Pet Food Storage and Automated Feeder

by

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ABSTRACT

The problem addressed in this technical report is the lack of an effective system for feeding the family pet. The basic system for completing this task is to have a pet food storage container, to hold the food until feeding, and having a bowl for the food which is filled by the pet owner as a chore designated for a specific person in the family. There are some distinct flaws with this system. Some of which are that the food storage container is unsightly and it takes up too much space, and the task of feeding the pet has become cumbersome and sometimes goes undone (or is done too much due to a lack of communication.) In order to eliminate this problem a Pet Food Storage and Automated Feeder was developed in order to store all pet food up and out of the way while being able to feed the pet with little or no effort and at programmable times.

Many different steps were taken in the design and development of this project. In order to correctly identify and address the customer's needs for this product the first step which was taken was to identify what is currently available in the way of pet food storage and also what is available in automated pet feeders. From this information it was able to be determined what this product's potential customers could reasonably expect from this prototype and a corresponding survey was developed and conducted. The results from that survey were then processed and it was possible to extract a great deal of essential data which relayed the customer's most important wants and needs. This data allowed for the creation of the product objectives which outlined the parameters which needed to be met with this design. The next step in the process was to design and draw the device with computer aided design software. Once the prototype was drawn and the components had been selected then the fabrication of the feeder could commence. Upon completion of the prototype it could then be tested to see if all previously determined design requirements had been met.

The prototype constructed from using the steps detailed above was able to meet all expected requirements and shows the viability of a Pet Food Storage and Automated Feeder device in the homes of today.

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INTRODUCTION

Many household tasks can be adequately handled through the use of technology, one such task is the feeding of the family pet. The concept of an automated pet feeder is not a new one, but prior feeders have been designed with the idea of feeding the pet while the owner is out of town or away for a period of time. This thought process has led to feeders being too small and battery operated, meaning that if the feeders were used on a full-time basis they would require more work (filling, changing batteries and reprogramming) and would be less dependable (cheap materials and battery failure) than feeding the pet by hand. Also, it is important to understand that pets are creatures of habit and require routines that will allow them to lead happy and healthy lives. It is important to feed pets the same amount, at the same time and without failure. Overfeeding can lead to health problems associated with pet obesity and underfeeding can lead to irrational behavior (such as tearing into the trash, getting into food storage, etc.). An effective pet feeder and storage system would allow owners to spend more time relaxing with their families and pets rather than performing the chores associated with feeding pets and storing their food.

CURRENTLY AVAILABLE PET FEEDERS

Pet feeders on the market are both aesthetically unappealing and not programmable or they are too small and not capable of storing entire bags of dog food. The feeder shown in the Figure 1(A) is only capable of holding 4 pounds of food or approximately 1/5 of the amount sold in an average sized bag of pet food. The feeder in the Figure 1(B) is only designed to feed 6 meals to your pet and would need to be refilled every third day or so depending on the feeding habits of your animal. The feeder in Figure 1(C) is designed for outdoor use, and while it is large enough to hold entire bags of pet food, it is not pleasant to look at and it also allows for constant (over) feeding. A proper pet feeder would allow for storage of large amounts of food, while being aesthetically pleasing and requiring very little maintenance.

[1] [2] [3]

(A) **(B)** **(C)**

Figure 1 – Current Pet Feeders on Market

CURRENTLY AVAILABLE PET FOOD STORAGE

Pet food storage containers on the market include, storage bins like the ones found in Figure 2 below. These storage solutions are somewhat adequate for storing pet food when feeding pets by hand but when used with a pet feeder they become burdensome. The largest drawback with the Stack n Stor system on the left is that it is a unit that was not intended for use indoors and therefore is rather bulky and unsightly. As most people feed their pets in the kitchen, they would have to go to the garage or basement in order to access this storage bin, thereby adding to the task. The Iris pet food storage container on the right is more acceptable for indoor use but it is also rather unsightly for use out in the open and would more likely be placed in the pantry or laundry making access to it also somewhat cumbersome. In order for a storage system to be appropriate for use in the home, it should be attractive in its design, capable of storing large amounts of food, all while being very accessible and easy to operate.

[4]

[5]

Figure 2 – Current Pet Food Storage on Market

CUSTOMER FEEDBACK

The features mentioned above were addressed in a survey completed by 32 potential customers. "Potential customers" had to own at least one pet (cat or dog) and their feedback was recorded and quantified in order to better understand the *most* important features which should ultimately be included and what should be discarded. From this information it was determined that the two most important types of features were, low cost and ease of use.

Table 1 – Survey Respondents Ranking of Type of Feature Importance

Survey Feature "Type" Rankings

Feature Type	Average Score
Ease of use	3.5
Low cost	3.4
Appearance	2.8
Storage capability (capacity)	2.7
Reliability	2.6

Another way used to further analyze the results obtained from the customer survey was the derivation of a "House of Quality." This House of Quality allows for its creator to analyze the absolute and relative importance of certain engineering characteristics (EC) which are determined by the designer in order to address each customer need or want. For the Pet Food Storage and Automated Feeder it was easy to see that the EC with the most impact on the design would be the use of "few parts, and standard fasteners," because these characteristics would significantly impact "Ease of Use" and it would also subtly impact "Low Cost." Meaning that if it is possible to use very few parts and entirely standard fasteners then the final product will be easier to install and be cheaper to make, allowing for a considerably more practical design.

Table 2 – Engineering Characteristics Shown in Order of Importance

Engineering Characteristics Importance

Proposed Engineering Characteristics	Relative Importance
Few parts, standard fasteners	0.236
Simple, variable controls	0.132
Standard parts	0.118
In wall placement, with cover	0.096
Robust materials	0.090
Hardwired to home's electric	0.089
Large volume hopper	0.068
Large filler opening	0.062
Plexiglass viewing window	0.055
Simple mechanisms	0.054

FEATURES

There are many important features which should be included with any pet food storage and feeder system. Table 3 below shows results obtained from the portion of the customer survey in which it was asked what features were most important to them in a new design (arranged into order of importance).

Table 3 – Survey Respondents Ranking of Feature Importance

		1	2	3	4	5	N/A	Avg.
1	Consistent operation (does not break)	0	0	1	7	24	0	4.7
2	Low initial cost	0	0	7	5	20	0	4.4
3	Maintenance free	0	0	4	15	13	0	4.3
4	Easy to fill	0	1	5	16	10	0	4.1
5	Easy to install	0	0	11	9	12	0	4.0
6	Looks nice (blends in)	0	3	4	17	8	0	3.9
7	Easy to program	0	4	3	15	8	2	3.9
8	Food level indicator	1	5	6	11	9	0	3.7
9	Large storage capacity (20 pounds or more)	5	3	10	8	5	1	3.2
10	AC Powered (not battery operated)	4	6	7	12	3	0	3.1

The following list gives some important characteristics derived through a combination of product research, survey response and analysis:

1) It should be able to feed the pet a specific amount of food at programmable intervals or times.
2) The programming panel should be easy to read and be of an intuitive design.
3) It is necessary for the automated feeder to not require batteries so that the owner does not have to worry about battery failure leading to the undernourishment of their pet.
4) It is very important that the food level be able to be checked at a glance so as to not allow for the feeder to become empty.

PRODUCT OBJECTIVES

The product objectives are stated measurable and/or observable characteristics of the finished product. Table 4, below, lists the customer requirements with the corresponding design specifications, or engineering characteristics, this table makes it easier to understand why certain design decisions were made.

Table 4 – Customer Requirements and Corresponding Engineering Characteristics

Customer Requirements	Engineering Characteristics
Looks nice (blends in)	In wall placement (with cover)
AC Powered	Hardwired to home's electric
Consistent Operation	Robust materials
Low Initial Cost	Standard parts
Maintenance Free	Simple mechanisms, made from long life parts known to withstand many cycles
Easy to Install	Few parts (pre-assembled) standard fasteners
Easy to Program	Simple, variable controls
Easy to Fill	Large filler opening
Large Capacity	Large volume hopper
Food Level Indicator	Plexiglass viewing window

From the established engineering characteristics it was then possible to develop the corresponding product objectives. These objectives help to keep the prototype within scope, without an understanding of what objectives this product is to achieve the design may become muddled and unsuccessful. Table 5 below shows what the product objectives are and how they relate to the engineering characteristics discussed in Table 4.

Table 5 – Engineering Characteristics and Corresponding Product Objectives

Engineering Characteristics	Objective
In wall placement (with cover)	The prototype will be installed within the wall cavity between two studs.
Hardwired to home's electric	The solution will be to place the device in a wall directly next to an electrical outlet, and will be wired to that electrical source.
Robust materials	The prototype will be made of metal and plexiglass and will include a motor with relatively high torque (enough so that any food caught will be broken and not lead to jamming).
Standard parts	All parts other than the hopper will be purchased "off the shelf" in order to limit any additional costs due to specialization.
Simple mechanisms, made from long life parts known to withstand many cycles	The prototype will be constructed using mechanisms that contain very few moving parts in order to limit the proliferation of defects and breakdowns.
Few parts (pre-assembled) standard fasteners	The product when finished will be self-contained, other than the electircal wiring, so that any customer will only have to mount the device using 8 screws and all electrical work will be able to be performed with no prior electrical experience.
Simple, variable controls	The prototype will use an electronic controller similar to a coffee maker, that is readily available and will be able to be programmed with ease.
Large filler opening	The filler opening will be positioned slightly above waist height (approximately 4 feet) and will be easily opened using a maximum of 4 lbf of pulling power.
Large volume hopper	The prototype will have a hopper that will be able to contain a minimum of 30 pounds of dry pet food.
Plexiglass viewing window	At minimum a plexiglass strip will be placed down the front of the hopper to allow for the user to easily assess the amount of food present in the feeder.

DESIGN

DESIGN ALTERNATIVES AND SELECTION

When it came time to design the Pet Food Storage and Automated Feeder system there were many different decisions which had to be made. The first step taken was to define the functions of the product. Next, possible solutions were discussed. Upon further review unusable solutions were discarded and finally the best possible solutions were chosen. The first decision was how the issue of dispensing food was to be resolved. The gravity fed cups design was chosen because it would require the least amount of space and if it were to malfunction it would not release all of the pet food onto the floor. The second decision to be considered was that of how the user would load the food into the feeder. The hinged door design was chosen so that the user could pull the door open and let it rest in the open position while they picked up the bag with two hands and dumped its contents into the feeder. With the spring loaded door the user would have to hold the door open with one hand while loading with the other and the slide open door would not help to create a "chute" to aid in the loading of the device. For function number three, holding food, it was easy to decide that the feeder be placed in the wall because that was the most aesthetically appealing design. The power design decision came down to whether or not the device was going to use batteries or if it was going to be hardwired to the home's electric. In order to keep the prototype as maintenance free as possible it was decided that it be hardwired in order to eliminate the need for changing batteries. The final two decisions ultimately were financial decisions more than they were engineering decisions. The digital controller was chosen, in this case a coffee maker, in order to keep costs low while being easy to operate and an electric motor was chosen in part to keep costs low and also so that it would be compatible with the controller. Table 6 on the following page shows the decision making processes discussed above.

Table 6 – Functions versus Possible Design Solutions

Step #	I Possible Functions	II Possible Solutions	III Better Solutions	IV Chosen Solutions
1	Dispensing food	Auger system Gravity fed (cups) Gravity fed (gates)	Auger system Gravity fed (cups)	Gravity fed (cups)
2	Loading food	Hinged door Spring loaded hinged door Slide open door	Hinged door Spring loaded hinged door	Hinged door
3	Holding food	In wall placement On wall placement On floor placement	In wall placement	In wall placement
4	Power	120 V 10 V	120 V	120 V
5	Controller	Digital Controller PLC	Digital Controller	Digital Controller
6	Motor	Stepper Motor Servo Motor Electric Motor	Stepper Motor Electric Motor	Electric Motor

DRAWINGS

The following are drawings which show the preliminary design of the Pet Food Storage and Automated Feeder system. Figure number 3 shows the top, front, side and isometric views of the completed system (minus the motor, power transmission, electronics and power supply).

