Summary:

The USB-I2C/IO interface board provides a simple, "drop-in", solution for customers that need to connect hardware to a P.C. The new Rev. C1 board provides up to 32 bits of user-configurable digital I/O, an I^2C/SMBUS interface with a configurable clock (100Kbps, 400Kbps, 1Mbps, etc.), and more.

Key Features:

-12Mbps USB 2.0 interface (full-speed device) to host P.C.
-Silicon Labs C8051F340 micro-controller (48Mhz, 63KB flash, 4KB sram, USB, I2C/SMBUS, SPI, etc.).
-Up to 32 bits of user configurable, general purpose digital I/O via commonly available 0.1" spacing connectors.
- I^2C/SMBUS multi-channel interface supporting configurable clock speeds, onboard 16KB I^2C eeprom (fully available to user, and on it's own I2C bus segment for isolation), 5 pin connectors for attaching external I^2C hardware.
-USB Status LED, lights on enumeration, blinks to indicate USB traffic, off when suspended. Error LED, indicates when the board's firmware has detected an error, error can be read and cleared via API.
-Small form factor (3.0" X 2.25") with 0.125" mounting holes in corners.
-Downloadable board firmware, simplifies updates and allows for code customization.
-Included API (applications programming interface) software implemented as Windows DLL in C, gets your application up and running fast!

Applications:

-USB to I2C/SMBUS bridge for interfacing to a wide variety of I2C/SMBUS components.
-USB to general purpose digital I/O bridge for interfacing to switches, LEDs, and other hardware.
-Can be used as low cost prototype hardware for developing your own Silicon Labs C8051F340 micro projects.
-Test fixture interface.
-Rapid prototyping interface.
-Data Acquisition.

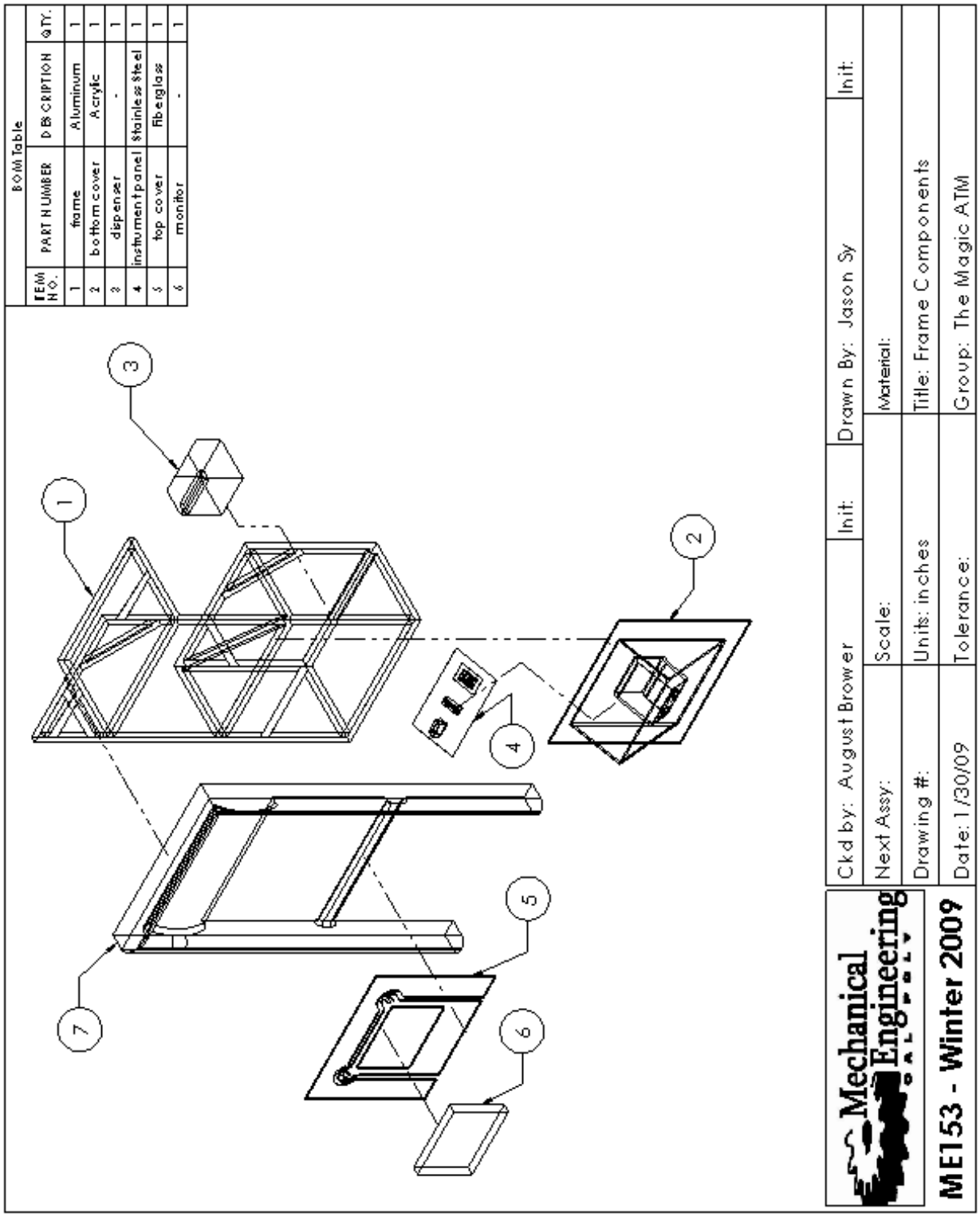
Hardware:

