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# J.C.A.T.I. Automated Pyrolysis Project

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# J.C.A.T.I. Automated Pyrolysis Project

By

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# 1: Introduction

## Description

This Project is a compilation of past projects, tasked to the seniors of CWU by The Joint Center for Aerospace Technology Innovation (JCATI) to create device that can separate the carbon fiber from the resin in so that it can be reused. The method that CWU students chose to accomplish this goal is a heating process called Pyrolysis. This project specifically takes the Oven and Cover created in the past and attempts to create an automated system for it, hence the name "Automated Pyrolysis".

## Motivation

The goal of this project is to create a device that can automate the movement of the Material, the time it takes for Pyrolysis, and control how much Material goes in at a time.

## Function Statement

Device is needed to separate resin from carbon fiber using pyrolysis process.

## Requirements

- Successfully moves Material from Dispenser, through the cover, and into a Collector without outside help. Must be above 80% of Material successfully passed per batch.
- Success of Device must work at all positions and must be functional for prolonged use, therefore the Device needs to be able to independently loop through a Cycle with no intervention 10 times.
- The Dispenser must be able to function in a consistent matter. Batches need to be within a 10% margin of error between each batch.

## Engineering Merit

1. Over 80% Material Successfully Passes.
2. Over 10 Independent Cycles of Success in a row.

3. All batches within 10% Margin of Error.

## Scope of Effort

Effective use of pyrolysis to remove resin.

## Benchmark

The device will be more efficient using the pyrolysis process than other devices have been using different methods.

## Success Criteria

Effectively remove over 90% of pre-existing resin from carbon fiber.

# 2: Design and Analysis

## Approach: Proposed Solution

Given that the oven for this project was already completed in the previous year, the only part left was to find a way to automate this process and optimize the oven for automation.

## Design Description

To automate this project, four obstacles needed to be solved.

1. A way to store the overflow of carbon fiber coming into the pyrolysis oven
2. A way to separate the overflow into batches
3. A way to get the material from the shredder and through the oven
4. A way to get the material into and out of the cover without releasing the heat or argon gas.

## Benchmark

Boeing already has an automated pyrolysis system on a large scale that can almost perfectly remove the resin without ruining the carbon fibers. For this project the goal is to come as close to this level of purity while making the entire process automated with the resources that are available.

## Performance Predictions

While the majority of this project is dedicated to creating a system that will let the entire pyrolysis process become automated, the measure of success will focus on how pure the material will be at the end of the process which will be determined by the oven which was already built in a previous year. A project from a previous year provides a measure of time and temperature to use for the material but does not provide a good measure on the purity or integrity of the material which makes it hard to predict the outcome of this project.

Most likely, the material will come out still in some clumps when it should ideally be completely separated. However, the automation should work perfectly fine.

## Analyses (See Appendix A)

**A1. Pyrolysis Analysis:** A temperature and duration needed to be established for the oven.

**A2. Output Analysis:** he Output Analysis is the yield of the device and is what will determine the practicality of the device.

**A3. Desired Conveyor Speed:** The conveyor can only move at an unknown constant speed; this speed needs to be at a certain value to make sure that the material stays in the device for the desired heating time.

**A4. Mass of Chip Overflow:** The Dispenser can hold a limited amount of overflow from the shredder, this analysis will determine the limit of how much can be put into the device system at a time.

**A5. Batch Size:** A test needs to be taken to determine how much material can go in the oven at one time and how many turns of the dispenser is equal to this batch size.
**A6. Dispenser Speed:** Calculations need to be done to determine how long it takes for the device to dispense so that the Output time of the deice can be determined.
**A7. Friction on Inner Slide:** There is not much allotted vertical height for the cover which means that the angle of the Slide might not be steep enough to allow the material to slide off. To this end, a friction for the Slide will need to be known.
**A8. Friction on Panel:** The Panels will have to be in preset positions to block out heat at each interval. This means that the material will have to be able to slide off the panel at whatever angle it ends up at. This needs to be analyzed to make sure that the device will work.
**A9. Dispenser Motor Strength:** A test needs to be performed to determine the strength required of the motor for the dispenser.
**A10. Rotary Motor Strength:** Calculations need to be done to determine the bare minimum strength of the door motors.
**A11. Chip Fall-Off from Panel:** A close look at the point where it is safe for the chips to fall vs the point the chips will fall of the Panel.
**A12. Chip Fall-Off from Slide:** The position of the Back-Door Panel is predetermined; therefore, an analysis needs to be performed on the design constraints of the slide.

## Calculated Parameters

From each Analysis, these parameters were solved:

**A1.** The oven needs to heat the material at **752º F** for 1 hour.
**A2.** The average overall output rate is **[0.134]** grams per minute.
**A3.** Assuming the conveyor is capable, the desired conveyor speed is **0.4** inches per minute.
**A4.** Overflow won't be a problem.
**A5.** The size of each batch to be heated in the oven is **[3]** dispenses or **[8.01]** grams.
**A6.** The amount of time it takes for the device to finish the dispensing phase is **[2.93]** seconds.
**A7.** The desired friction coefficient of the Slide must be less than **[0.577].**
**A8.** The Device will work.
**A9.** The Dispenser requires Minimal Force to turn.
**A10.** The Panels require Minimal Force to rotate.
**A11.** The Device will work.
**A12.** The end of the slide needs to be 1.5 inches or closer from the back wall and 4 inches or higher from the floor

## Best Practices

Boeing has a system for pyrolysis that is completely automated and needs only to be activated. The end product results in the carbon fibers coming out of the machines as long pure strands. This system also includes a series of ovens and cooling systems to keep the carbon fiber from being ruined.

# 3: Methods and Construction

## Description of Parts

i. ***Door Panels:***
The Doors can made at CWU either using sheet metal found at location or purchased online.

ii. ***Door Motors:***
The Door motors will have to be purchased online in the event that the motors located at CWU cannot be obtained. They will then be programmed at CWU

iii. ***Storage and Batch Separator:***
These devices should be able to be combined into one. The easiest way to create this system is to purchase a candy dispenser then remodel it to be able to contain the overflow and dispense the materials directly onto the door panel slide system.

iv. ***Panel Housing and Inner Slides:***
This will be made out of sheet metal made out of the same material as the Door Panels.

v. ***Outer Slides:***
Can be made out of any sturdy material with low friction which will be purchased online.

## Construction Process Proposal (Need Revisit)

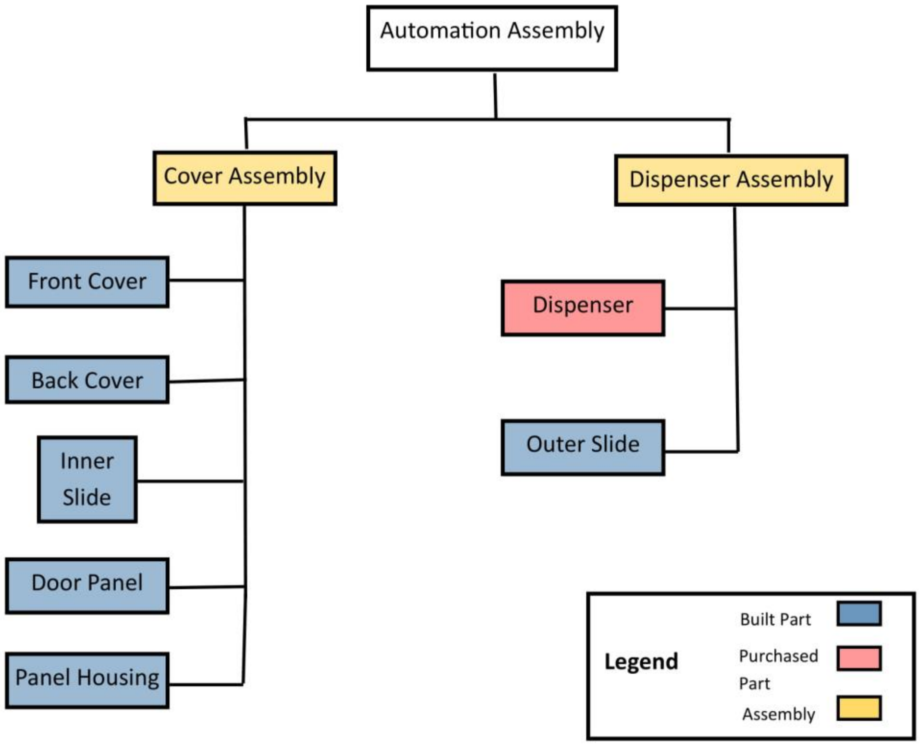
1. The first part of construction will be to optimize the dispenser to fit the constraints of the design. If this can't be done, then the dispenser will have to be made from scratch.
2. The door panels and panel housing will have to be made and then tested to confirm that the design works as intended.
3. The inner slide will have to be combined with the conveyor to make sure the conveyor can reliably drop the material onto the slide and the slide onto the second door panels.
4. Once all other parts have been created and tested the cover will then be cut to fit the design. This must be done last and be done very precisely as the cover will not be able to be repaired or replaced if there is an error.
5. The Housing, and slides will then need to be attached to the cover.
6. Finally, once the design is completed the motors and circuitry will need to be attached and programmed to the timing found in Analyses A-2, A-3 and A-6.