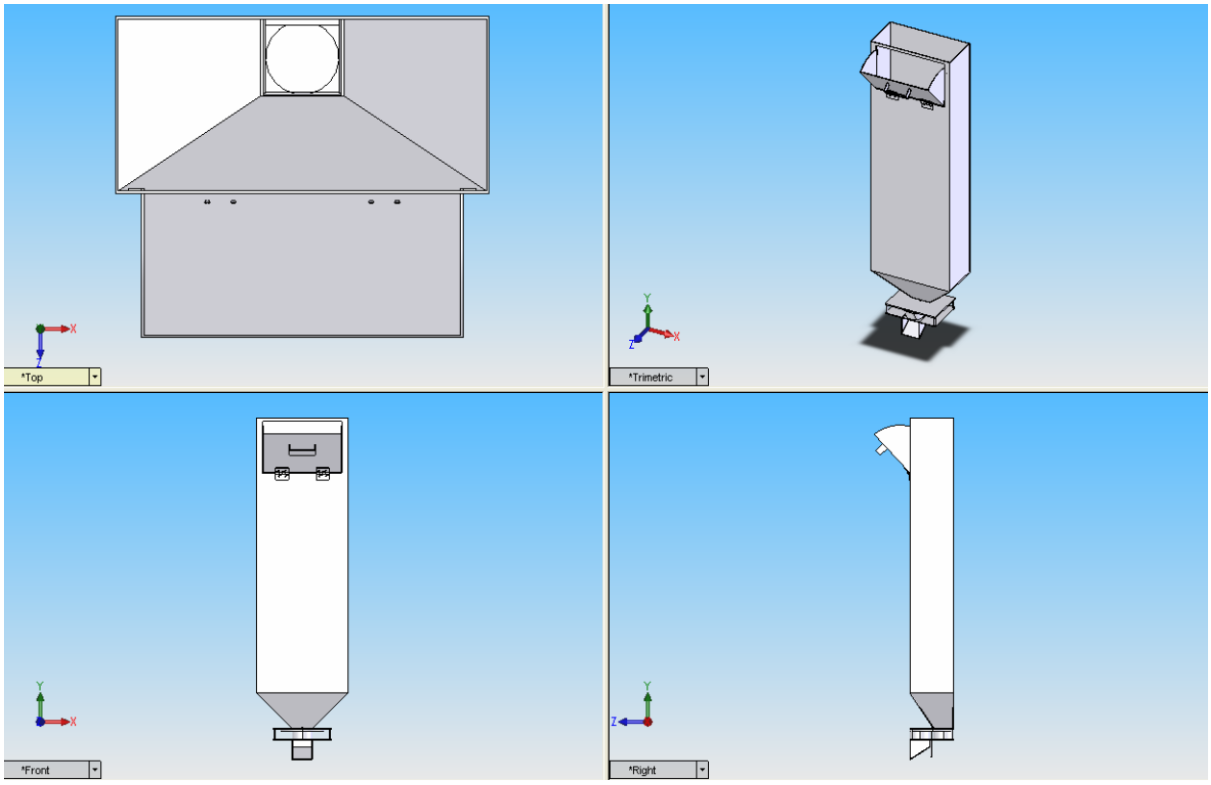


Figure 3 – Four Standard Views of Pet Food Storage and Automated Feeder

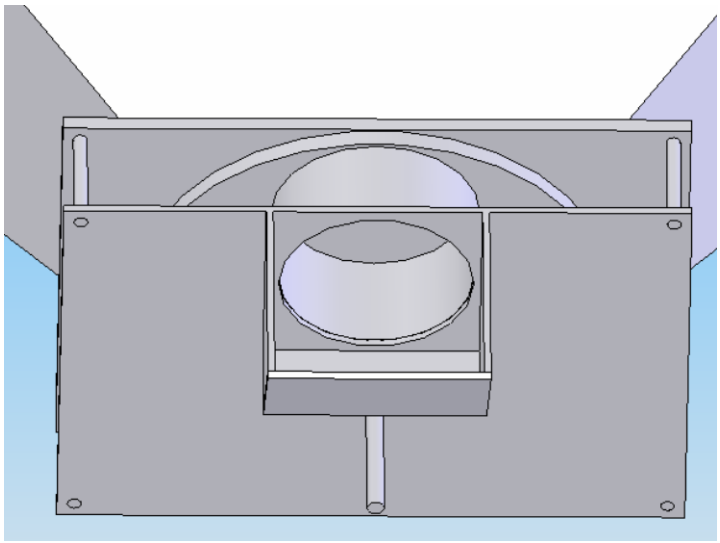


Figure 4 – Bottom View

In the next figure, Figure 4, it is easier to see how the alignment of the cups allows for the dispensing of the food. As shown here, when the cup rotates into the forward position it allows for the pet food to dispense out into the pet's bowl.

Figure number 5 (below, on the next page) shows an expanded view of the top of the Pet Food Storage and Automated Feeder, which allows for viewing of a couple design features. The hopper door has two tabs which do not allow for it to be opened to far which

would create gaps on the sides of the "chute" causing pet food to spill out the sides while loading. Also, this view allows the opportunity to more clearly see the shape of the hopper bottom which funnels the food back to a opening where it fills one of the two cups, which will eventually deliver the food to the pet's bowl.

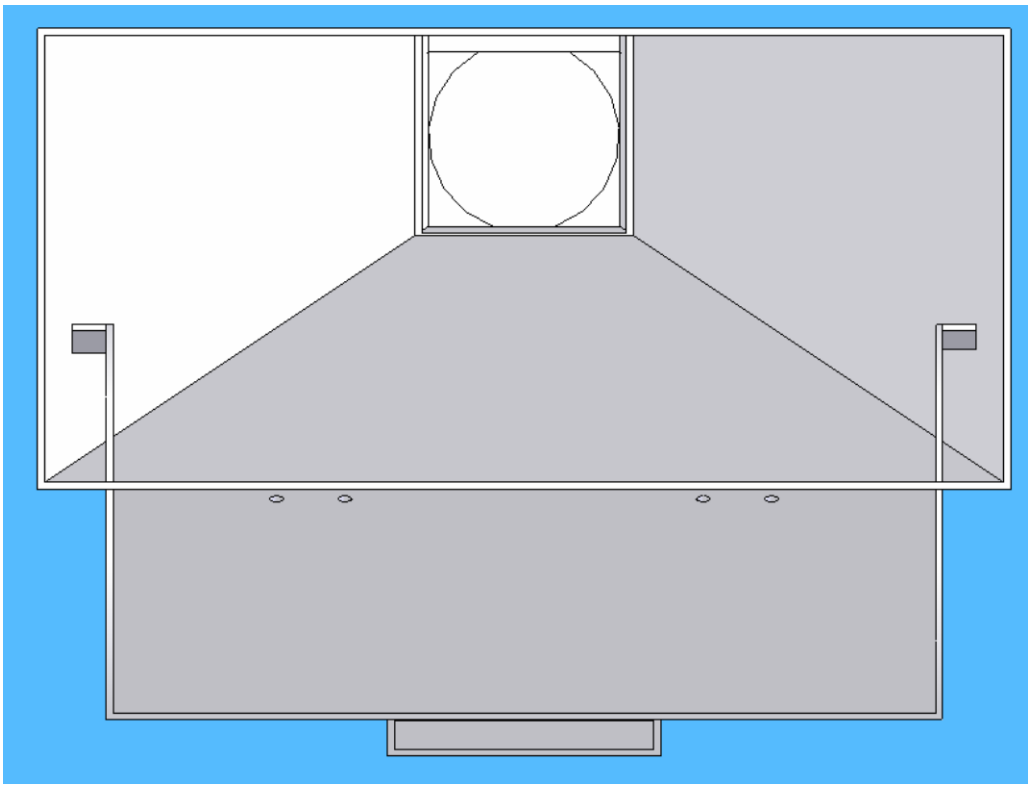


Figure 5 – Expanded Top View

The next drawing shows the "cups" mechanism which displays both of the food delivering cups and the shaft which causes their rotation. In their current position, the cup on the left would be filling up with food while the cup on the right is dispensing food. When the mechanism rotates 180 degrees the sequence starts over, and the food which was filling before is delivered while the empty cup is filled again.

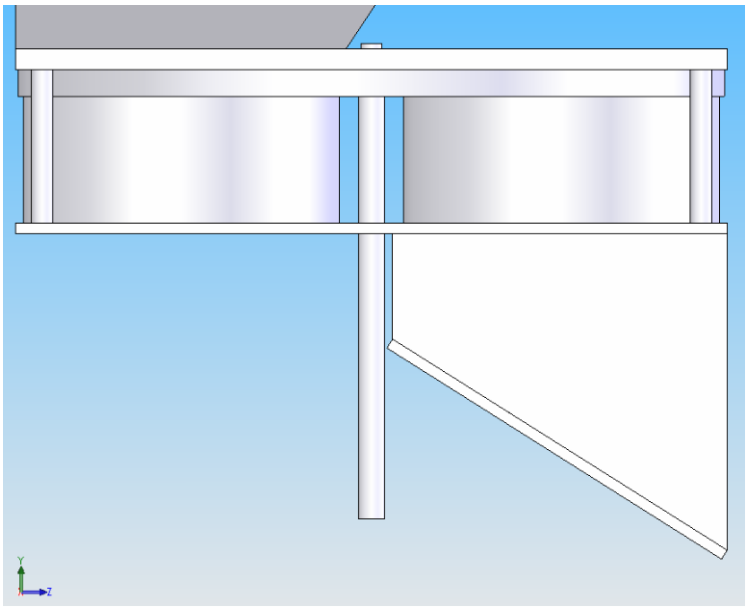


Figure 6 – Close-up Side View, Showing Food Dispenser

The last figure shown here is of the Pet Food Storage and Automated Feeder as it would appear placed in a standard wall cavity (between two studs within the wall.) The top of the opening will end up approximately 4.5 feet off the ground, which is approximately chest height of an average male. Any problems that someone of a smaller stature might have lifting a full bag of pet food up high enough to load the device could be easily alleviated by using a scoop to load the food rather than lifting the entire bag.