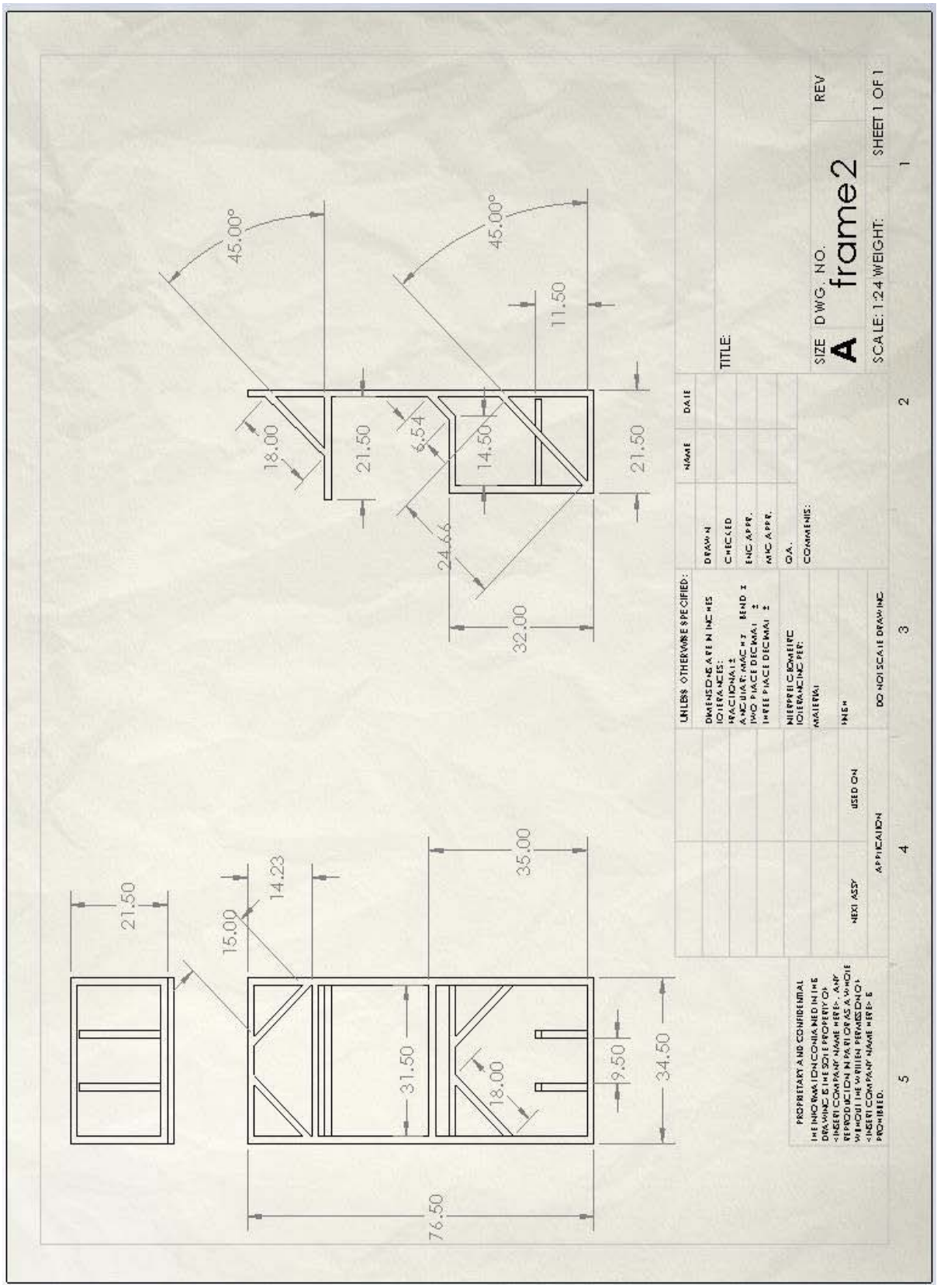
-The full-speed USB interface provides your application hardware with a "Hot Plug and Play", 12Mbps, industry standard connection to your P.C. host.
-Utilizes Silicon Labs C8051F340 USB micro-controller.
-Power configuration jumper allows board to be powered by USB or by external circuitry.
-I2C power configuration jumper allow I2C bus to be powered by variety of sources (+5V, +3.3V, External voltage).
-Debug Connector footprint provides for using board as low cost development hardware for your own C8051F340 projects.
-Eeprom Write Protect jumper provides protection from accidental onboard eeprom erasure.