## Construction Process Actual

M/C 01 = **1/24/2020:** The first part to be made will be the door panel. However, since this needs to be welded, the final assembly will be done with the assistance of a professor. Now that the material for this part has been determined, some issues in the design need to be addressed. One of the problems is that the part will need a way to be seated onto the cover as well as a gear placed onto the shaft. These problems need to be solved in detail as all dimensions are based on each other. Before construction on these parts can begin, a 1:1 model of the final design for the entire device needs to be constructed so that all parts can be built and assembled.

M/C 02 = **2/19/20:** When manufacturing of the parts began, the method of assembly was revisited. Due to constraints on welding, it was decided that it would be best to look for a better way to fasten the parts together. The design has been changed so that no welding will be needed for the final device and will mean that the drawings will have to be updated again. For example, the Rotary Panels will now be fitted inside of the Rotary Wall instead of being welded to the Shaft. The Housing will be made of L-bars that attach to the Cover instead of them being welded together.

## Drawing Tree, Drawing ID's




## Device Operation

To run the system, a motherboard will be used to start and stop the process. Since the device will not have sensors, the entire process will have to be on a set timing. Preferably this timing will be correct so there won't be a need for the user to adjust it. However, in the event something becomes calibrated incorrectly over time, an option to change the motor's timing should be implemented if possible. Given the nature of how long the oven process takes it will be difficult for the user to test the timing of the motor and adjust accordingly.

# 4: Testing Method

## Introduction

### Requirements

1. The Dispenser must be able to function in a consistent matter. Batches need to be within a 10% margin of error between each batch.
2. Must be able to move the Material Scraps from the Dispenser, through the Cover, and into a Collector.
3. The Device needs to be capable of moving all Material Scraps in the Dispenser through the Oven System autonomously.

### Parameters of Interest

1. Average Mass
2. Pass Rate
3. Pass Rate

### Predicted Performance

1. The Material in the dispenser is received from a Shredder which is another Group's Project. The Range of the Dispenser will depend on the consistency of the chip's sizes from the Shredder and the effectiveness of the Dispenser itself. The Range is predicted to be within 10% of the average batch size.
2. The Door Panels are slightly unsymmetrical which will result in uneven positioning; however, the Material should be dumped at the designated positions, albeit at varying angles. It's predicted the Device will *Succeed* however the Average efficiency might be anywhere from about 80% to 50%.
3. Based on the rough appearance of the Device and the Analyses found in the Overall Report, it is predicted that 70%-90% of the Material will pass through successfully.

### Data Acquisitions

The data will be collected by using a Weighing Scale for each test. The data will be measured to the closest 0.1 gram.

## Method/Approach

### Resources

- Power Outlet (In case VEX battery dies)
- Carbon Fiber and Resin Composite scraps (Referred to as "Material" or "Scraps")

### Test Procedure Overview

So long as all the Resources listed above are supplied, the test can be performed anywhere.

### Operational Limitations

1. The Oven cannot be stopped unless the Cover is taken off.
2. The speed of the Conveyor cannot be changed unless the Cover is taken off.
3. The Panel does not rotate at the same angle as the Shaft, this is because the Panel is driven by a pin in the Shaft. However, the Pin is just scrap metal shoved into a hole.

The device should work as follows.

1. The Dispenser will activate and let out a set amount of Scraps.
2. The Scraps will fall onto the 1st Rotary Panel.
3. The 1st Rotary Panel will rotate to the next set position.
4. The Scraps will fall onto the Oven's Conveyor
5. The Scraps will stay on the Conveyor for as long as needed.
6. Once the Scraps get to the end of the Conveyor the Scraps will fall onto the Slide which leads to the 2nd Rotary Panel.
7. The 2nd Rotary Panel will rotate at a set time to a set position to allow the Scraps to fall into a Collector.

### Data Analysis and Presentation

The data was recorded in the Tables below.

## Test Procedure

**Test1:** The first test is very simple but necessary to determine functionality of device.

**Steps:**

1. First, fill the Dispenser with the Material.
2. Rotate the Dispenser knob to the next position to get a Batch worth of Material, collect and weigh the Material, then record the data.
3. Perform this test 3 times.
4. Calculate Average weight and Record in Table.
5. Compare all trials to Average weight and determine the Range. Record this value in Table.

**Discussion:**

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**Test 2:** The best way to test the Device is simple trial and error. The Device can be tested once built without turning on the Oven so that the Material can be used repeatedly without being ruined. All tests will be "Dry-Runs," which is a run without the use of the Heat or Gas that is normally used during pyrolysis, however the only function of interest is the device's autonomous ability.

**Time to Complete 1 Cycle**

About **1 min**.

**Location and Resources:** The test needs to be performed at CWU. The resources needed are Carbon Fiber Scraps (Scraps) and a power outlet for the Oven. The parts used in this test are a V5 Robot Brain, a device created for heating the scraps (an Oven), a Cover for the Oven (Cover), a Dispenser, 1st Rotary

Panel, 2nd Rotary Panel, a Slide, and a bucket or anything that can be used to collect the Scraps once they are through the Device (Collector).

**Steps:**

1. First, fill the Dispenser with the Material.
2. Rotate the Dispenser knob to the next position to get a Batch worth of Material, collect and weigh the Material then record the data.
3. Return Material back to Front Door Panel then activate the Dry Run cycle.
4. Collect and weight the Material then record the data.
5. Take the Final weight and divide it by the Initial weight, this value is the Pass Rate. Record this value in the Table.
6. Repeat test 3 times and calculate average pass rate.

**Risk:** Since no Gas or Heat will be used for this test there shouldn't be any real dangers with the test with the exception of potential pinch points but the motors are not that strong so they shouldn't pose a threat.

**Discussion:**

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**Test 3:** The Device will be tasked with passing all Material in the Dispenser through the Oven and into the Collector and it must do all of this Autonomously.

**Time to Complete Test:**

About **1 min** per Cycle and about **10 min** per test.

**Steps:**

1. First, weigh the Dispenser and record the Data.
2. Next, fill the Dispenser with the material being tested, weigh the Dispenser again, and record the Data.
3. Activate the V5 Robot Brain and activate the Complete Code program. Press A to activate the Autonomous Mode. The device should work as follows.
    a. The Dispenser will rotate 3 times and let out the Scraps.
    b. The Scraps will fall onto the 1st Rotary Panel.
    c. The 1st Rotary Panel will rotate halfway to the next position, stop for a second, then rotate the remainder of the distance. This is to help shake the Scraps off the Panel.
    d. The Scraps will fall onto the Oven's Conveyor
    e. The VEX program will wait 50 seconds, the Scraps should get to the end of the Conveyor, fall onto the Slide, and be caught by the 2nd Rotary Panel in this time.

    f. The 2nd Rotary Panel will turn twice, and the Scraps will fall into a Collector.

4. Collect the Scraps from this trial and weigh them. Compare this value to the initial amount of Scraps to find the Pass Rate and Record this value in the Test 3 Table.
5. Repeat Test 3 times and then find the Average Pass rate.