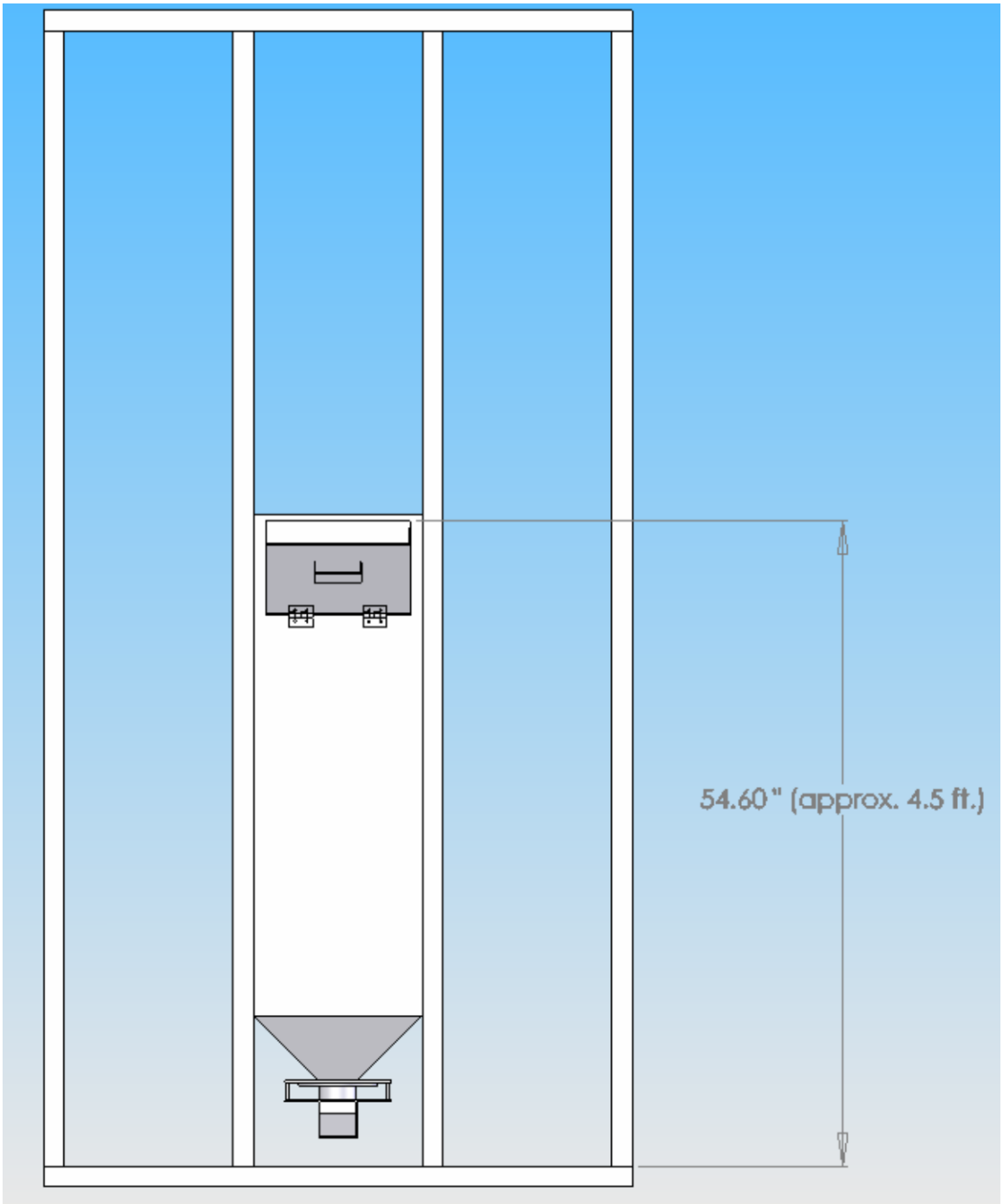


Figure 7 – View of In-Wall Placement

TORQUE CALCULATIONS

In order to calculate the expected torque needed for the feeding mechanism on the Pet Food Storage and Automated Feeder, it was first determined the amount of force needed to crush a typical piece of pet food. Based upon testing, which involved crushing pet food on a scale, it was determined that approximately 0.5 lbs of force should be able to crush any bit of pet food which might get stuck within the mechanism. Upon calculating the amount of force needed the minimum torque requirement was then calculated using the formula: Torque = r x F. In the Figure 8 below it is shown that the radius from the point of rotation to the center of the cup is 1.8 in., so with a force of 0.5 lbs and a radius of 1.8 in. the calculated torque is 0.885 in. lbs. (1.8 in x 0.5 lbf. = 0.885 in. lbs.) Once it was determined that 0.885 in. lbs. of torque would be all that might be needed to crush the food and move it out of the way it was then determined that this would not be a limiting factor in motor selection.

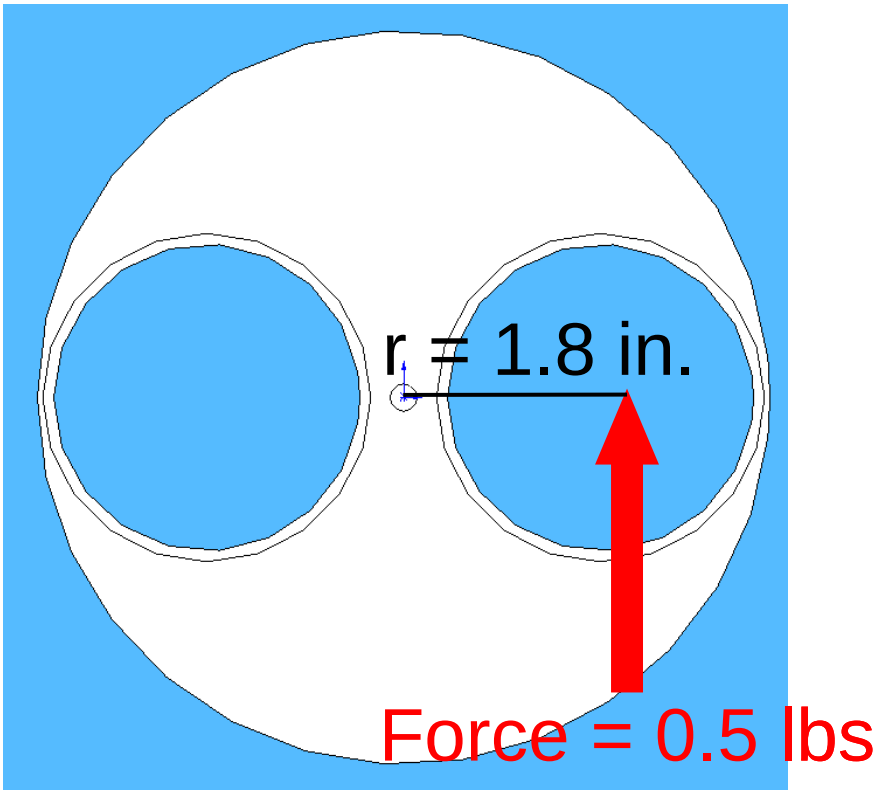


Figure 8 – Torque Calculations

COMPONENT SELECTION

Upon completing the torque calculations it was then possible to select a motor which then lead the selection of a controller for the trial product. The motor selected for this product was a Chicago Electric Company drill model no. 3670-2VGA; this drill was low in cost and provided ample torque while lacking only in appearance. After selecting the motor it was determined that it would be possible for the system to be controlled very simply with the electronics supplied within a programmable coffeemaker. These controls allow for the user to easily turn on the apparatus in person or to be able to set the feeder so that it will feed while the user is away. By choosing an inexpensive drill and coffeemaker to make up the heart of the prototype it was possible to keep costs low while still producing the desired results.

Materials chosen to construct this project were selected for many different reasons. A plexiglass type of plastic was chosen to construct the "hopper" or food storage container; this was done in order for the spectators and judges to be able to see what was going on with the mechanics of the project while on display at the Tech Expo. Pine was used in order to construct the front of the hopper because it was readily available, relatively inexpensive, easy to work with and somewhat attractive. Other items associated with the construction of this product were basic materials associated with the construction of a wall, such as plywood, drywall, 2 x 4 studs, nails, screws, etc. These items were needed in order for the feeder to be adequately displayed as it would appear in someone's home.

FABRICATION AND ASSEMBLY

HARDWARE

The following figures show the completed prototype from different vantage points which should give an adequate picture of how the apparatus was constructed and how it functions. Figure 9 shows the completed prototype and the mock wall constructed to house the device. From this photo one should be able to assess how the prototype would appear in it's intended setting.

Above is the controller. The top left button activates the previously set timer, while the buttons in the center allow for setting the time and setting the feeder for a specified time of feeding. The two buttons on the top right turn the feeder on and off.

Figure 9 – Completed Prototype (Front)

The picture to the right (Figure 10) shows the prototype assembly with the loading door in the open position, with the controller just to the right of the device. The following photo (Figure 11) shows the assembly from the rear with the door still in the open position. The black box in the upper left hand corner of the figure is where the controller is housed, and you can see the dimmer placed in the lower left hand corner of the photograph. The dimmer was included so that the motor rpm used in the prototype could be adjusted to a suitable speed for this application.

Figure 10 – Completed Prototype (Front – Isometric View)

The hopper back was constructed using 1/10 inch plexiglass and the front was made out of project grade pine board. The hopper is held together with a combination of epoxy, construction adhesive, clear duct tape and screws. It is mounted between the studs with 8 screws which penetrate through the studs and the plexiglass and into the pine board front. The top of the food metering system was attached to the bottom, with the cups in between, with the use of four carriage screws and 12 nuts and washers.

Figure 11 – Completed Prototype (Rear)

The following figures (Figure 12 and 13) show the food metering system as it was constructed. Figure 12 is a photo taken from the side of the system and it illustrates the two "cups" used to carry the food from the back of the assembly, where it is loaded from the hopper, to the front, where it can then be dispensed into the pet's food bowl. In this figure you can also see the motor mount shaft which was bolted to the cups and wheel configuration.

The screws visible on the lip of the wheel of the disc are what actuate the switch in order to turn off the device after the feeding. In Figure 13 it can clearly be seen where the motor mount is bolted to the food metering device and the switch activating screws can be seen at the top of the disc.

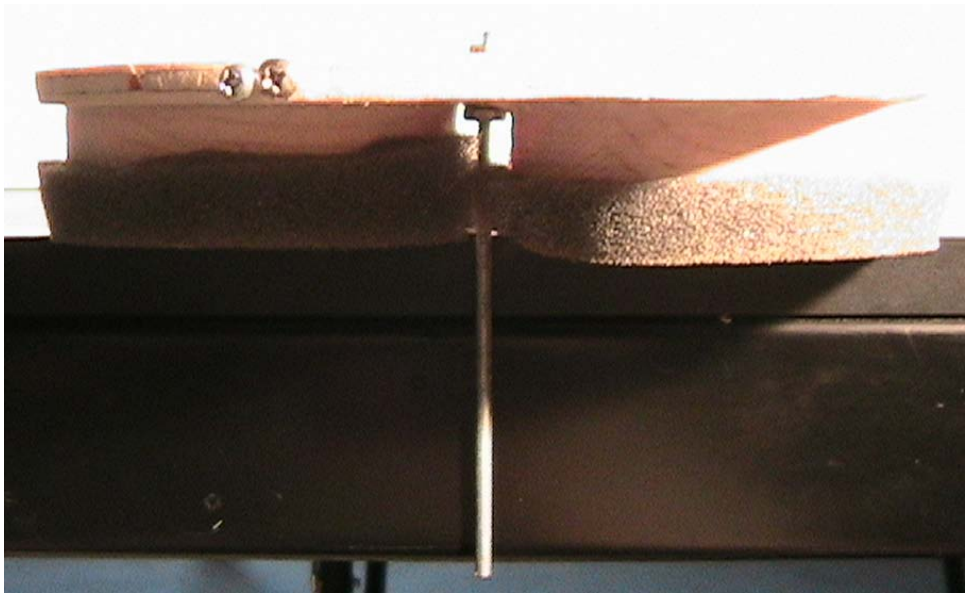


Figure 12 –Side View of Food Metering Prototype

This device was constructed out of plywood and pine with a steel motor mount shaft. The disc was first cut out of ¼ inch plywood and then the appropriate holes were cut out for the food to pass through into the cups. The cups were constructed utilizing two hole saws. The first saw was 3 ¼ inches in diameter which cut out a disc with a diameter of approximately 3 inches across. The next hole was cut using a hole saw with a diameter of 2 ¾ inches which created a ring which had a 2 ¾ inch inside diameter and an outside diameter of approx. 3 inches.