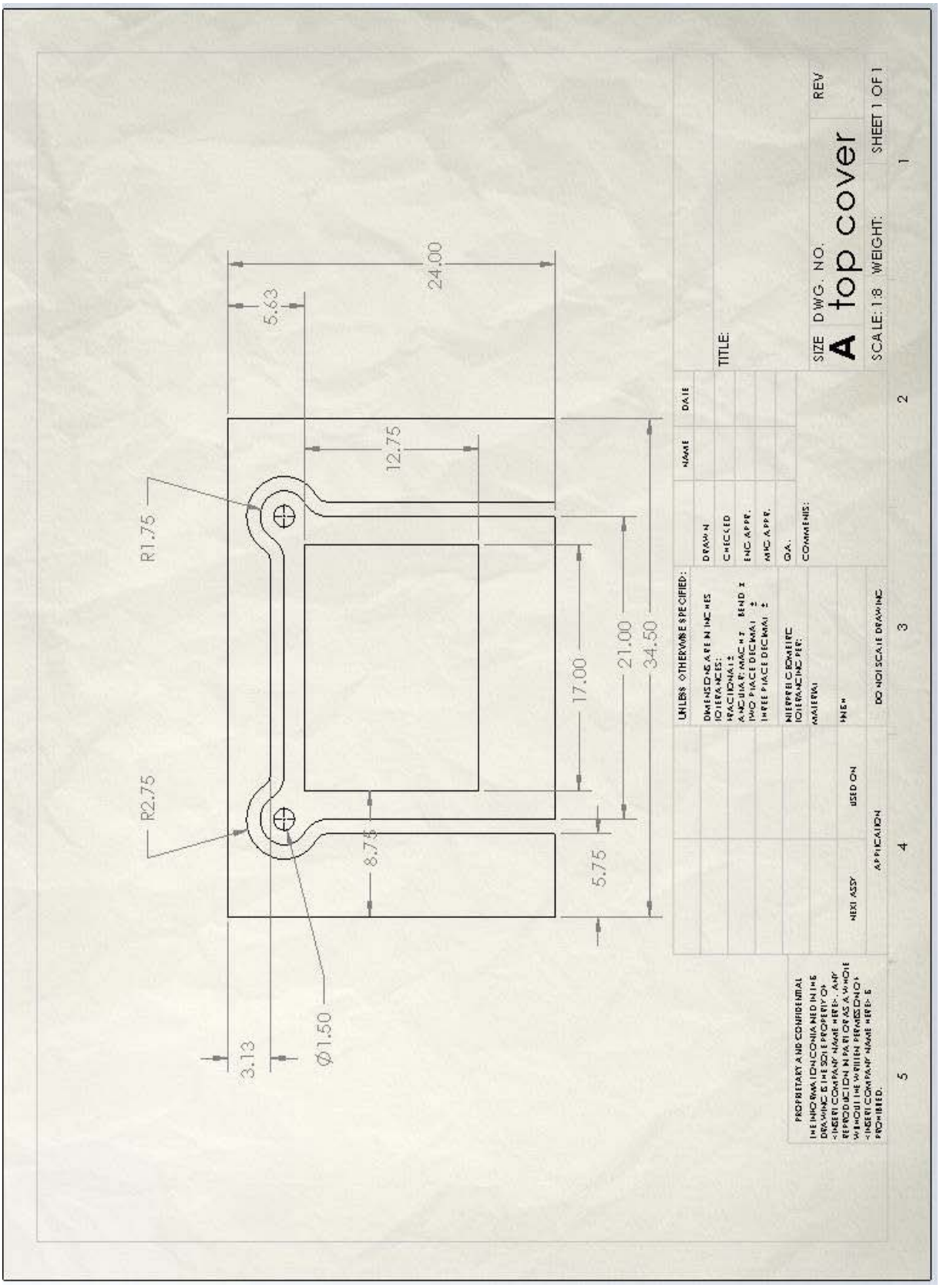
Software:

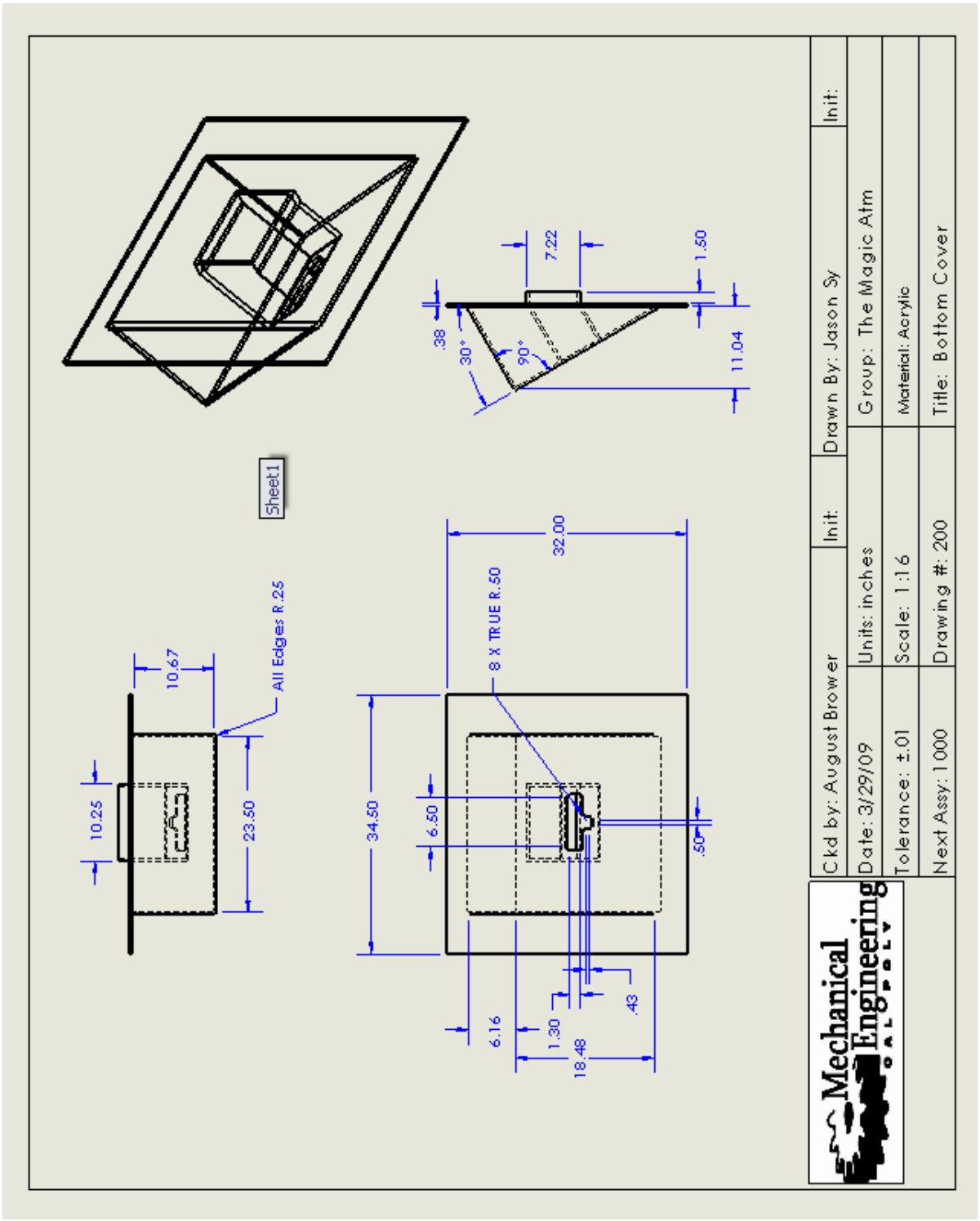
-The included device driver, dll, and example application software make it easier than ever to access your application hardware from your P.C.
-The software provides support for connection of multiple boards, making the USB-I2C/IO a great solution when multiple equipment instances are required (test fixtures, production equipment, instruments, etc.). Each board can be uniquely identified and accessed by your application software via a serial number.