**Risks:** Since no Gas or Heat will be used for this test there shouldn't be any real dangers with the test with the exception of potential pinch points but the motors are not that strong so they shouldn't pose a threat.

**Discussion:**

# Deliverables

## Parameter Values (results)

1. The Dispenser Batches were an average of [4.78] grams and each batch were within [20] % of this average.
2. The average amount of material that passed through is **[N/A] %**
3. The Device has an average pass rate of [N/A] %

## Calculated Values

First Test:

| | **Trial 1** | **Trial 2** | **Trial 3** | **Average** |
|---|---|---|---|---|
| **Batch Size** | 4.73 Grams | 6.16 Grams | 3.44 Grams | **4.78 Grams** |
| **Margin of Error** | 0.98% | 28.96% | 27.98% | **19.31%** |

Second Test:

| **Trial** | **1** | **2** | **3** |
|---|---|---|---|
| **Pass Rate** | 30.6% | 58% | 89% |
| **Pass?** | NO | NO | YES |

Third Test:

| **Date of Attempt** | **5/27** | **6/1** | **6/4** |
|---|---|---|---|
| **Pass Rate** | 9.60% | 42.02% | ??? |
| **Pass?** | NO | NO | ??? |

## Success Criteria Values

1. **Both Values above 80%**

2. **Pass more than 8/10 Trials. Average Value above 80%**
3. **Average of all Trials Margin of Error less than 10%.**

### Conclusions

## Deliverables:

If the Material can consistently flow through the System at a timing that finishes the Pyrolysis, then the project will be considered a success. To prove whether or not the device is performing its function, the batch of Material that is being tested will have to be weighed before and after it runs through the device. The data will reveal roughly how much of the material makes it through. If over 85% of the material makes it through safely then the device is a success.

The test will then be performed again but this time with the Heat and Argon Gas activated. The problem with this method for testing is that when the heat is activated the properties of the material will change so weight won't be able to determine what percent of the material made it through the device. Also, the goal of this project is to help make the pyrolysis process easier, but it does not improve the effectiveness of the pyrolysis process. Even if the pyrolysis process fails, no improvement of this project will increase the effectiveness of the oven and cover. When trying to determine the effectiveness of the automation process when in tandem with the pyrolysis process, a different method will need to be used. Most likely the test will have to be done using simple observation, as in, how much looks like made it through and how much is stuck somewhere along the way and where?

# 5: Budget/Schedule/Project Management

## Cost and Budget:

Bud 01=**Fall:** The budget is unknown; however, the costs ideally should be kept below $500.00 as most of this project is automating a machine so that future human operation costs won't be necessary. If it costs too much to build the device then it will take longer to see the payoff which would defeat the purpose of the Project. The Budget is outlined in Appendix D.

Bud 02=**5/22/2020:** In order to perform the testing of the Device, some items were required. To fill in the slots in the Conveyor Belt, tape was used. In place of the scraps of material, wooden chips were used to simulate a surplus of material and make the testing process easier. Initially, it was believed that argon gas would be needed for the heating process of testing the device, however it was determined that the automation system would work regardless of the heat in the oven. Testing while using the heating function would only ruin the Material and maybe some parts since the device still needs to be heat-proofed, however this will most likely be a future project.

Bud 03=**6/8/2020:** For this project, the total expenses came out to be about $65, this is because most of the materials and parts needed were already available at Hogue Hall so only three additional parts were purchased. Two of these parts were bearings that were purchased from McMaster-Carr that were needed to support the Rotary Panels. The final part was a Cereal Dispenser from Zevr0 that was purchased off of Amazon. This part was needed so that a new device wouldn't have to be created that could store the Material Scraps and dispense a specific amount each time. The project came about $435 short of its predicted necessary budget of $500, that's a lot of prediction money.

## Parts List:

The price, order method, and current progress towards obtaining the materials and parts is outlined in Appendix C.

## Schedule:

Sch 01=**2/7/2020:** The design that was going to be used has a flaw in it that ruins half of the device. The design needed to be reworked and remade as drawings which set back manufacturing. As of today, the Schedule still has not been reworked to show what has been accomplished so far and what will be accomplished in the future. Once the final design is created and improved, work can finally begin on the project however this might set back the rework of the Gant Schedule. Regardless, manufacturing the device is the most important task for this quarter and must be completed as soon as possible.

Sch 02=**5/14/2020:** For all of Spring Quarter, the amount of time that could be spent in the labs was limited severely due to unforeseen circumstances. Meeting time was restricted to 1 pm to 5 pm and only on Monday and Thursday. The finishing construction ended up taking far longer than previously predicted. The results from testing show that most of the Material gets lost on the Oven Conveyor, which was predicted to be able to contain the Material, so now the

Design will most likely need another part added in. This will cause construction to take even longer.

Sch 03=**6/8/2020:** This project was on schedule for a month at most and never recovered. An original draft of the Gantt Chart was made in Fall quarter, it was filled with predicted work times for all tasks up until the Project was finished. When some tasks weren't completed in time it was fine because it could just be completed later and there would be a list that laid out all tasks that needed to be performed, so long as these tasks were still needed that is. When the construction process started it was discovered that the design was impossible to build. The entire design needed to be updated and the tasks never got updated due to already being too far behind schedule.

The Design went through a series of changes throughout most of Winter quarter so it wasn't until the end of the quarter that the parts could finally be built. The device was mostly assembled but not quite working yet by the end of Winter quarter and it looked like the project was finally starting to get on track. Then the coronavirus happened. The school was closed and work on the device was limited to Monday and Thursday and only for about 4 hours each day. What could have been accomplished in a couple weeks took all quarter and the Gant Chart (Appendix E) never got fully updated. Currently, a rough estimate of times and dates are recorded on the Gant Chart, however the predicted time of 174 hours is most likely worthless as the estimated actual time of 232 hours was nowhere close.

## Milestones:

All milestones and deliverables are outlined in Appendix E.

## Project Management:

The biggest hurdle to overcome in this project is the limited scope of resources. All resources will have to be easy enough to obtain that anyone could do it provided they have the money. This means that most of the resources will not be obtained at CWU and will have to be found through the internet.

While most of the materials will not be provided on location, most construction tools are available at CWU.

# 6: Discussion

## Fall Quarter

Originally, the Pyrolysis Oven used a tray system where bits of material from the shredder would be wrapped in foil and then put on a tray before entering the oven. This became difficult to incorporate in an automated system, so it was removed. The material chunks are big enough so that it shouldn't be a problem to put it on the conveyor as is, however this might need to be changed in the future.

A lot of Analyses for this project need to be calculated after a material or a part can be obtained in Winter, so these won't be included in the Fall Proposal. Also, certain parts and materials can't be determined until some tests can be run on the current oven system in Winter.

## Winter Quarter

Dis 01 **1/31/2020:** Work has begun on the drawings and 3D models to create a more detailed version of each part before construction begins. As the work goes on, tiny details keep appearing that need to be addressed to make the part work. For example, the design will need a bearing for support and a way to mount it onto the device. Another problem is integrating the VEX Robotics into the device without modifying the VEX parts. Finally, a lot of the parts needed to be broken up into smaller parts and then assembled in order to make a part that works as intended.

Dis 02 **3/5/2020:** Before construction began, the design changed two times form the original design. After construction started the design changed two additional times, once immediately and the other two days ago. Luckily, the general shape of the parts did not need to change, so the new design can pick up from where the old one left off. This new design should be the final change needed, so now the finer details of the parts such as hole locations can finally begin. All parts have been made and now that a final design has been created, the parts can finally be finished and assembled, which won't take long.

## Spring Quarter

Dis 03 **5/1/2020:** Construction on the device continued into spring quarter on April 16th. Access to the labs was limited so as of May 1st there has only been 5 work sessions on the device. Progress is smooth albeit slower than previously expected. The tasks that remain are the finishing touches on the Cover and Panel integration, half of the VEX setup, and seating the Dispenser on the Cover. Testing should begin May 11th at the latest and May 7th at the earliest. On the bright side, testing of the device should be simple and fast given that the only metric of success is getting the Material in and out of the device.