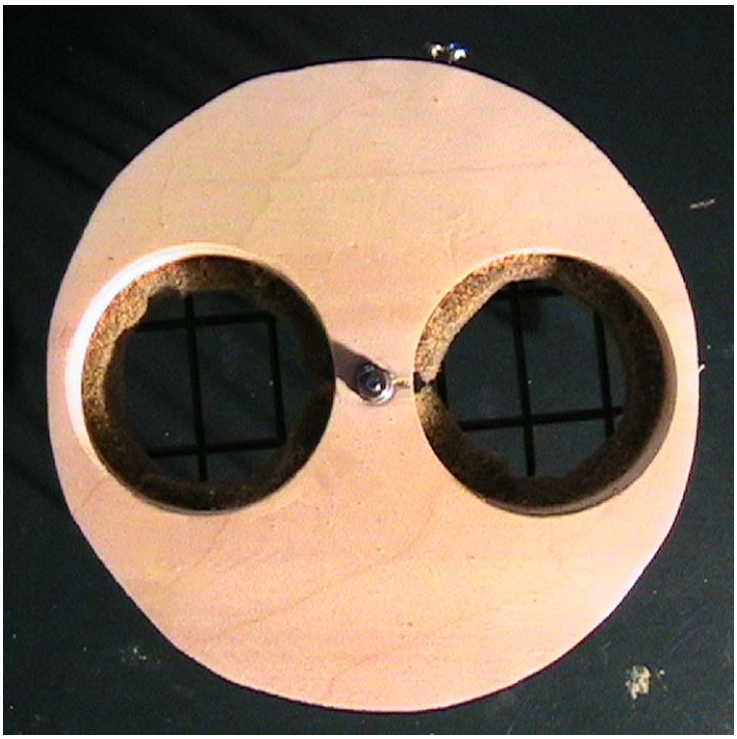


Figure 13 – Top View of Food Metering Prototype

ELECTRONICS

In order to wire up this project it had to first be determined what the sequence of items would be, and how the electricity would flow from one component to the next. Figure 14 shows a schematic which represents the order in which all of the components were wired up.

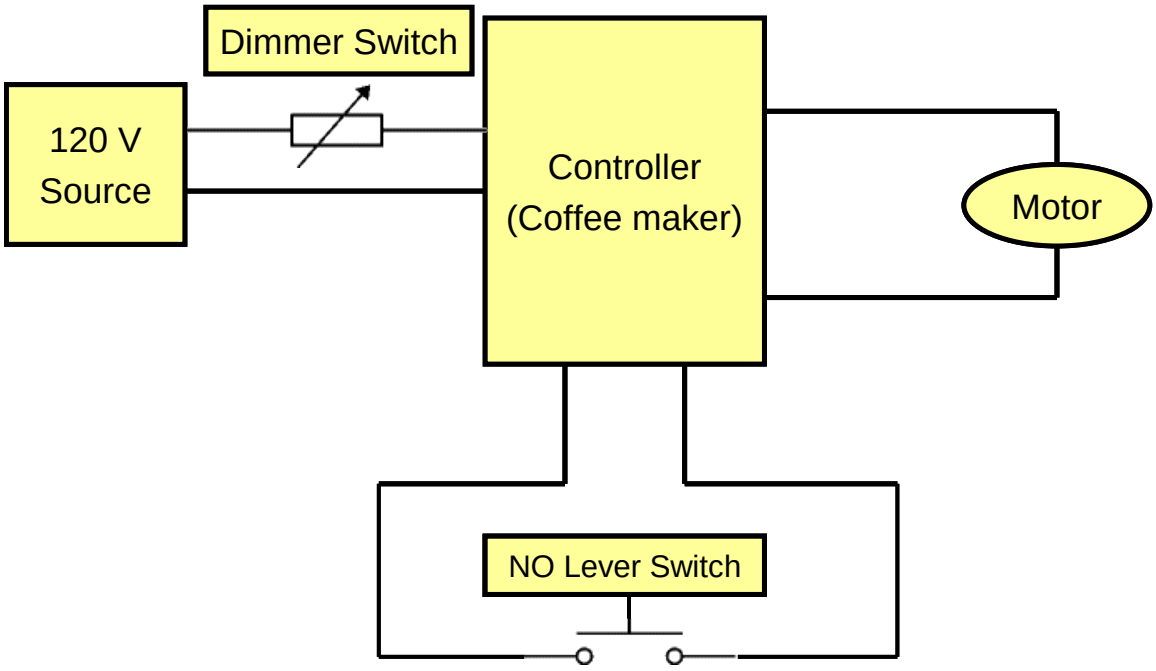


Figure 14 –Electronics Schematic

As it is shown above, the electronics portion of this prototype were kept relatively simple. The incoming 120 V power is standard household voltage. This power was then directed through a dimmer switch which allowed the prototype motor to be adjusted as needed. The power was then directed into a controller which allowed for the motor to be easily turned on and off and also programmed to come on at a specific time. The NO (normally on, "push to make") lever switch was wired up directly to the off button on the controller thus turning off the motor when activated.

TESTING AND PROOF OF DESIGN

In order to test the prototype to see if it met the design specifications some simple trials were executed. There were six parameters which needed to be satisfied with this prototype. The following table (Table 7) lists each of these parameters, how the prototype was tested and whether or not the prototype met each parameter. Tests numbered two and three were performed by three different persons who were not associated with the design and construction of the prototype. They were conducted by each person one time and received an adequate score if they were able to be completed without failure.

Table 7 – Design Parameters with Testing Procedures

#	Parameter	Testing Procedure	Adequate ? (Y/N)
1	Ease of Use - Loading Food	Attempt to load hopper without spilling food.	Y
2	Ease of Use - Program the Clock	Have someone set time with no instruction.	Y
3	Ease of Use - Set the Timer	Have someone set the timer with little instruction.	Y
4	Capacity (30 lb minimum)	Load the hopper with 40 lbs. of food.	Y
5	Operational Capability	Turn on the prototype and check to see if it dispenses food.	Y
6	Operational Capability	Set the timer and see if it dispenses food at the appropriate time.	Y

PROJECT MANAGEMENT

WINTER QUARTER SCHEDULE (PROPOSED/ ACTUAL)

This project was able to stay almost precisely within schedule during the Winter quarter. The only major change occurred with the controller design and programming task which was moved from week six to week ten. We were also called upon to complete our oral presentation a week earlier and our written report a week later. Figures 15 and 16 show my proposed schedule and actual schedule after those changes were made.

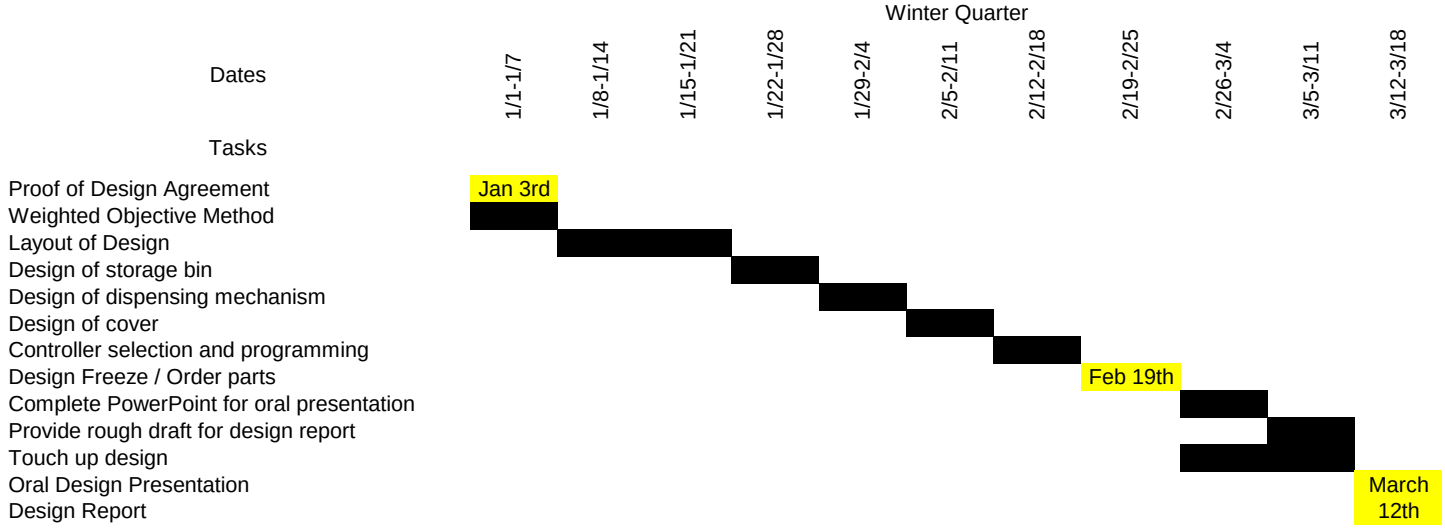


Figure 15 – Proposed Schedule (Winter)

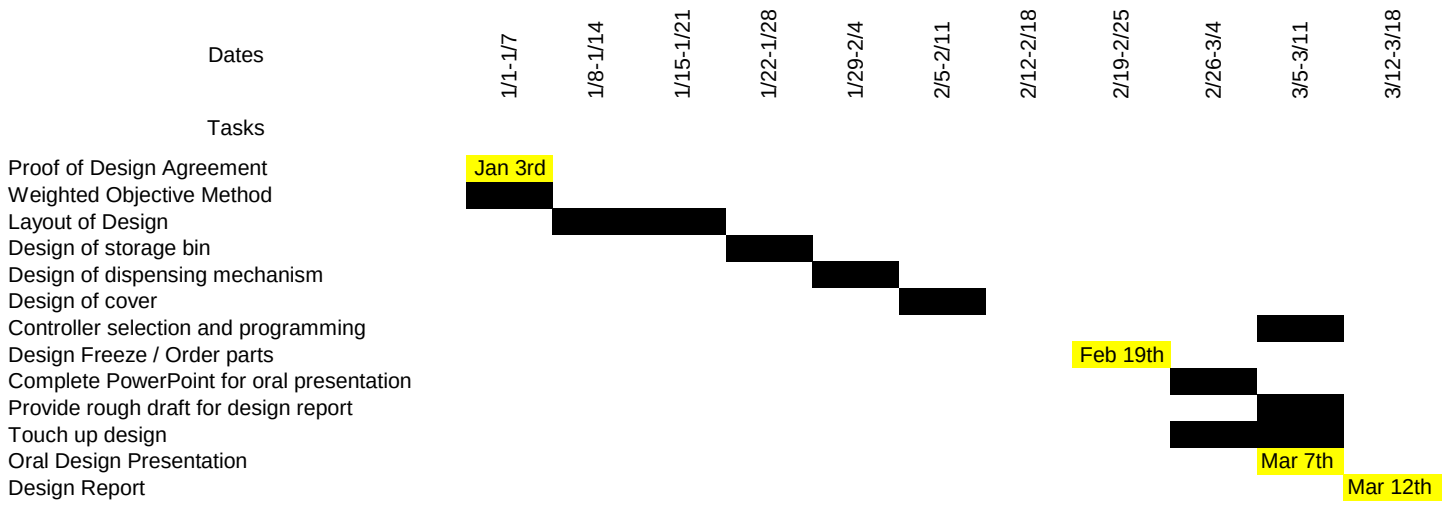


Figure 16 – Actual Schedule (Winter)

SPRING QUARTER SCHEDULE (PROPOSED/ ACTUAL)

During the Spring quarter some minor adjustments were made to the proposed schedule so that it represented what times items were actually completed. In Figure 17 the proposed schedule is shown. Figure 18 shows the actual schedule with the minor changes discussed above. The first seven weeks of the schedule are unchanged. The first change occurred in the eighth week, where the correct Tech Expo date was inserted. In week nine the task of completing the oral presentation was pushed back so that the rough draft for the final report could be completed. Also during week ten the oral presentation was moved up to the 30th of May.