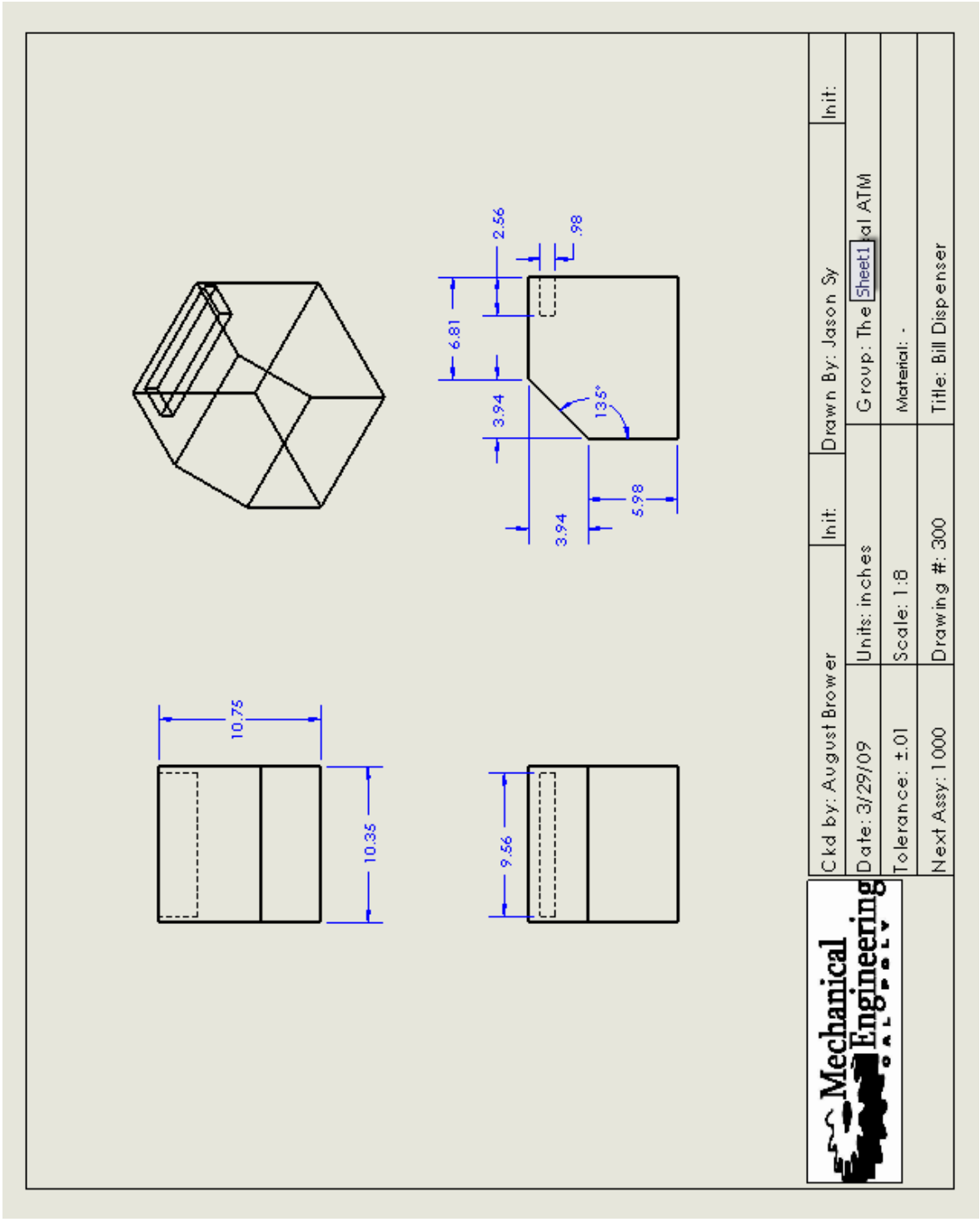
Appendix F: Detailed Design Drawings

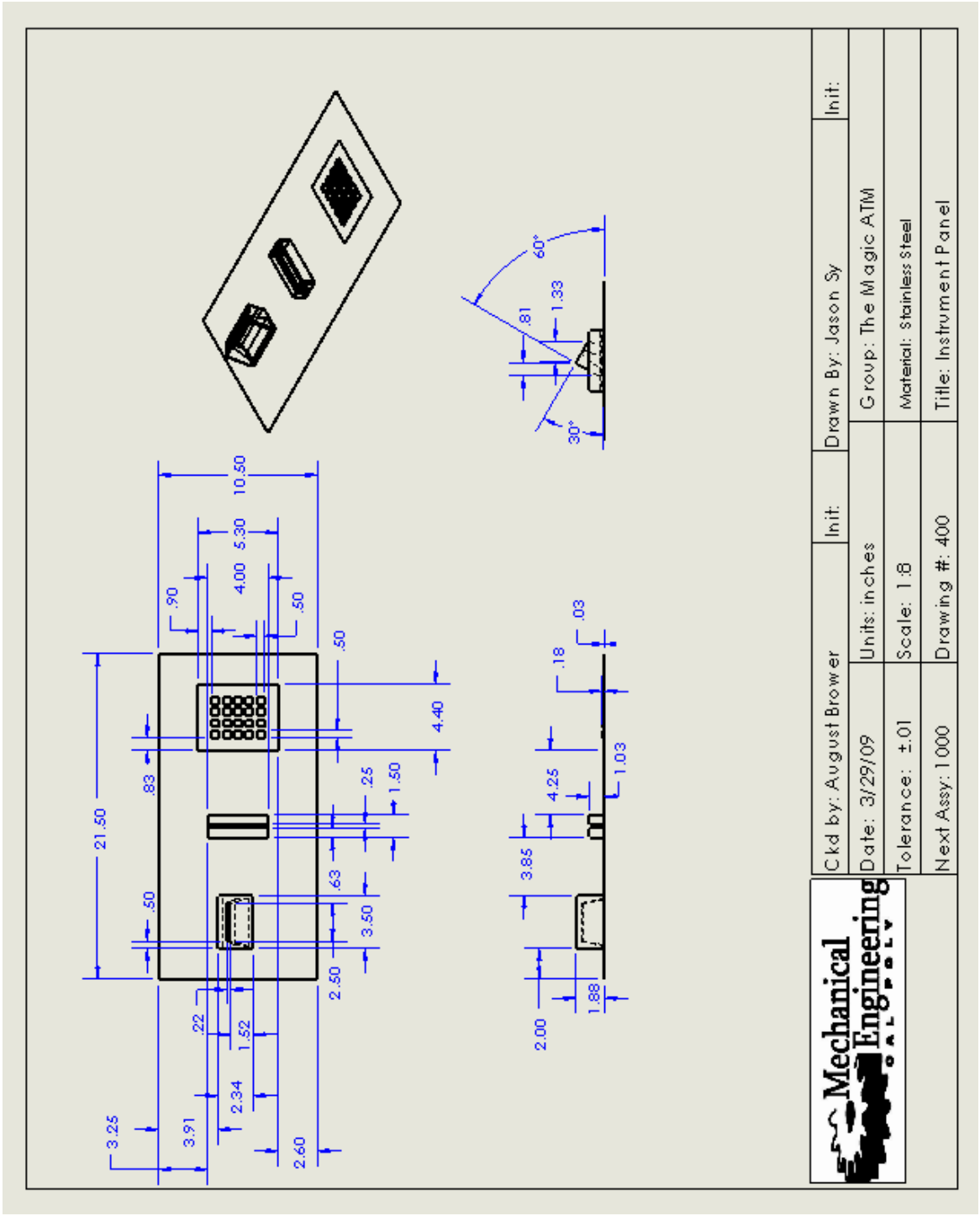


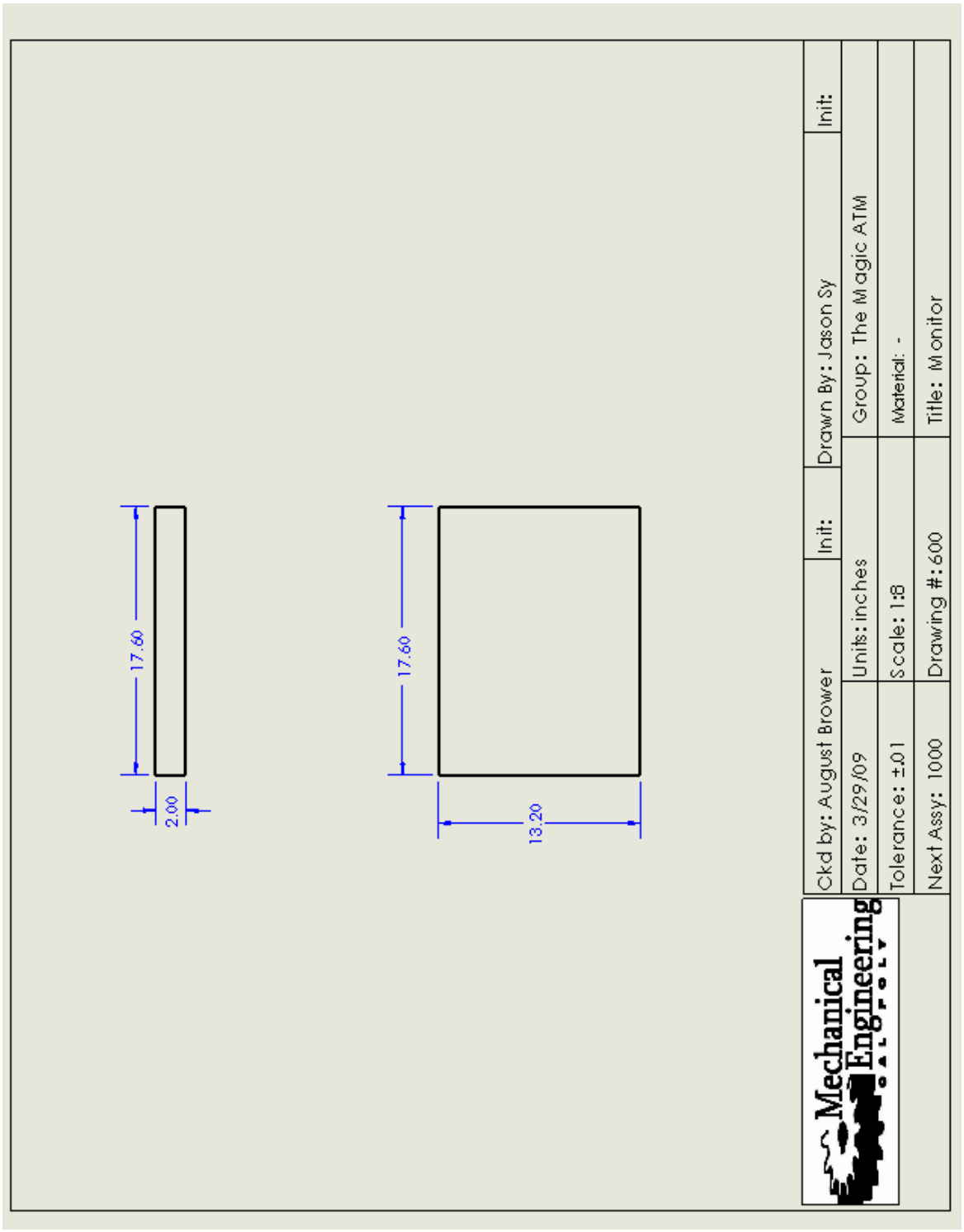

45.00°
45.00°
18.00
21.50
6.54
14.50
11.50
21.50
24.66
32.00
21.50
15.00
14.23
35.00
31.50
18.00
9.50
34.50
76.50
UNLESS OTHERWISE SPECIFIED:
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
NAME
DATE
TITLE:
SIZE
DWG. NO.
REV
A
frame2
SCALE: 1:24 WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING

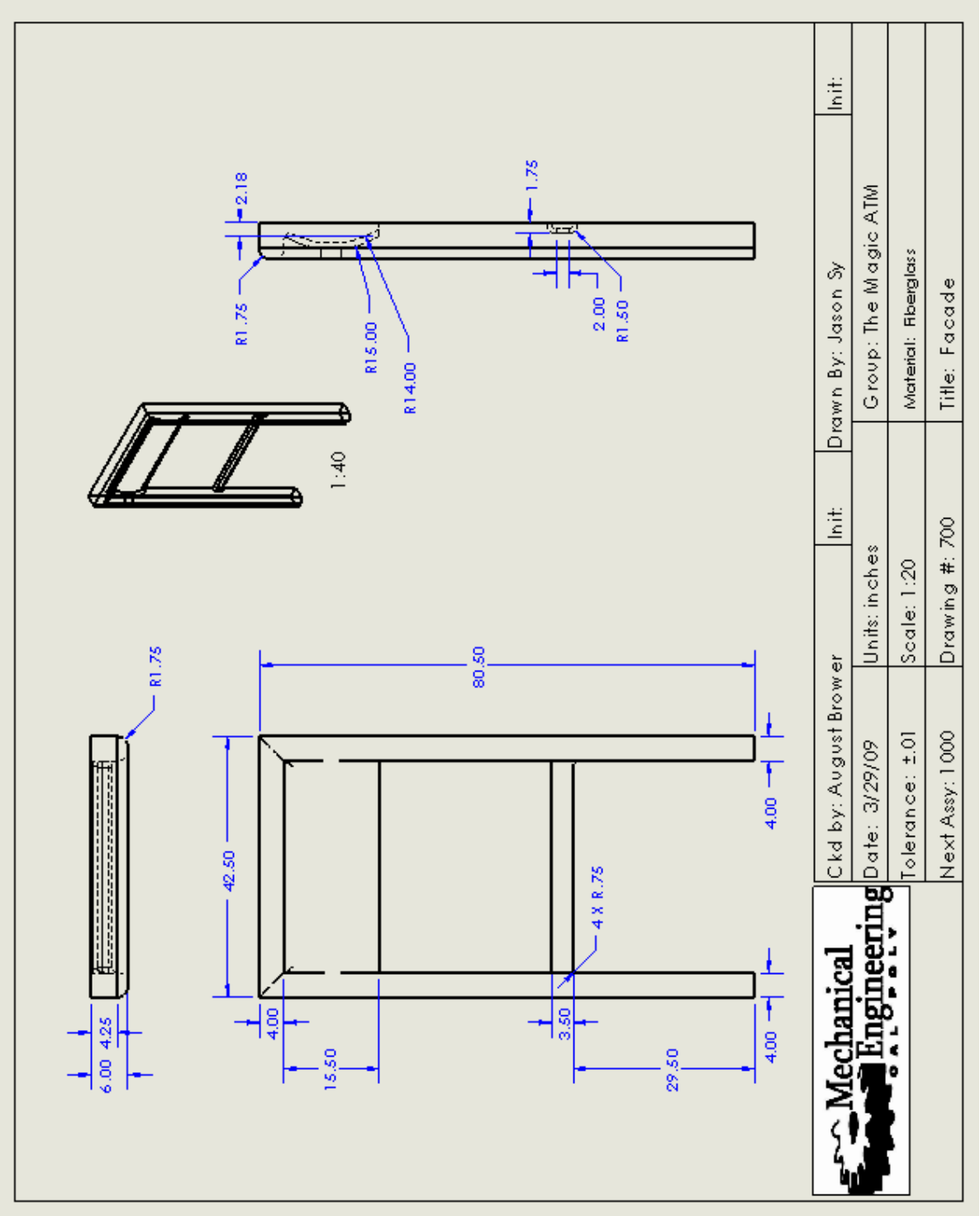

24.00
5.63
12.75
R1.75
R2.75
17.00
21.00
34.50
8.75
5.75
3.13
Ø1.50
A top cover
SIZE DWG. NO. REV
SCALE: 1:8 WEIGHT: SHEET 1 OF 1
TITLE:
UNLESS OTHERWISE SPECIFIED:
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
NAME
DATE
PROPRIETARY AND CONFIDENTIAL

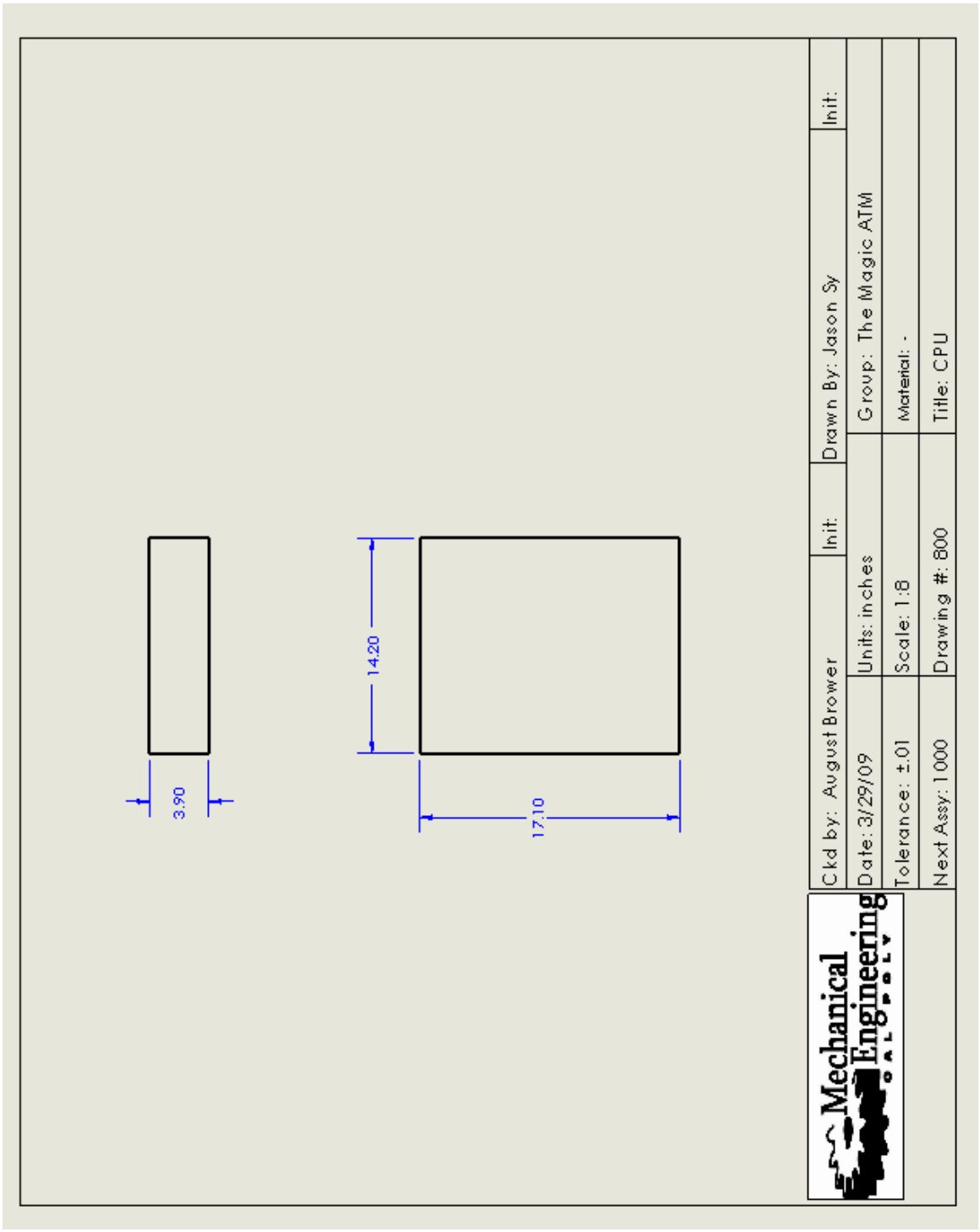

Sheet1
7.22
1.50
.38
30°
90°
11.04
32.00
8 X TRUE R.50
34.50
6.50
.50
6.16
1.30
18.48
.43
10.67
All Edges: R.25
10.25
23.50
Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Magic Atm
Tolerance: ±.01
Scale: 1:1.6
Material: Acrylic
Next Assy: 1000
Drawing #: 200
Title: Bottom Cover
Mechanical Engineering