Dis 04 **5/8/20:** Slowly approaching the end of construction, should be finished within the next two sessions. Decided that it would be easier not to attach the VEX system to the cover but instead connect them to a large and heavy base piece that sits on top of the cover. Started performing the testing process as well, however there is far less material to work with than what was predicted so this will change the test procedure a bit. In the test that was performed it was discovered that the Door Panels are shockingly efficient, however a significant portion of the Material gets lost on the Conveyor. This is due to the large gaps on the conveyor belt which was something that was struggled with in the original design which would have used a tray system, but it was ultimately decided that it wouldn't affect the outcome. This turned out to be a massive oversight which will have to be improved during construction.

**Final (6/9/20):** After the Conveyor was fixed, the first test was performed. The first test was to see if the Dispenser would function properly. The Dispenser turned out to be more inconsistent than predicted, however it still works for the needs of the device so it will have to do. The next test was to operate the device by hand to make sure all parts were lined up properly as well as making sure that the device functions. The first trial resulted in a Pass Rate, the percentage of material that goes through the device, of 30%. This was far below the minimum performance standard, so the Device was tweaked to increase this. The second trial had a pass rate of 58% so the device needed to be edited a bit more. Finally, the third trial resulted in a pass rate of 89% which means that as far as we know, the maximum efficiency of the device is 89%.

The last test was a test to see how well the automation program works. The test was performed in a similar fashion to the previous test: doing a trial run then tweaking the Device if it fails. The first two tests resulted in pass rates of 9.60% and 42.06%. The final tweaks were made however the test resulted in a pass rate of 54.3% which is still below the accepted minimum. It was determined that the rotary panels need to move back and forth to shake the Material off of them however time ran out so it was decided that the Device works and has the potential for automation, however the program needs to be fixed so until then: the Device is not automated.

# 7: Conclusion

**Fall =** The design for this project is almost complete. All main parts have been designed, the only area that is holding the project back is knowing what resources can be obtained, in what form, and at what cost. Once the ideal resources have been sorted out the design can be tweaked to accommodate the resources and construction can begin. Some of these resources will need to be tested to confirm that they can handle the assigned task, which will be documented in the Analyses.

Spring = The predicted performance parameters for the Device was that it be capable of moving the Carbon fiber composite scraps with an overall efficiency over 70%. The Device that was created is capable of moving the material with a mechanical efficiency of 89% and an automated efficiency of 54%. What this means is that the Device has the potential to properly process 89% of material that goes in, the rest gets lost somewhere inside the cover. The automated efficiency is the efficiency of the device when left completely alone. This value would have been bigger however time ran out just as it was discovered why the program wasn't working.

The goal of this project was to automate the Device that the previous seniors had left behind. In order for the device to be considered automated it needed to be capable of containing all input material, dispensing this material as needed, placing the material onto the oven conveyor and through the cover, obtaining the material from the conveyor and getting it out of the cover, all without outside help and at an efficiency above 80%. The device that was created is capable of all these tasks at an efficiency of 89%, however, the Device is not considered automated because when left by itself the device has an efficiency of 53% which is below the requirement.

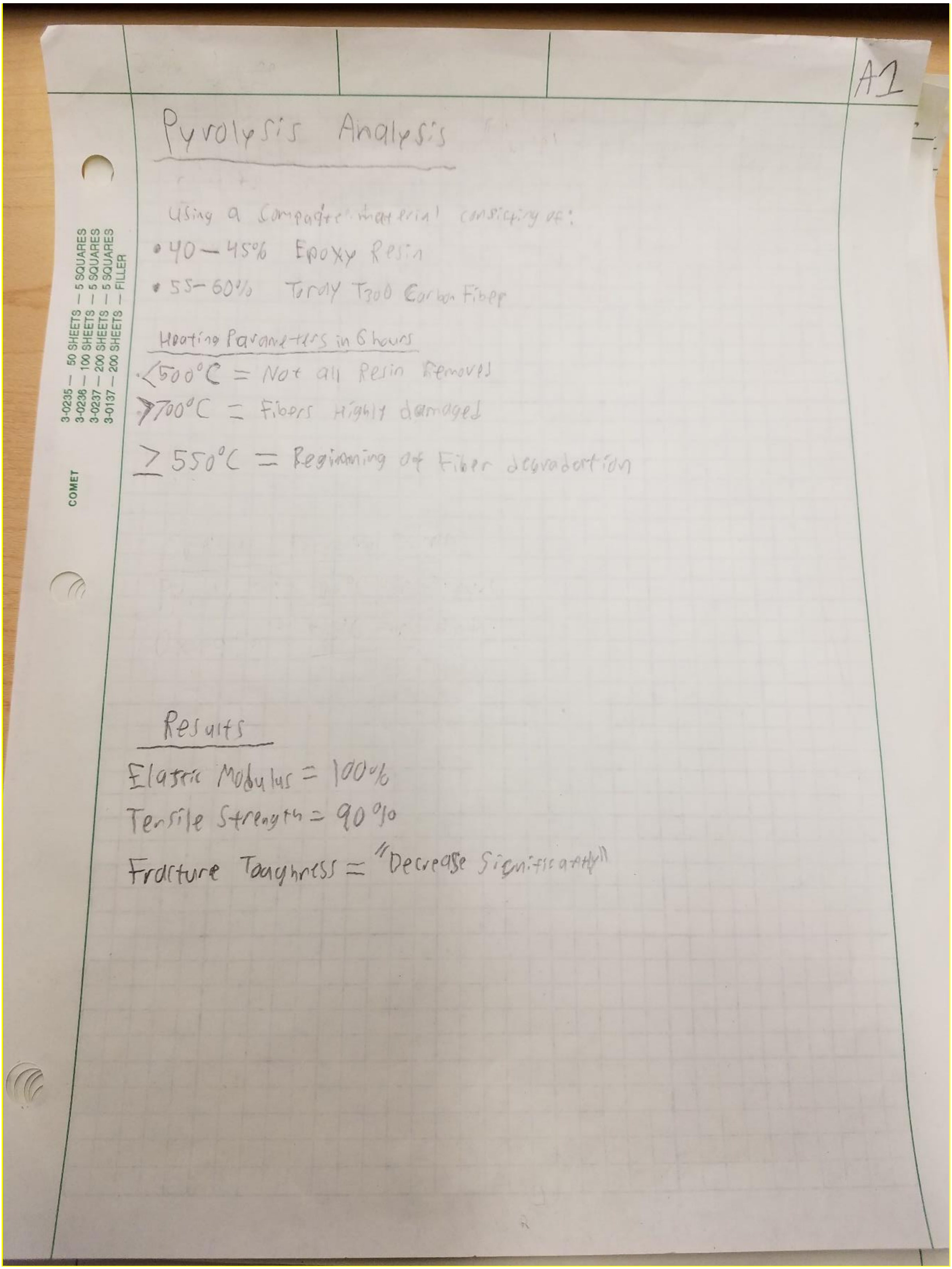
The Device is not oven ready in its current state. The Device will not be oven ready until a replacement can be found for the tape that can cover the conveyor slots and withstand heat. The reason for this is that the material scraps get stuck in the gaps of the conveyor, so a system needs to be implemented to prevent this.

# Acknowledgements

This project is sponsored by JCATI
Mentored by Charles Pringle, Craig Johnson and John Choi.