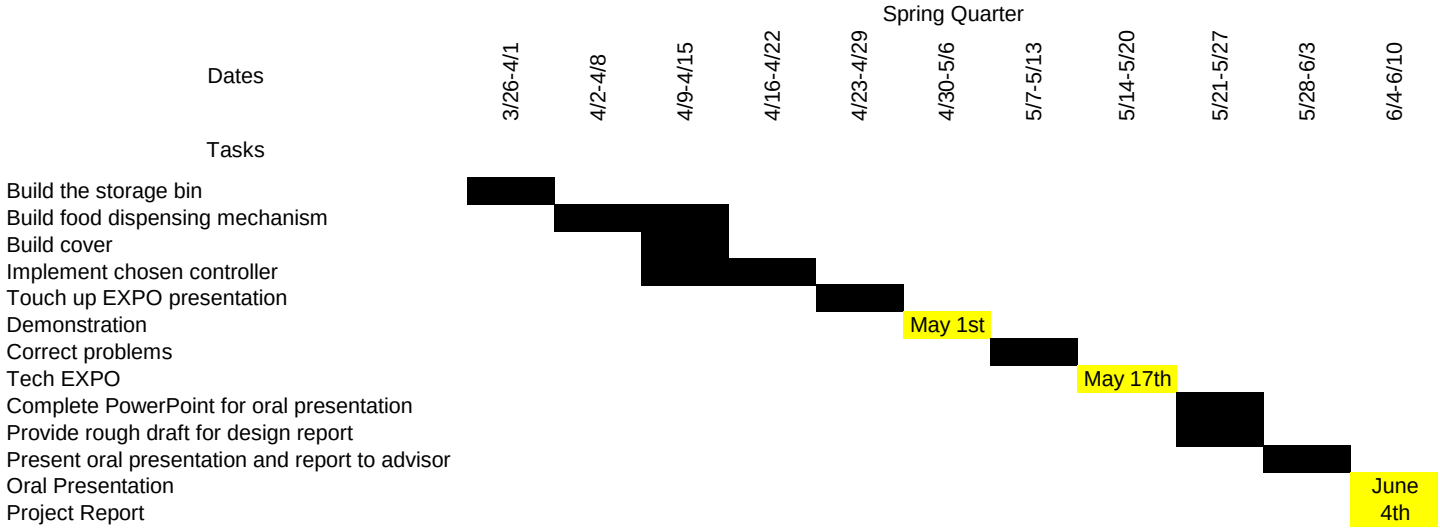


Figure 17 – Proposed Schedule (Spring)

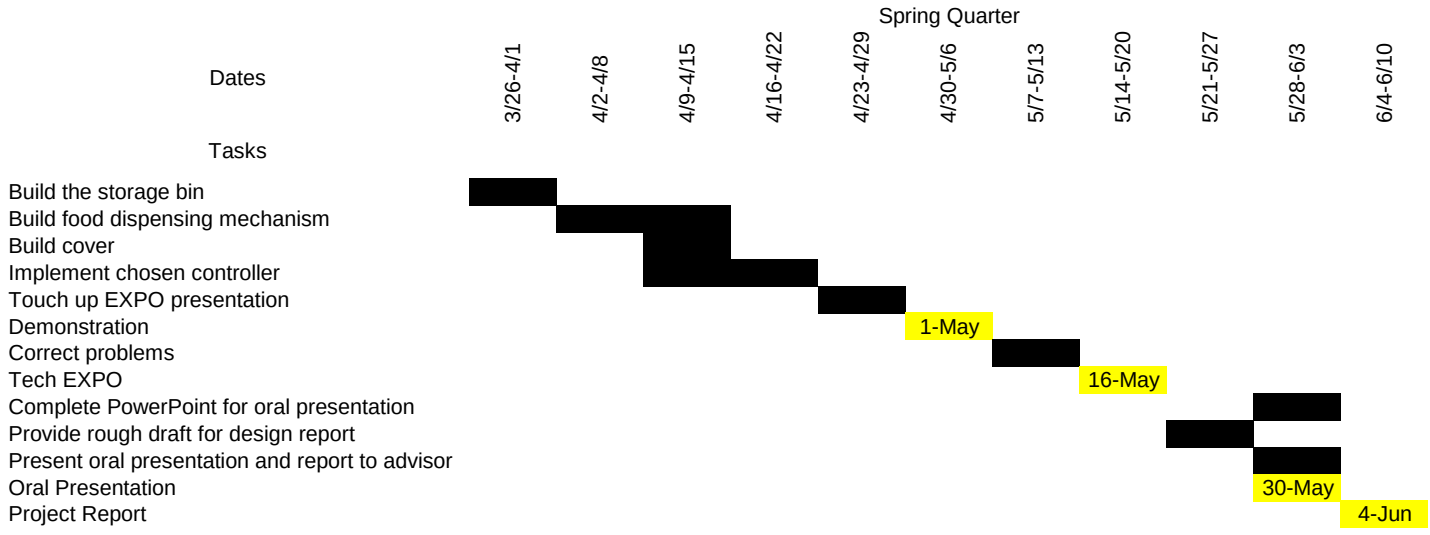


Figure 18 – Actual Schedule (Spring)

BUDGET

The budget shown below in Table 8 represents the expected expenditures that were expected during the construction of the Pet Food Storage and Automated Feeder prototype. Many of the amounts shown below were approximated and as the actual amounts were spent on the components of the project they were recorded into what eventually became the bill of materials for this prototype.

Table 8 – Preliminary Prototype Production Budget

Materials,Components or Labor	Forcasted Amount
Food Storage (Bin)	$65.00
Electrical Wiring	$50.00
Controller	$150.00
Dc Motor	$75.00
Mock wall	$50.00
Misc services/parts	$50.00
Total	**$440.00**

Table 9 below shows the BOM for the final project (including the mock wall which housed and displayed the prototype.) The forecasted budget for this product prototype was $440 (Table 8, above) and the final cost of the prototype was $318.86, for difference of -$121.14 or -27.5%. The major cause of this difference was in the money saved in the cost of the controller (coffee maker) and the motor (drill). The expected cost of the controller and motor was $225 while the final cost of the two was only $48, for a difference of $177.

Table 9 – Bill of Materials

Item #	Item Description	Quantity	Cost (ea)	Cost (total)
1	Chicago Electric Power tools model no. 3670-2VGA	1	$12.99	$12.99
2	Acrylic Sheet 24" x 48" x 1/10" (.098) Thick	3	$24.86	$74.58
3	Pint Polycarbonate Cement	1	$15.00	$15.00
4	2X4X96" Top Choice Stud	10	$2.98	$29.80
5	4' x 8' Drywall Sheet	1	$8.00	$8.00
6	4' x 8' 3/4" Plywood	1	$18.99	$18.99
7	100 ct. Box of 1.5" Screws	1	$6.00	$6.00
8	4" Bolt	5	$0.98	$4.90
9	Package of nuts	1	$2.46	$2.46
10	Package of two hinges	1	$3.15	$3.15
11	8" Bolt	1	$1.50	$1.50
12	Powergrab contact adhesive	2	$9.00	$18.00
13	Spray on adhesive	1	$8.49	$8.49
14	Handle	1	$6.00	$6.00
15	Controller (out of a coffee maker)	1	$35.00	$35.00
16	Lever Switch	1	$8.00	$8.00
17	Misc. Electronics	-	$50.00	$50.00
18	Project Box	1	$8.00	$8.00
19	1/4" sheet of ash plywood	1	$8.00	$8.00
	Total Cost of Project			**$318.86**

RECOMMENDATIONS

Future development of this product would need to proceed in two distinct paths. In one direction the prototype currently constructed would have to be refined and added to and in the other direction a new prototype would need to be constructed with new materials and components. The first path would be chosen so that the designer could show the prototype to potential manufactures to display the product concept and the second path would be chosen once financial backing had been received.

In order for the current prototype to work correctly a few minor adjustments could be made. The prototype as it is currently constructed utilizes a lever switch which is activated when the screws in the rotating disc make contact with the lever arm. The original idea behind the design was that the inertia of the mechanism would allow for the screws to carry past the switch after activation so that the device would again be ready for use. However, once completed it was evident that the switch needed to be depressed for more than just a moment to activate the off button to which the switch was wired. In order to address this problem the motor speed was adjusted down in order for the screws to remain on the switch long enough to turn off the feeder. The problem then created was that the mechanism did not have enough inertia to carry it past the switch and instead the screws rested upon the lever arm which did not allow for the device to be restarted without physically moving the disc so that the screws were no longer in contact with the switch. In order to alleviate this problem I would propose that a magnetic switch be utilized in place of the lever switch so that the disc would no longer be in physical contact with the switch. In addition a timer would have to be installed in line between the switch and the off button so that the magnetic switch would only send a timed pulse to the off button, allowing for the device to be restarted when the pulse is complete. Figure 19 below shows the proposed changes to the electronics associated with this prototype.

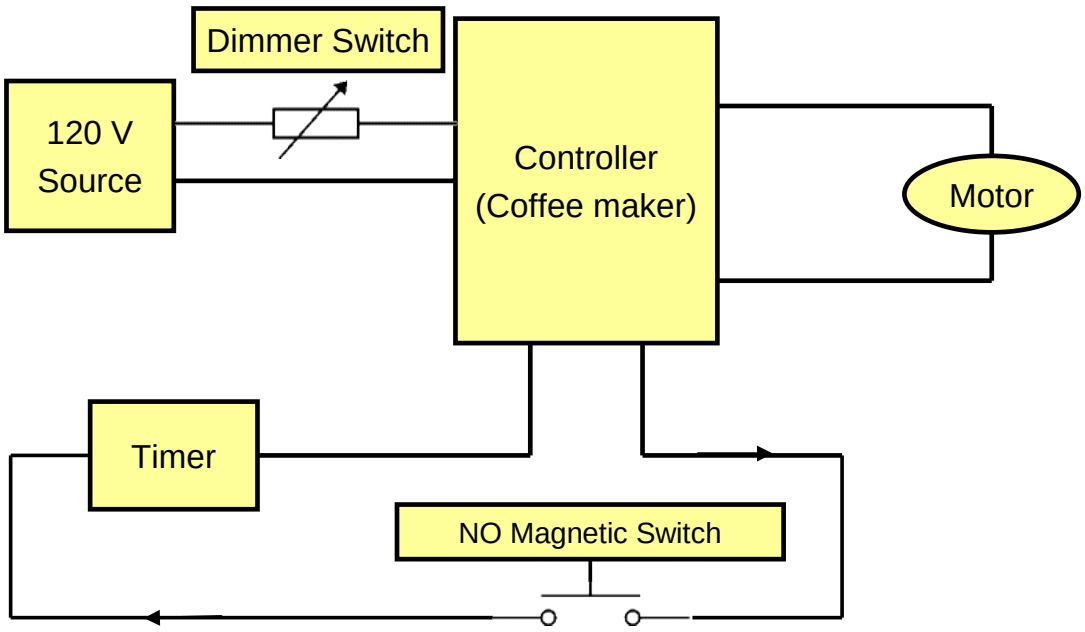


Figure 19 –Proposed Changes in the Electronics Layout

Once freed of the financial restraints placed upon the construction of the first prototype the design for this product could be reworked so that the user could have virtually unlimited control of the device while eliminating all issues involving switches. The materials used in construction of the hopper and food metering system would be plastic and aluminum, thereby creating a more robust and reliable product. The new design would also feature new components such as a servo motor and a programmable logic controller (PLC), which is a computer like device, which would allow the user complete control over the feeder. In addition to a more controllable delivery of the amount of food (the controller would allow for a certain number of turns to be inputted thus allowing for more or less food to be delivered) this type of programmable controller would allow for very specific times and days of feedings. The device could also be linked up to the internet very easily so that even if the user is away from home they could very simply control the amount and times of feedings from anywhere in the world.

CONCLUSION

This prototype was constructed to show the viability of a Pet Food Storage and Automated Feeder as a singular unit capable of eliminating the task of feeding the family pet while storing that pet's food up and out of the way. It was shown with this prototype that this task was achievable and, with the help of the Tech Expo, that there are people that would like to own such a product. With time and further financial support this product could become an item found in households throughout the country and furthermore, the world.