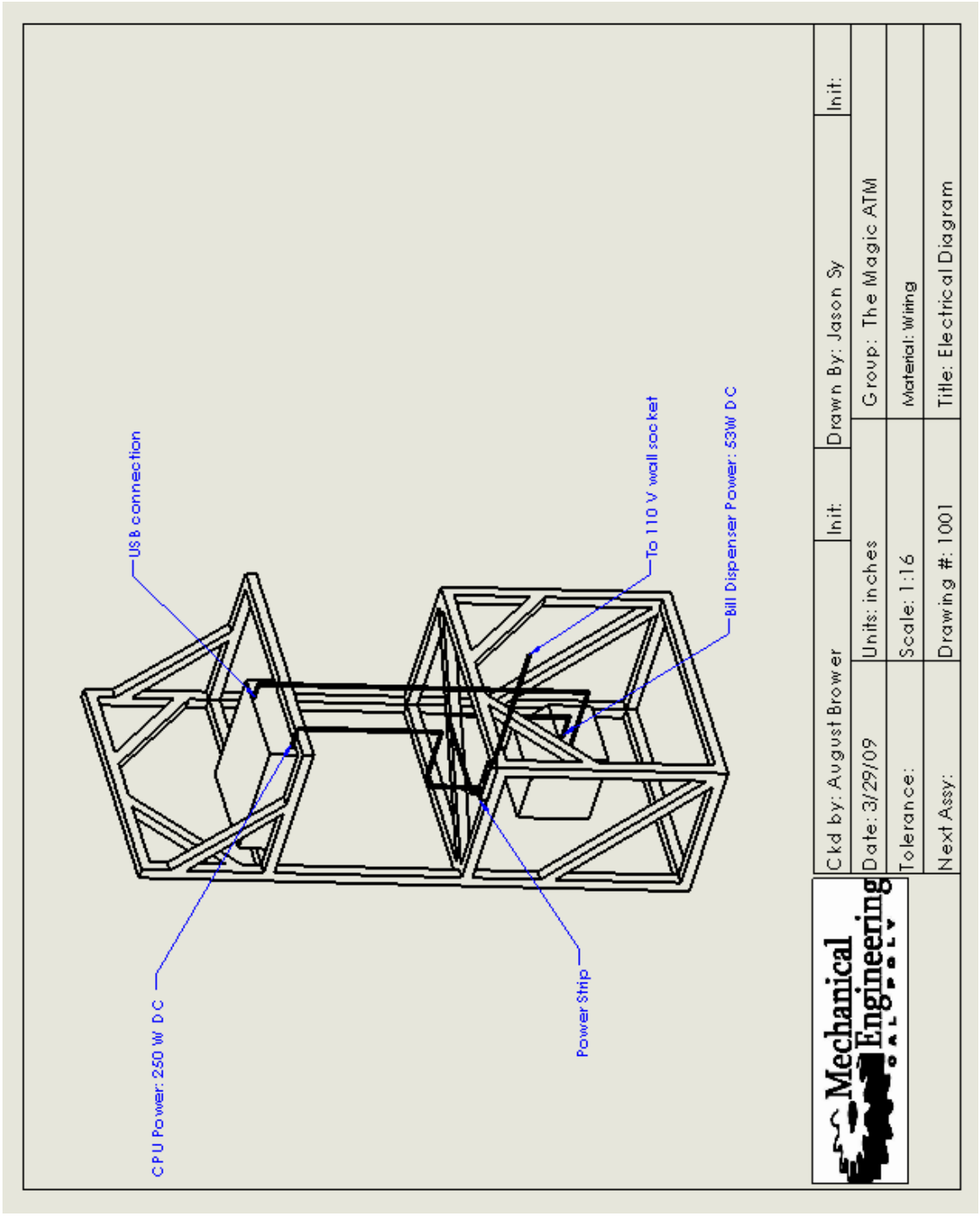

2.56
.98
6.81
3.94
135°
3.94
5.98
10.75
10.35
9.56
Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Sheet1 al ATM
Tolerance: ±.01
Scale: 1:8
Material: -
Next Assy: 1000
Drawing #: 300
Title: Bill Dispenser
Mechanical Engineering


Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Magic ATM
Tolerance: ±.01
Scale: 1:8
Material: Stainless Steel
Next Assy: 1000
Drawing #: 400
Title: Instrument Panel
Mechanical Engineering
10.50
5.30
4.00
.90
.50
.50
4.40
21.50
.83
.25
1.50
.50
.63
3.50
2.50
.22
1.52
2.34
3.25
3.91
2.60
60°
30°
.81
1.33
.03
.18
1.03
4.25
3.85
2.00
1.88


17.60
2.00
17.60
13.20
Mechanical Engineering
Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Magic ATM
Tolerance: ±.01
Scale: 1:8
Material: -
Next Assy: 1000
Drawing #: 600
Title: Monitor


2.18
1.75
R1.75
R15.00
R14.00
2.00
R1.50
1:40
R1.75
80.50
42.50
4.00
4 X R.75
4.00
3.50
4.00
6.00
4.25
15.50
29.50
Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Magic ATM
Tolerance: ±.01
Scale: 1:20
Material: Fiberglass
Next Assy: 1000
Drawing #: 700
Title: Facade
Mechanical Engineering


3.90
14.20
17.10
Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Magic ATM
Tolerance: ±.01
Scale: 1:8
Material: -
Next Assy: 1000
Drawing #: 800
Title: CPU
Mechanical Engineering


USB connection
To 110 V wall socket
Bill Dispenser Power: 53W D C
CPU Power: 250 W D C
Power Strip
Ckd by: August Brower
Init:
Drawn By: Jason Sy
Init:
Date: 3/29/09
Units: inches
Group: The Magic ATM
Tolerance:
Scale: 1:16
Material: Wiring
Next Assy:
Drawing #: 1001
Title: Electrical Diagram
Mechanical Engineering