# Appendix A – Analyses

## A-1 Pyrolysis Analysis



A1

Pyrolysis Analysis

Using a composite material consisting of:

- 40–45% Epoxy Resin
- 55–60% Toray T300 Carbon Fiber

Heating Parameters in 6 hours

$< 500^{\circ}C$ = Not all Resin Removed

$> 700^{\circ}C$ = Fibers Highly damaged

$\geq 550^{\circ}C$ = Beginning of Fiber degradation

Results

Elastic Modulus = 100%

Tensile Strength = 90%

Fracture Toughness = "Decrease Significantly"

## A-2 Output Analysis

A2

### Outputs Analysis

**Given**

- Cycle time = 60 min
- Batch size = 8.01g

**Find**

- Output of device ($\dot{m}$)

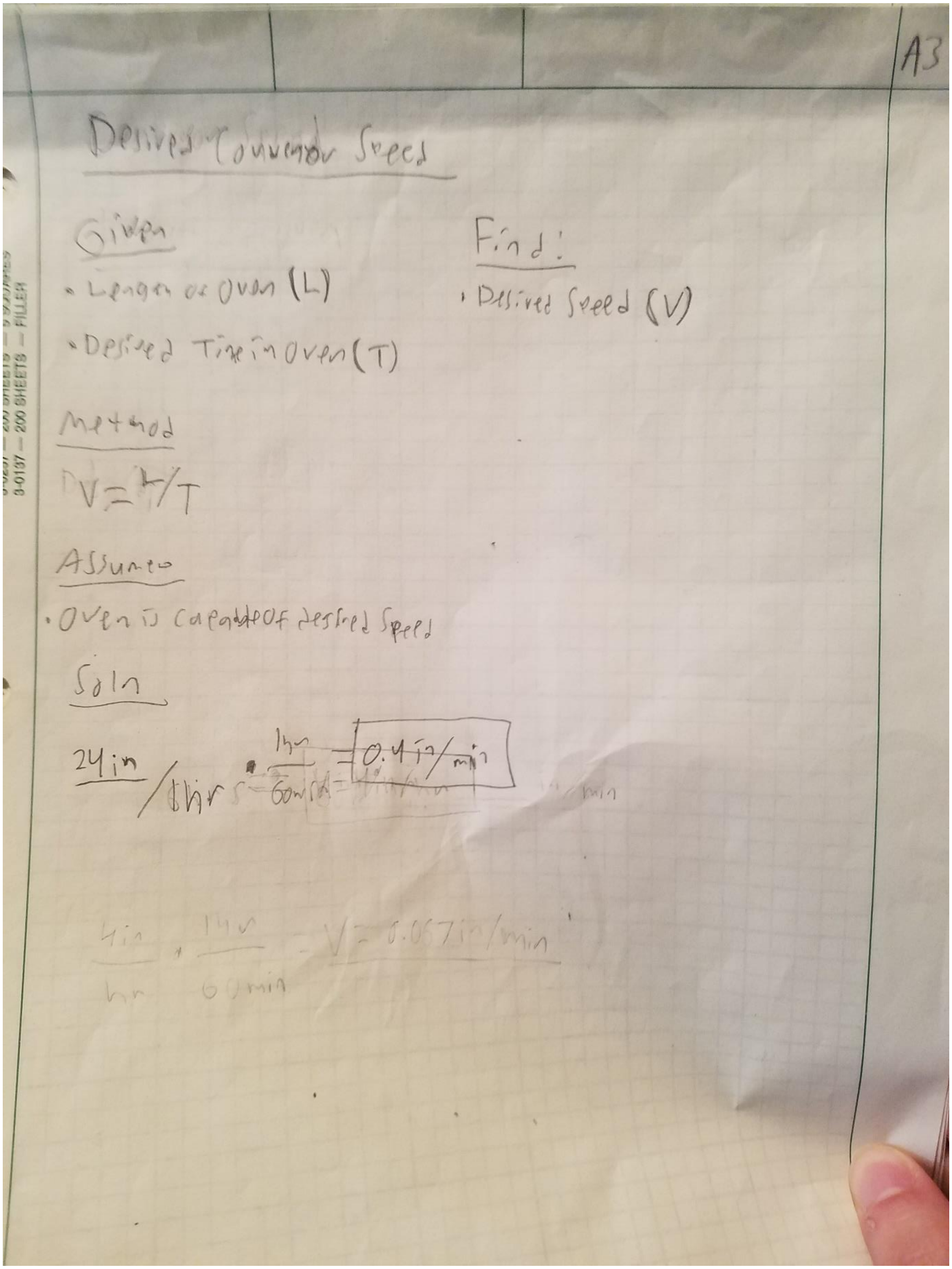
**Method**

$$\dot{m} = m/t = \frac{8.01\,g}{60\,min} = 0.134\ g/min$$

**Soln**

$$\boxed{\dot{m} = 0.134\ g/min}$$

## A-3 Desired Conveyor Speed



A3

Desired Conveyor Speed

**Given**

- Length of Oven (L)
- Desired Time in Oven (T)

**Find:**

- Desired Speed (V)

**Method**

$V = L/T$

**Assume**

- Oven is capable of desired speed

**Soln**

$\frac{24\,in}{1\,hrs} \cdot \frac{1\,hr}{60\,min} = \boxed{0.4\,in/min}$

$\frac{4\,in}{hr} \cdot \frac{1\,hr}{60\,min} = V = 0.067\,in/min$

# A-4 Mass of Chip Overflow

A4

## Mass of Chip Overflow

**Given (Assumed)**

- Capacity of Dispenser ($V$)
- Density of Composite ($\rho$)

**Find**

Mass of Overflow ($m$)

**Method**

$V \cdot \rho = m$

**Assume**

- Space between chips is negligible.

**Soln:**

$V = 3.785\ L$

$\rho =$ UNKNOWN

// Given the small size of the material scraps and low supply available, it was determined that **overflow won't be an issue.**

## A-5 Batch Size

A5

### Average Batch Size

**Given:**

- Dispenser Test Results
- Number of Dispenses per Batch, $(D_B) = 3$

**Method:**

- $m_{BAV} = 3 \cdot (2.67) = 8.01$
- $m_B$ Range $= 3 \cdot (m) - 3(M) \Rightarrow$ Range $= 6.96 - 8.67$

| Trial 1 | Trial 2 | Trial 3 | Average |
|---|---|---|---|
| 2.32g | 2.80g | 2.89g | 2.67 |

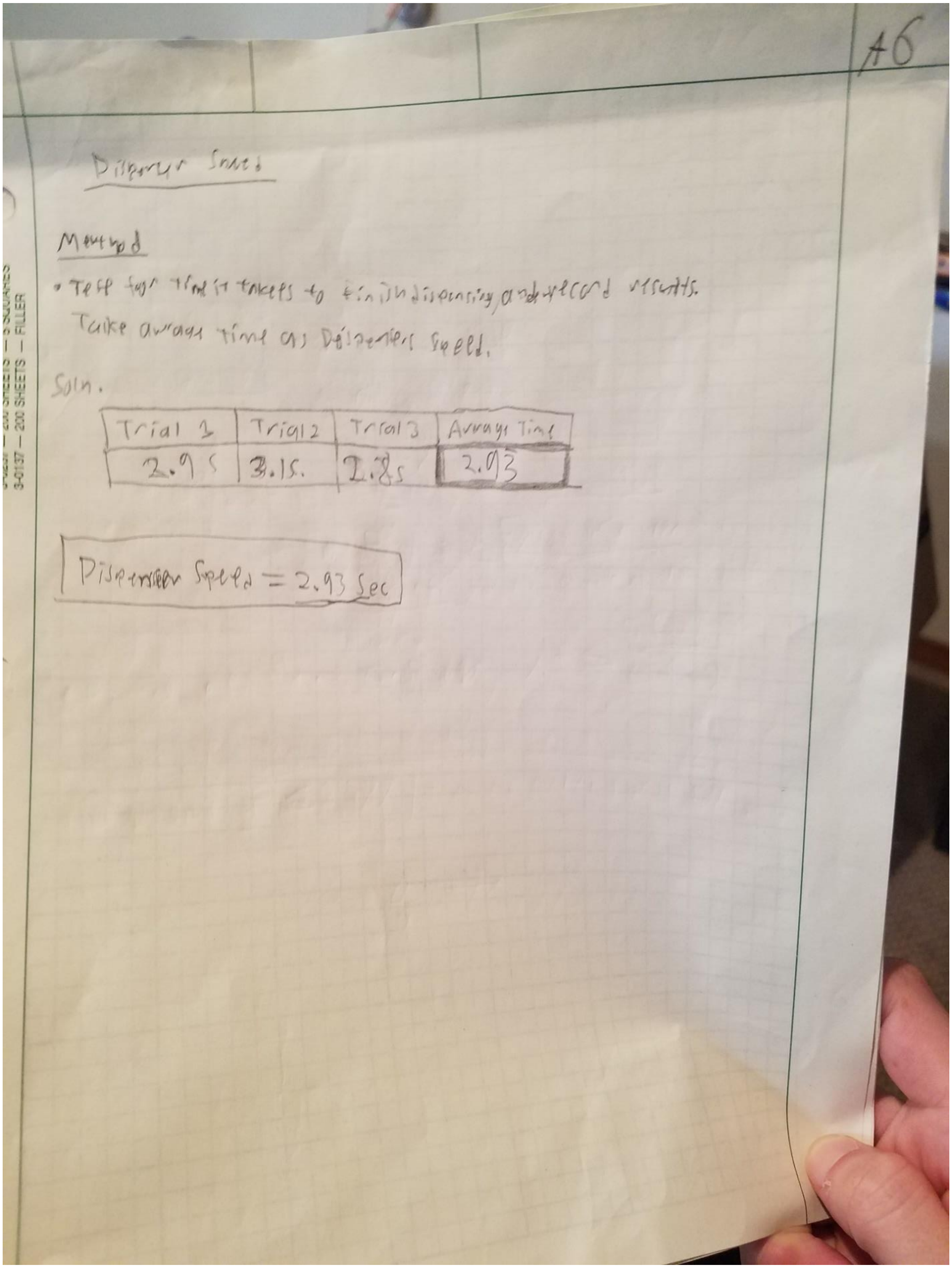
- Smallest Dispense $(m) = 2.32$
- Largest Dispense $(M) = 2.89$