REFERENCES

[1] "Le Bistro Electronic Portion Control Feeder." Pet Safe Store. [on-line catalog] <http://www.petsafestore.com/lebielpocofe.html>. 9 Oct. 2006

[2] "6 Day Automatic Pet Dish." Country Side Pet Supply. [on-line catalog] <http://www.countrysidepet.com/level.itml/icOid/283>. 9 Oct. 2006

[3] "25-Lb. Automatic Dog Feeder." Gun Dog Supply. [on-line catalog] <http://www.gundogsupply.com/-3752-.html>. 9 Oct. 2006

[4] "Stack N Stor 40 Dog Food Storage Bin." Gun Dog Supply. [on-line catalog] <http://www.gundogsupply.com/stacknstore40.html>. 9 Oct. 2006

[5] "Iris - Pet Food Storage Container." Stacks and Stacks! [on-line catalog] <http://www.stacksandstacks.com/html/80054_iris-pet-food-storage-container.htm>. 4 Dec. 2006

[6] "Ergo Automatic Feeder." Next Day Pets. [on-line catalog] <HTTP://WWW.NEXTDAYPETS.COM/DIRECTORY/PET_SUPPLIES/SHOW/3CF2EEFA-4005-9.ASPX>. 9 Oct. 2006

APPENDIX A - PRODUCT RESEARCH

http://www.gundogsupply.com/stacknstore40.html ; 10/09/06 Stack n Stor 40 Dog Food Storage Bin

Doesn't feed pets
Unattractive (designed for garage, outdoor storage)

Costs $22.50
Holds 20 lbs of dog food (also available in 45 and 100 lb sizes)

Stack n Stor 40:

- Holds over 20 LBS per bin / ideal for pet food storage
- Constructed of durable plastic.
- The door to the storage bin is lockable.
- Will hold over 20 pounds of misc. items.
- For use indoor or outdoor.
- Each bin has a 2 cup "scoop."
- Can stack up to 2 pieces high.
- Wide re-fill opening allows for easier cleaning.

http://www.stacksandstacks.com/html/80054_iris-pet-food-storage-container.htm ; 12/04/06 Iris Pet Food Storage Container

Doesn't feed pets
Unattractive (designed for garage, pantry storage, etc.)

Costs $14.99 – $48.99
Holds between 20 and 55 lbs of pet food

- An excellent storage solution.
- It features a seal tight lid which keeps the pet food fresh.
- Small holds: Cat Food 20 Lbs., Dog Food 17 Lbs., Bird Seed 30 Lbs.
- Large holds: Cat Food 40 Lbs., Dog Food 35 Lbs., Bird Seed 60 Lbs.
- Extra-large holds: Cat Food 55 Lbs., Dog Food 50 Lbs., Bird Seed 100Lbs.

http://www.gundogsupply.com/-3752-.html 10/09/06 **25-lb. Automatic Dog Feeder**

For outdoor use
Unattractive appearance
Allows for constant (over) feeding

Costs $29.95
Easy to install
Holds 25 lbs of food (they have larger models which hold up to 50 lbs)

Automatic "pest proof" dog feeder. Heavy gauge galvanized steel construction. Magnetic strips help keep door closed. Sizes are approximate amount of food, depending on size of the kibble, which each feeder will hold. The 25lb feeder is around 12x11x22. You put feed in the top and the dog can open the door and eat when ever he wants.850 lbs. capacity

- 25 lb capacity
- “Pest proof” design

http://www.countrysidepet.com/level.itml/icOid/283 ; 10/09/06 Automatic Pet Dish™

Only holds a small amount of food (six feedings) Takes time to setup after emptied Battery operated (battery could die and you wouldn't know it)	Costs $37.94 (plus shipping) Automatically feeds pet

- Selectable feeding intervals of 6, 12 or 24 hrs.
- Switch selectable feeding intervals
- Six separate food trays each hold 2/3 cup of dry, or 5.5 ounces of moist food
- Removable lid for easy cleaning
- Includes 2 refreezable inserts to keep pet's food fresh
- Great for dry or wet pet food
- Durable ABS plastic
- Operates on one 9-Volt battery (not included)

http://www.petsafestore.com/lebielpocofe.html ; 10/09/06 Le Bistro® Electronic Portion Control Feeder

Only stores a relatively small amount of food (4 lbs) (a separate storage container would also be necessary)
Battery operated
Takes up a relatively large amount of floor space
Accessible to children

Costs $49.95 (plus shipping)
Programmable amounts and times of feedings
Looks nice, attractive appearance

- Simple to set, easy to read programming panel.
- The large screen displays the current time, meals programmed, meal size and meals served.
- Can be programmed to dispense portions from ¼ cup to 2 cups, at 3 selected times per day.
- See-Thru Food hopper holds approx. 4.2 lbs of dry food and can be monitored at a glance..
- Handles a range of dry food sizes, shapes & types, up to ¾" diameter.
- Removable, large mouth hopper refills easily and is easily cleaned with warm soapy water and a cloth.
- Battery operated with 3 "D" size batteries (not included) for portability and convenience.
- Has a handy low-voltage light to indicate when it's time for a battery change.
- Batteries last up to 6 months.

http://www.nextdaypets.com/directory/pet_supplies/show/3cf2eefa-4005-9.aspx ; 10/09/06 Ergo Automatic Feeder

Only stores a relatively small amount of food (4 lbs) (a separate storage container would also be necessary)
Takes up a relatively large amount of floor space
Accessible to children

Costs $80.00 (plus shipping)
Programmable amounts and times of feedings
AC Powered (plugs in)
Looks nice, attractive appearance

- This dog feeder also comes with detachable bowl for easy cleaning.
- Clear storage container on this Feeder enables visibility from all angles and from farther distances
- Airtight cover for storage container keeps pet food fresh in our feeder
- Large opening in the food store bin of the automatic pet feeder enables for easy fill of pet food
- Precise feeding of food is accomplished with this feeder by using high torque 110Vac synchronous motor
- Horizontal feed auger system, which provides precise control over feed rate. Pets cannot get more food by tapping on our feeder or clawing at it
- Stainless steel protective sheathing on the cord to prevent pets from chewing the cord
- Safety interlock switch and safety basket is included in all sizes of our electronic pet feeder UL and CUL approved
- All our Feeder feature digital timer with battery backup, rotating plug for vertical and horizontal outlets, manual override switch, 8 programs per day and daylight saving feature

APPENDIX B - SURVEY RESULTS

Pet Food Storage and Automated Feeder

Survey Results

In order to design and develop a more effective means of storing and dispensing pet food, I would like to gain an understanding of what is most important and essential to customers. Please take a few moments to fill out the following survey.

Please rank in order of the importance to you the following five features / specifications being considered for our pet food feeder / storage device (5 being the most important and 1 being the least important).

		Frequency of Each Value				
		5	**4**	**3**	**2**	**1**
2.8	Appearance	4	5	9	10	4
2.6	Reliability	5	3	8	7	9
3.4	Low Cost	8	10	5	4	5
3.5	Ease of Use	11	8	4	4	5
2.7	Storage Capability (Capacity)	4	6	6	7	9

What is important to you in the design (capability) of a pet food storage / feeding system? Please circle the most appropriate number. (1 = Low Importance and 5 = High Importance)

		1	**2**	**3**	**4**	**5**	**N/A**	**Avg.**
1	Looks nice (blends in)	0	3	4	17	8	0	3.9
2	AC Powered (not battery operated)	4	6	7	12	3	0	3.1
3	Consistent operation (does not break)	0	0	1	7	24	0	4.7
4	Low initial cost	0	0	7	5	20	0	4.4
5	Maintenance free	0	0	4	15	13	0	4.3
6	Easy to install	0	0	11	9	12	0	4.0
7	Easy to program	0	4	3	15	8	2	3.9
8	Easy to fill	0	1	5	16	10	0	4.1
9	Large storage capacity (20 pounds or more)	5	3	10	8	5	1	3.2
10	Food level indicator	1	5	6	11	9	0	3.7

Are you satisfied with your current pet food storage / feeding system? Please circle the most appropriate number. (1 = Unsatisfied and 5 = Very Satisfied)

		1	**2**	**3**	**4**	**5**	**N/A**	**Avg.**
1	Looks nice (blends in)	8	5	8	3	0	8	2.3
2	AC Powered (not battery operated)	0	2	1	1	0	28	2.8
3	Consistent operation (does not break)	1	1	3	1	7	19	3.9
4	Low initial cost	1	0	1	8	8	14	4.2
5	Maintenance free	0	2	1	0	3	26	3.7
6	Easy to install	0	0	0	0	0	32	-
7	Easy to program	1	2	1	0	0	28	2.0
8	Easy to fill	2	1	0	8	13	8	4.2
9	Large storage capacity (20 pounds or more)	1	0	2	11	10	8	4.2
10	Food level indicator	0	0	4	5	15	8	4.5

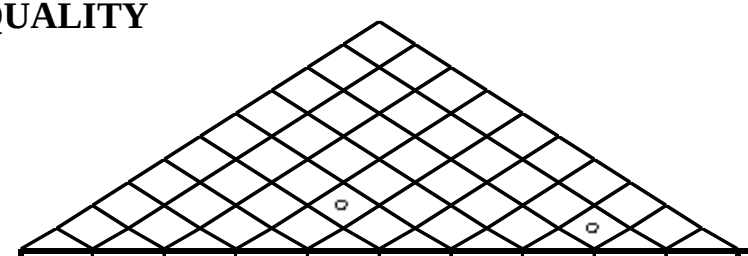
How much would you be willing to spend on a pet food storage / automated feeding device?

$20-$40	**$40-$60**	**$60-$80**	**$80-$100**	**N/A**	**Average**
5	10	7	3	7	$56.40

If you were to take the median price in each range and multiply this amount times the responses for each range and then average the results the targeted cost would be: $56.40

APPENDIX C - HOUSE OF QUALITY

Strong positive ●
Positive ○
Negative X
Strong negative #

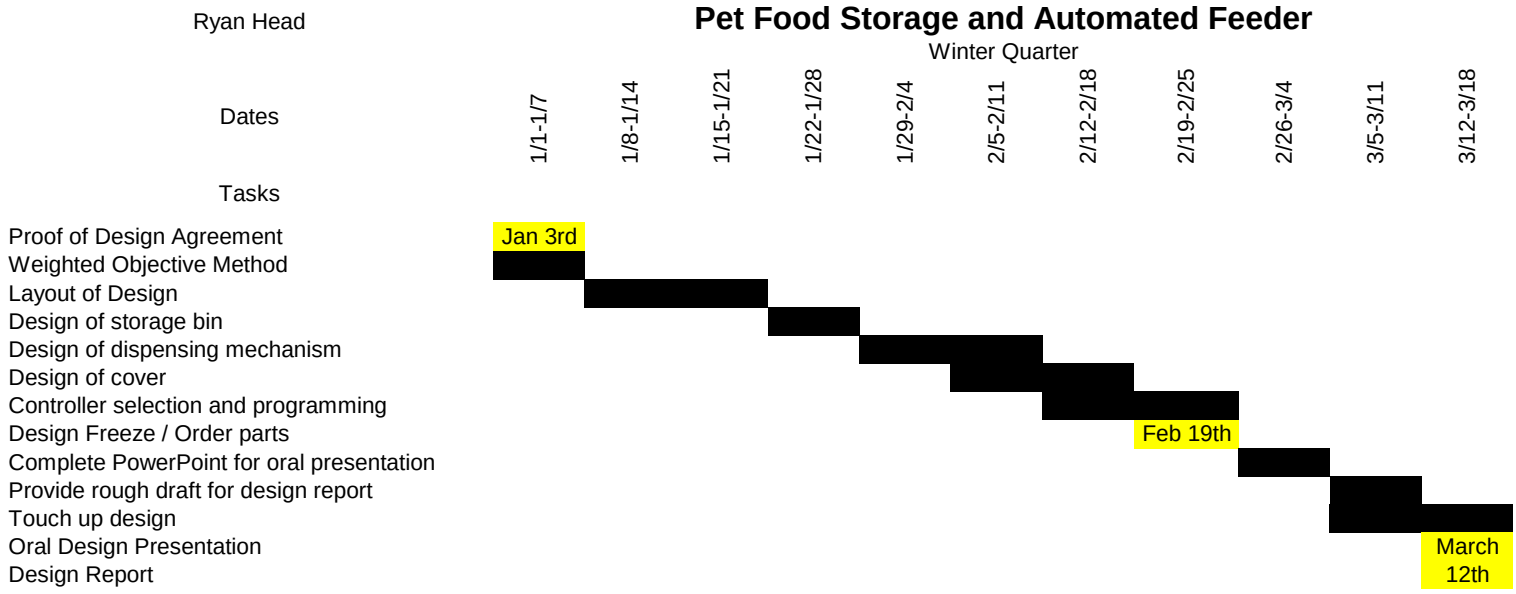


9 = Strong
3 = Moderate
1 = Weak

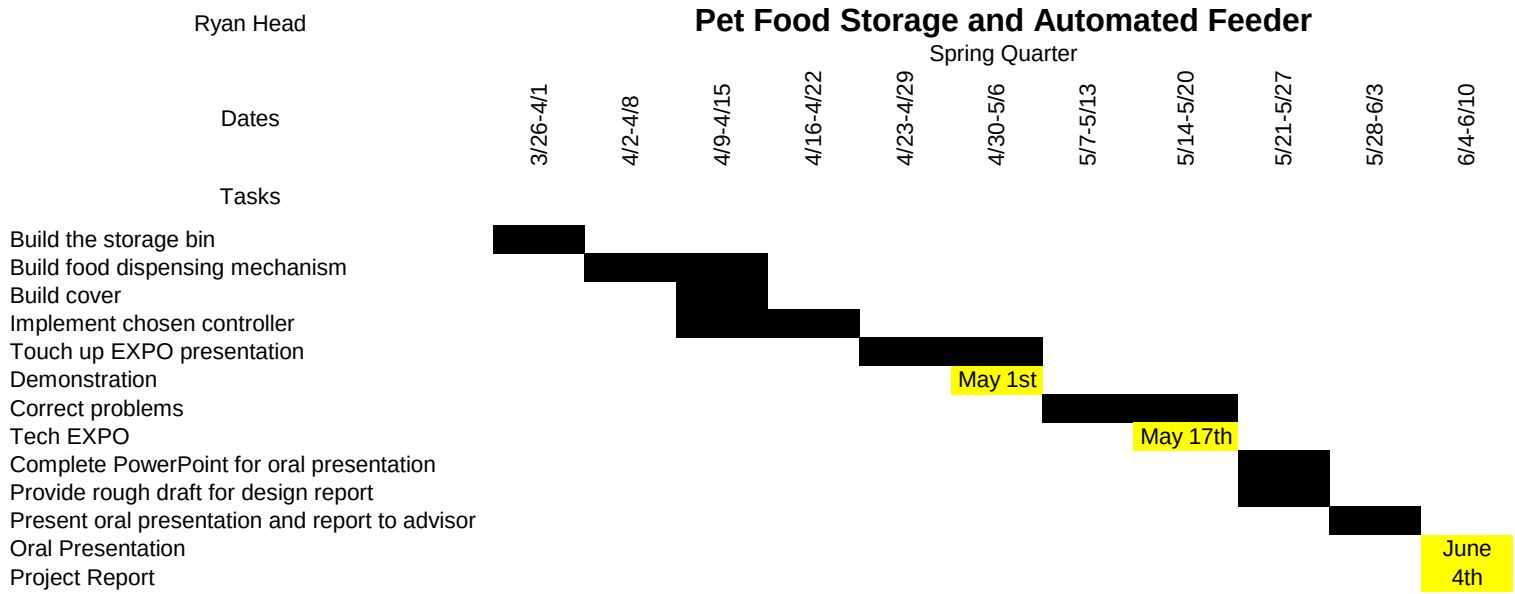
	In wall placement, with cover	Hardwired to home's electric	Robust materials	Standard parts	Simple Mechanisms	Few parts, standard fasteners	Simple, variable controls	Large filler opening	Large volume hopper	Plexiglass viewing window	Customer importance	Automated feeders on the market	Planned automated feeder	Improvement ratio	Sales points	Improvement ratio	Relative weight
Appearance																	
Looks nice (blends in)	9										3.9	2.3	5	2.2	1.3	11.4	0.12
Reliability																	
AC Powered		9									3.1	2.8	5	1.8	1.5	8.52	0.09
Consistent Operation		3	9								4.7	3.9	5	1.3	1.0	6.01	0.06
Low Cost																	
Low initial cost				9	3	3	1				4.4	4.2	5	1.2	1.0	5.22	0.06
Maintenance free			9		9						4.3	3.7	4	1.1	1.0	4.67	0.05
Ease of Use																	
Easy to install				3		9					4.0	1.0	5	5.0	1.3	26.2	0.28
Easy to program							9				4.0	2.0	5	2.5	1.5	15	0.16
Easy to fill								9	3	3	4.1	4.2	5	1.2	1.5	7.3	0.08
Storage Capability (Capacity)																	
Large storage capacity (20 pounds or more)									9		3.2	4.2	5	1.2	1.5	5.63	0.06
Food level indicator										9	3.7	4.5	5	1.1	1.0	4.14	0.04
Absolute Importance	1.09	1.01	1.02	1.33	0.61	2.67	1.49	0.7	0.77	0.63	11.3					94.1	1.00
Relative Importance	0.10	0.09	0.09	0.12	0.05	0.24	0.13	0.06	0.07	0.06							

APPENDIX D - SCHEDULE

WINTER QUARTER



SPRING QUARTER



APPENDIX E - BUDGET

PROJECTED BUDGET

Materials,Components or Labor	Forcasted Amount
Food Storage (Bin)	$65.00
Electrical Wiring	$50.00
Controller	$150.00
Dc Motor	$75.00
Mock wall	$50.00
Misc services/parts	$50.00
Total	**$440.00**

ACTUAL BILL OF MATERIALS

Item #	Item Description	Quantity	Cost (ea)	Cost (total)
1	Chicago Electric Power tools model no. 3670-2VGA	1	$12.99	$12.99
2	Acrylic Sheet 24" x 48" x 1/10" (.098) Thick	3	$24.86	$74.58
3	Pint Polycarbonate Cement	1	$15.00	$15.00
4	2X4X96" Top Choice Stud	10	$2.98	$29.80
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6	4' x 8' 3/4" Plywood	1	$18.99	$18.99
7	100 ct. Box of 1.5" Screws	1	$6.00	$6.00
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9	Package of nuts	1	$2.46	$2.46
10	Package of two hinges	1	$3.15	$3.15
11	8" Bolt	1	$1.50	$1.50
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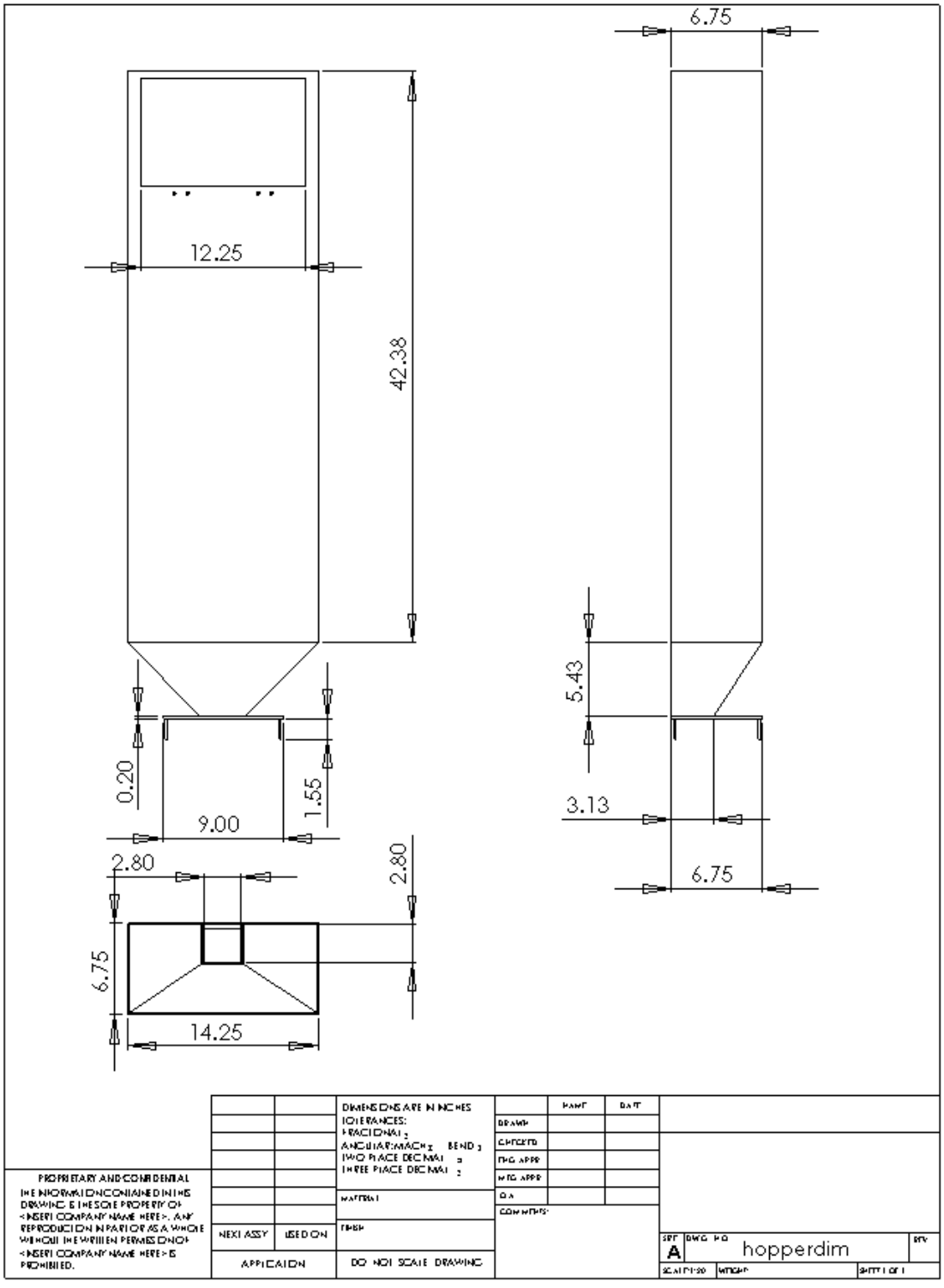
13	Spray on adhesive	1	$8.49	$8.49
14	Handle	1	$6.00	$6.00
15	Controller (out of a coffee maker)	1	$35.00	$35.00
16	Lever Switch	1	$8.00	$8.00
17	Misc. Electronics	-	$50.00	$50.00
18	Project Box	1	$8.00	$8.00
19	1/4" sheet of ash plywood	1	$8.00	$8.00
	Total Cost of Project			**$318.86**