**Find**

Range = 6.96g — 8.67g

Average Batch Size = 8.01g

## A-6 Dispenser Speed



A6

Dispenser Speed

Method

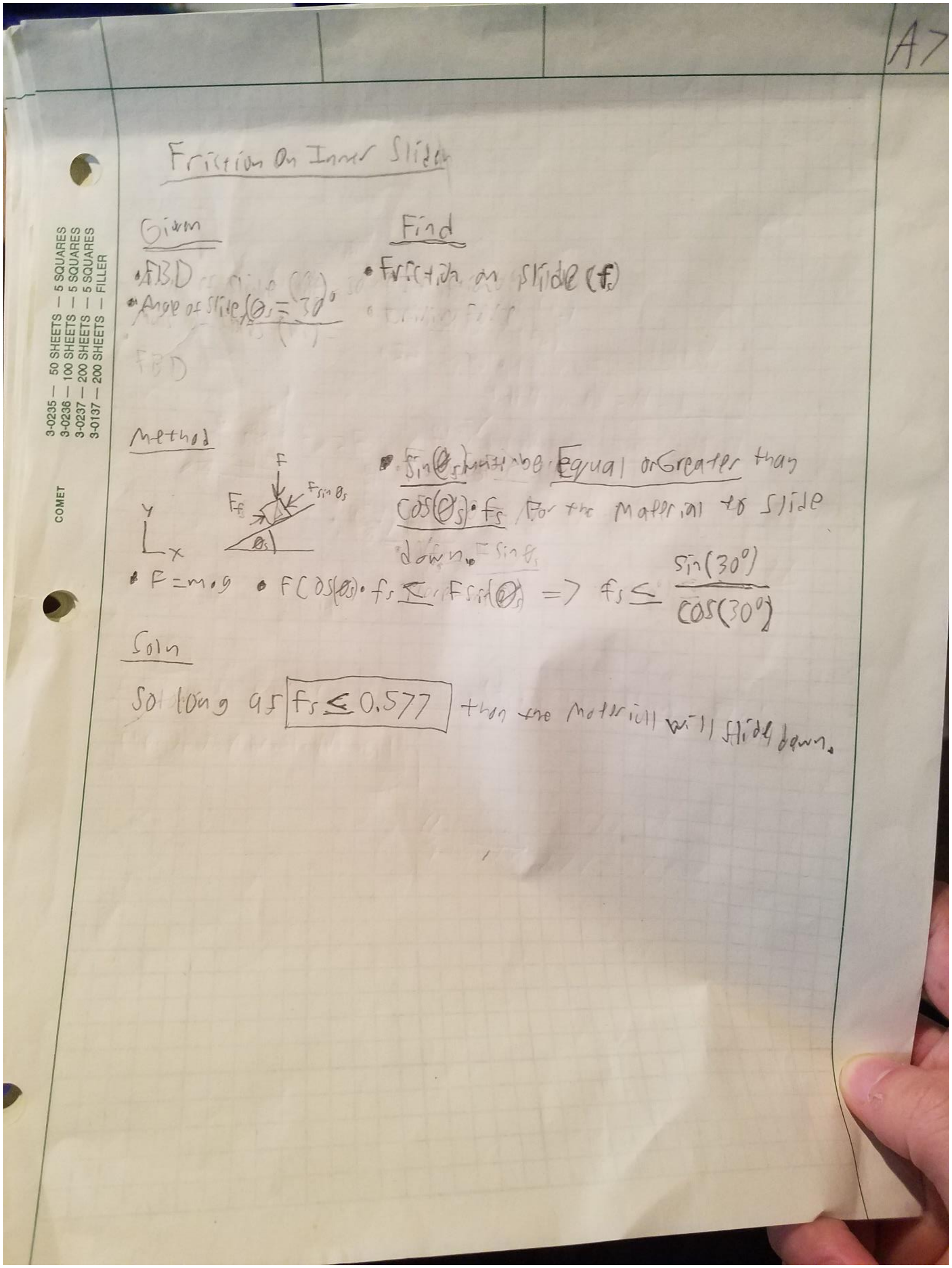
- Test for time it takes to finish dispensing and record results. Take average time as Dispenser Speed.

Soln.

| Trial 1 | Trial 2 | Trial 3 | Average Time |
|---|---|---|---|
| 2.9 s | 3.1 s. | 2.8 s | 2.93 |

Dispenser Speed = 2.93 Sec

# A-7 Friction on Inner Slide



A7

Friction On Inner Slide

Given
- FBD
- Angle of Slide ($\theta_s$) = 30°

Find
- Friction on Slide ($f_s$)

Method



- $\sin(\theta_s)$ must be Equal or Greater than $\cos(\theta_s) \cdot f_s$ for the Material to slide down.
- $F = m \cdot g$
- $F\cos(\theta_s) \cdot f_s \leq F\sin(\theta_s) \Rightarrow f_s \leq \frac{\sin(30°)}{\cos(30°)}$

Soln

So long as $f_s \leq 0.577$ then the Material will slide down.

# A-8 Friction on Panel

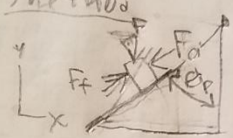
A8

## Friction on Panel

**Given**
- Angle of Panel ($\theta_p$) = 60°
- Mass of Chips (m) = ?
- FBD

**Find**
- Friction on Panel ($f_p$)
- Friction Force ($F_f$)
- Actual Force ($F_a$)
- If $F_f < F_a$

**Method**




- $m \cdot g = F \Rightarrow 0.5g \cdot 9.81\,m/s^2 = F = 4.91\,N$
- $F \cdot \sin\theta_p = N \Rightarrow 4.91\,N \cdot \sin 60 = N = 4.25\,N$
- $F_a = F \cdot \cos\theta_p \Rightarrow 4.91\,N \cdot \cos 60^\circ = F_a = 2.45\,N$
- $F_a \geq F_f$ , $F_f = f_p \cdot N \Rightarrow \frac{2.45\,N}{4.25\,N} = f_p = \frac{1}{\tan 60}$