APPENDIX F - PRODUCT OBJECTIVES

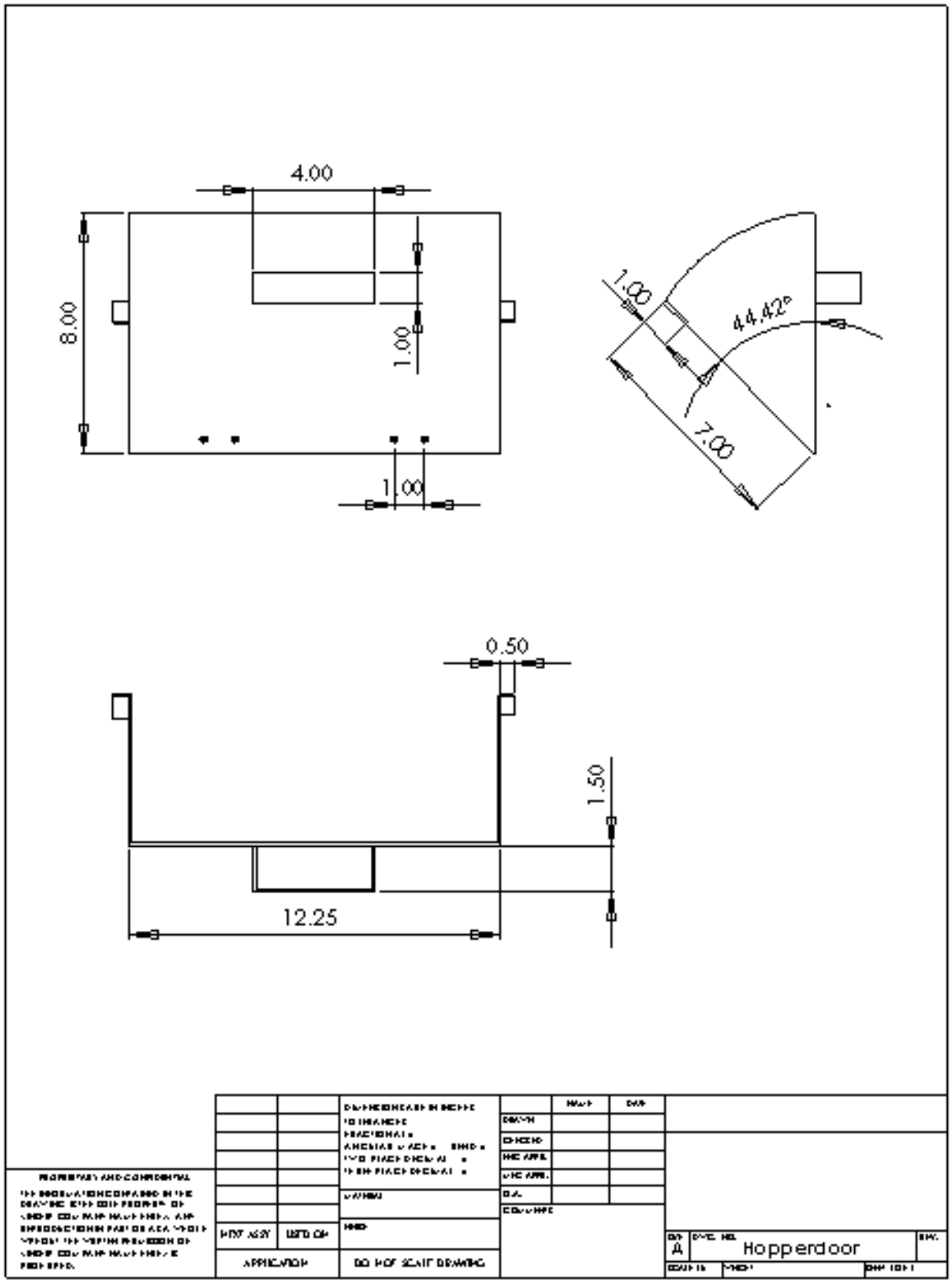
#	Customer Requirements	Engineering Characteristics	Objective
1	Looks nice (blends in)	In wall placement (with cover)	The prototype will be installed within the wall cavity between two studs.
2	AC Powered	Hardwired to home's electric	The solution will be to place the device in a wall directly next to an electrical outlet, and will be wired to that electrical source.
3	Consistent Operation	Robust materials	The prototype will be made of metal and plexiglass and will include a motor with relatively high torque (enough so that any food caught will be broken and not lead to jamming).
4	Low Initial Cost	Standard parts	All parts other than the hopper will be purchased "off the shelf" in order to limit any additional costs due to specialization.
5	Maintenance Free	Simple mechanisms, made from long life parts known to withstand many cycles	The prototype will be constructed using mechanisms that contain very few moving parts in order to limit the proliferation of defects and breakdowns.
6	Easy to Install	Few parts (pre-assembled) standard fasteners	The product when finished will be self-contained, other than the electircal wiring, so that any customer will only have to mount the device using 8 screws and all electrical work will be able to be performed with no prior electrical experience.
7	Easy to Program	Simple, variable controls	The prototype will use an electronic controller similar to a coffee maker, that is readily available and will be able to be programmed with ease.
8	Easy to Fill	Large filler opening	The filler opening will be positioned slightly above waist height (approximately 4 feet) and will be easily opened using xx lbf of pulling power.
9	Large Capacity	Large volume hopper	The prototype will have a hopper that will be able to contain a minimum of 30 pounds of dry pet food.
10	Food Level Indicator	Plexiglass viewing window	At minimum a plexiglass strip will be placed down the front of the hopper to allow for the user to easily assess the amount of food present in the feeder.

APPENDIX G – DETAILED DRAWINGS

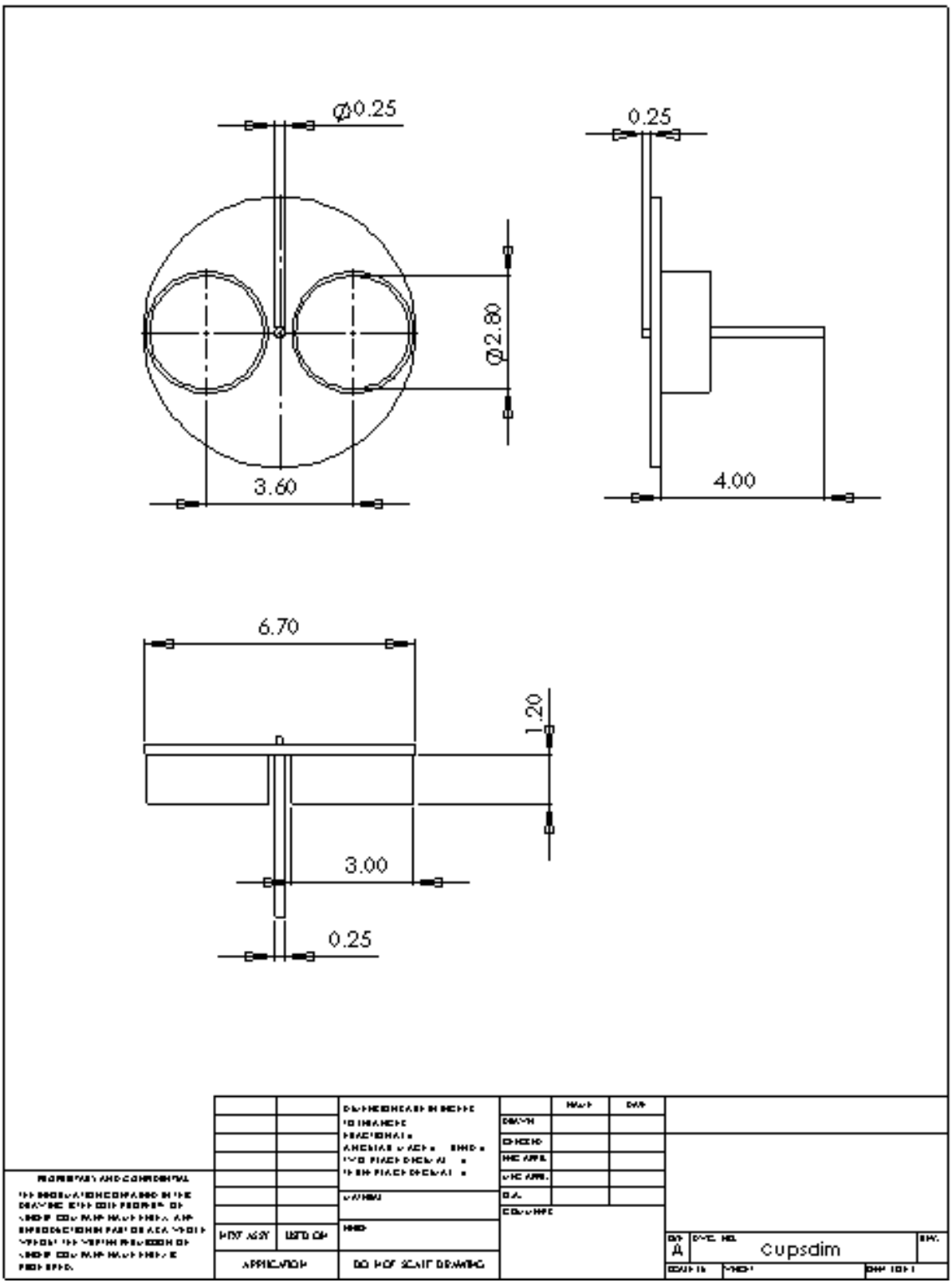
HOPPER



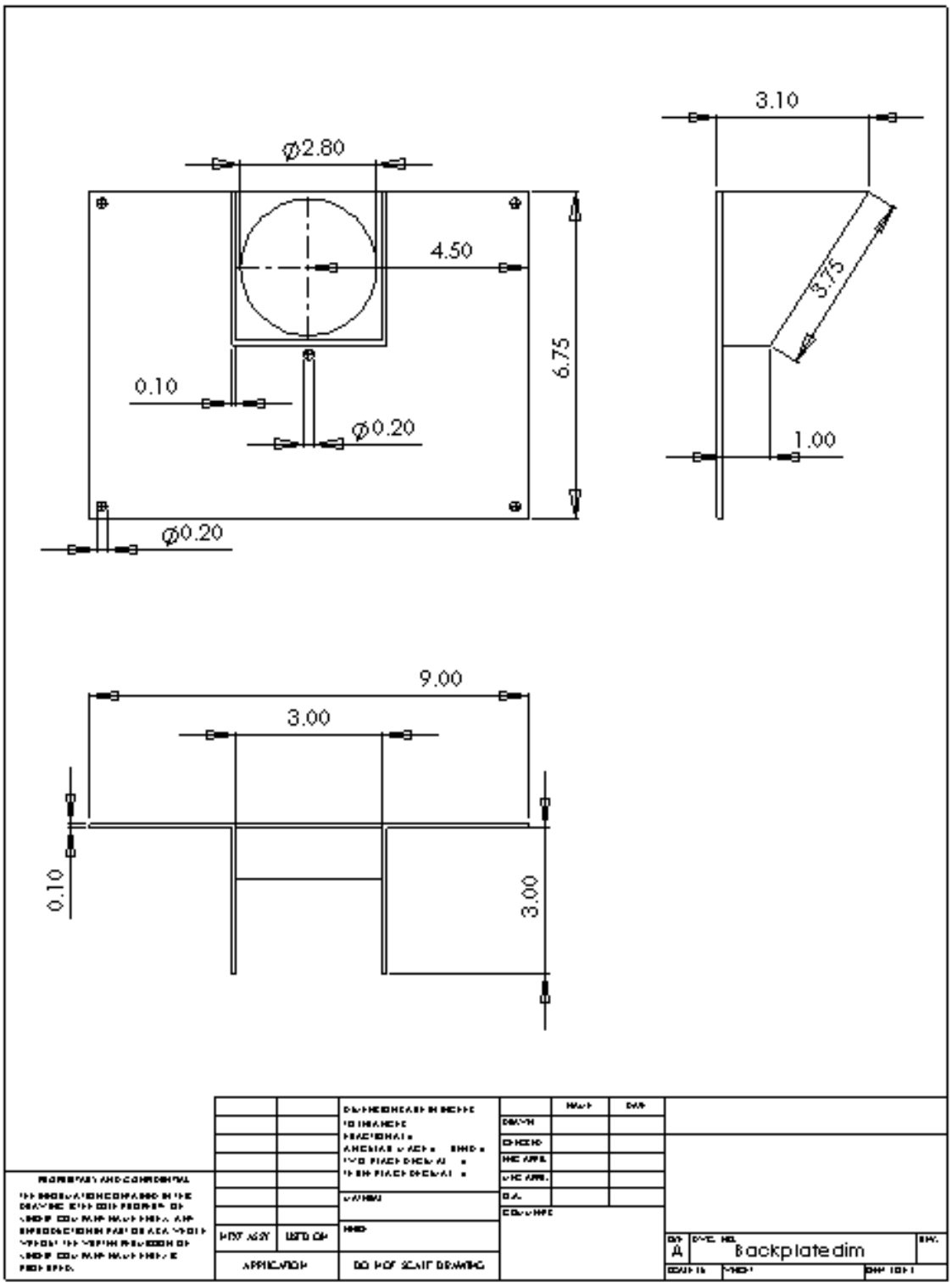
HOPPER DOOR



CUPS



BACKPLATE


3.10
Ø2.80
4.50
6.75
3.75
0.10
Ø0.20
1.00
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9.00
3.00
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Backplatedim

FOODPLATE