$f_p = 0.577$

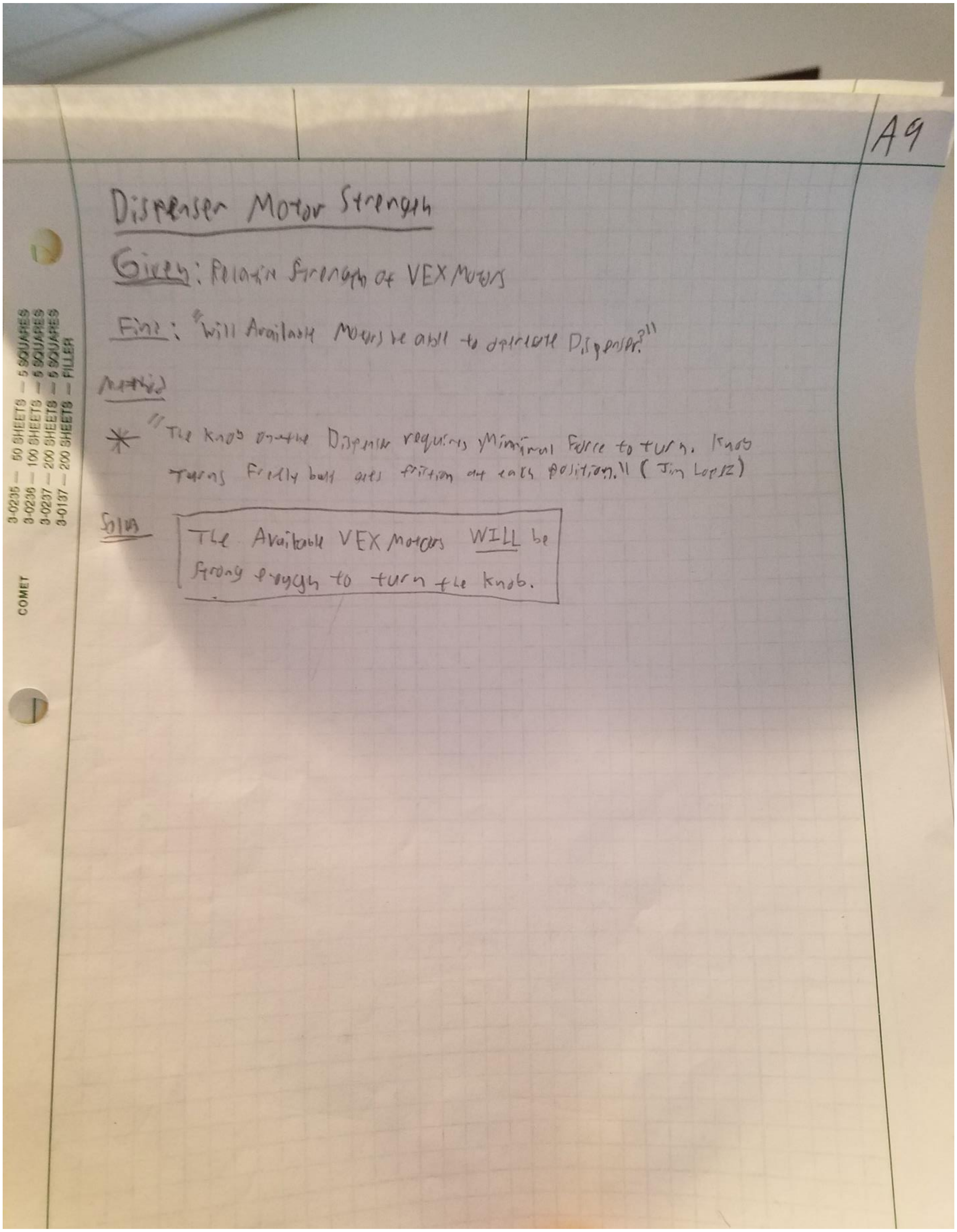
**Assume**
- Chips will only fall at $\theta_p$

**Solution**

As long as the Friction Coefficient ($f_p$) is Less Than 0.577:

**The Device is Functional**

## A-9 Dispenser Motor Strength



A9

**Dispenser Motor Strength**

**Given:** Relative Strength of VEX Motors

**Find:** "Will Available Motors be able to operate Dispenser?"

**Method**

* "The knob on the Dispenser requires Minimal Force to turn. Knob Turns Freely but gets friction at each position." (Jim Lopez)

**Soln:** The Available VEX motors WILL be strong enough to turn the knob.

# A-10 Rotary Motor Strength

A10

3-0235 — 50 SHEETS — 5 SQUARES
3-0236 — 100 SHEETS — 5 SQUARES
3-0237 — 200 SHEETS — 5 SQUARES
3-0137 — 200 SHEETS — FILLER

COMET

## Rotary Motor Strength

**Given:** Relative Strengths of VEX Motors

**Find:** "Will the Available Motors be able to operate the Door Panels?"

**Method**

* "The Door Panels rotate very smoothly thanks to the McMaster-Carr Bearings so it takes Minimal Force to rotate."

**Soln:** The Available Motors WILL be enough

# A-11 Chip Fall-Off from Panel

A11

## Chip Fall-Off From Panel

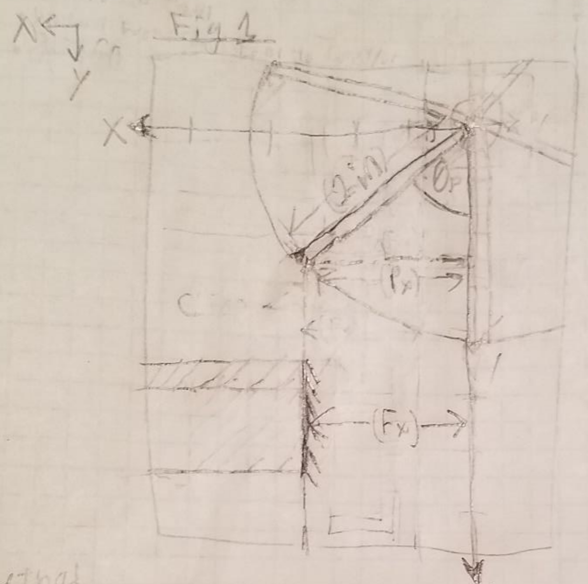
**Given**

- Length Of Panel, $(L_p) = 2in$
- Angle of Panel, $(\theta_p) = 60^\circ$
- Failure Zone Length, $(F_x) = 1.5in$

**Find**

- Distance From Y Axis to End Point Of Panel, $(P_x)$.

Fig 1




**Method**

- PBD
  - If $P_x \geq F_x$, then, Design is Functional
  - If $P_x < F_x$, then, Design is Dysfunctional
- $\sin\theta_p = P_x / L_p \Rightarrow \sin 60^\circ = P_x / 2 \Rightarrow P_x = 2\sin 60 = P_x = 1.73in$

**Solution**

- $P_x \geq F_x \Rightarrow 1.73in > 1.5in$, Design is Functional

## A-12 Chip Fall-Off from Conveyor



A1

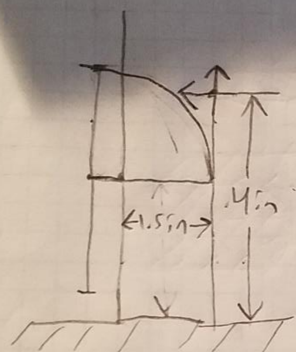
### Chip Fall-Off From Slide

**Given**

- Cover Length ≈ 18.5 in
- Conveyor Length ≈ 11in
- FBD

**Find**

- If Material will land on Back Door Panel.

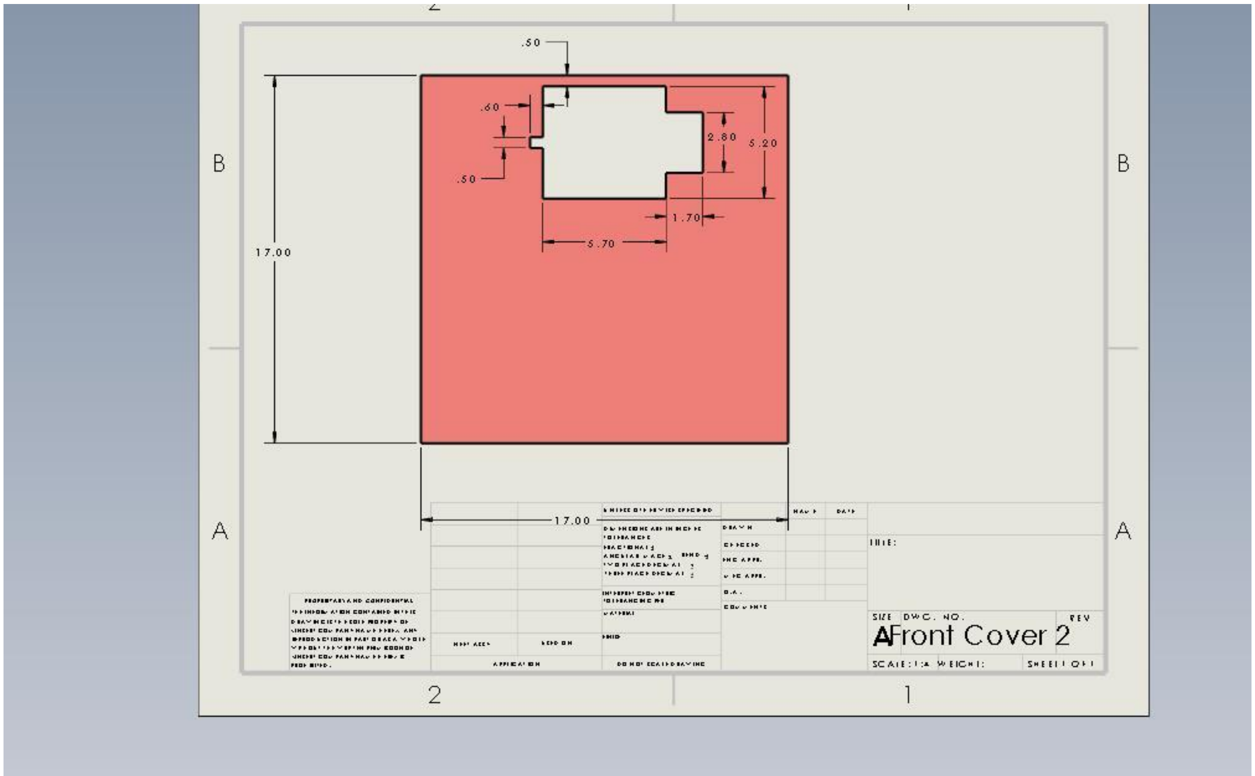



**Sln**

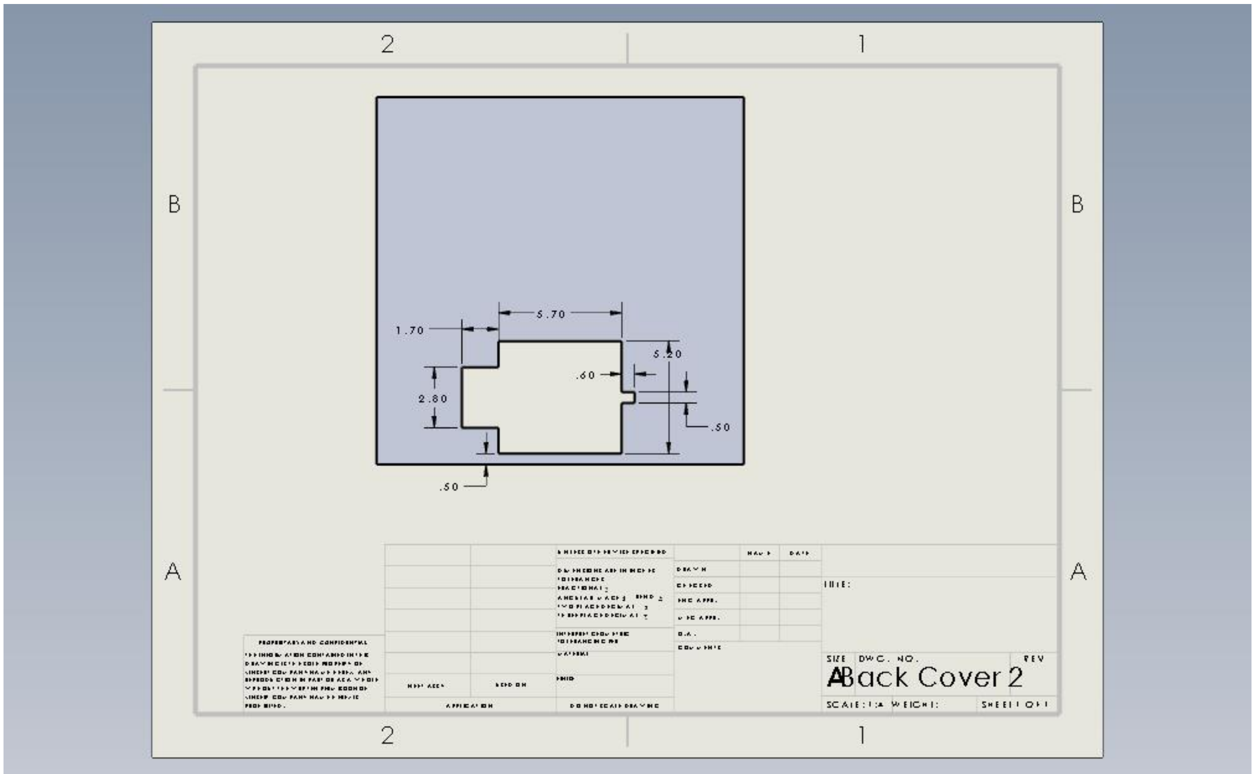
So long as the End of Slide is 1.5in or Closer to the Back wall and 4in or higher from the ground, the Slide is Clear

# Appendix B - Drawings

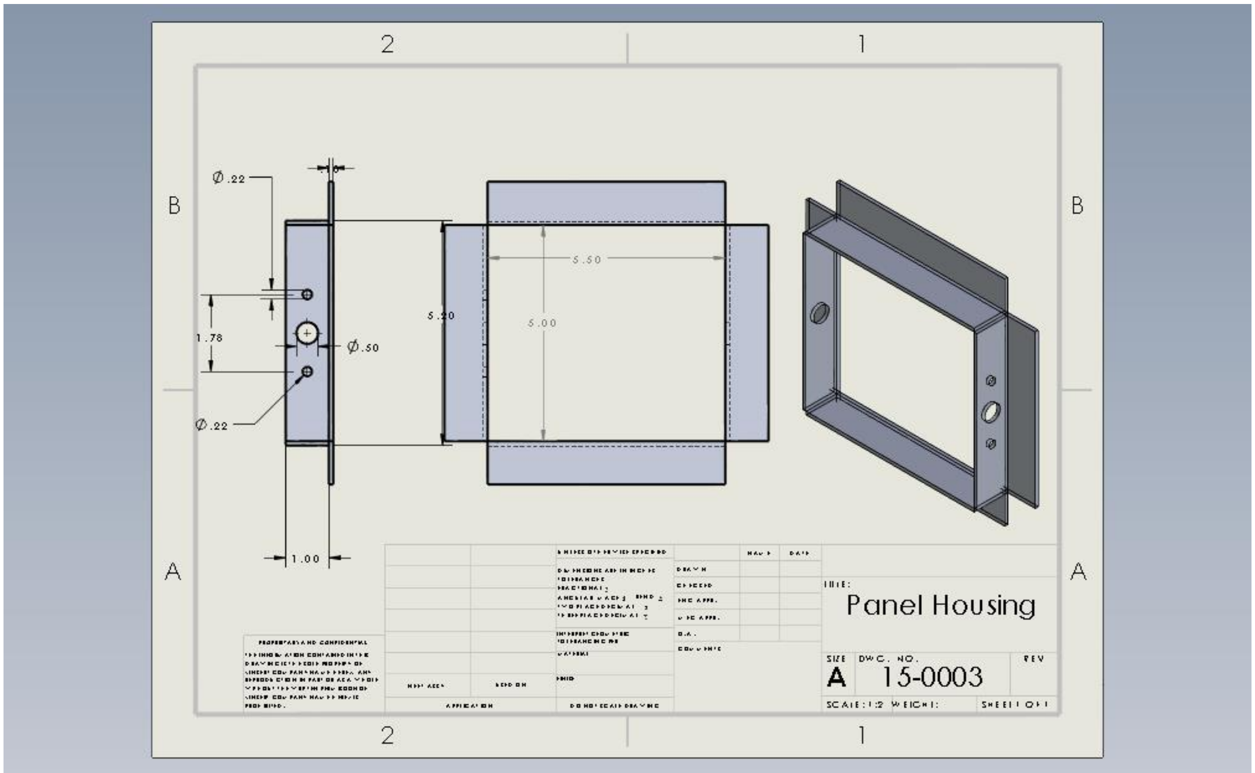
## B-1 Front Cover (15-0001)



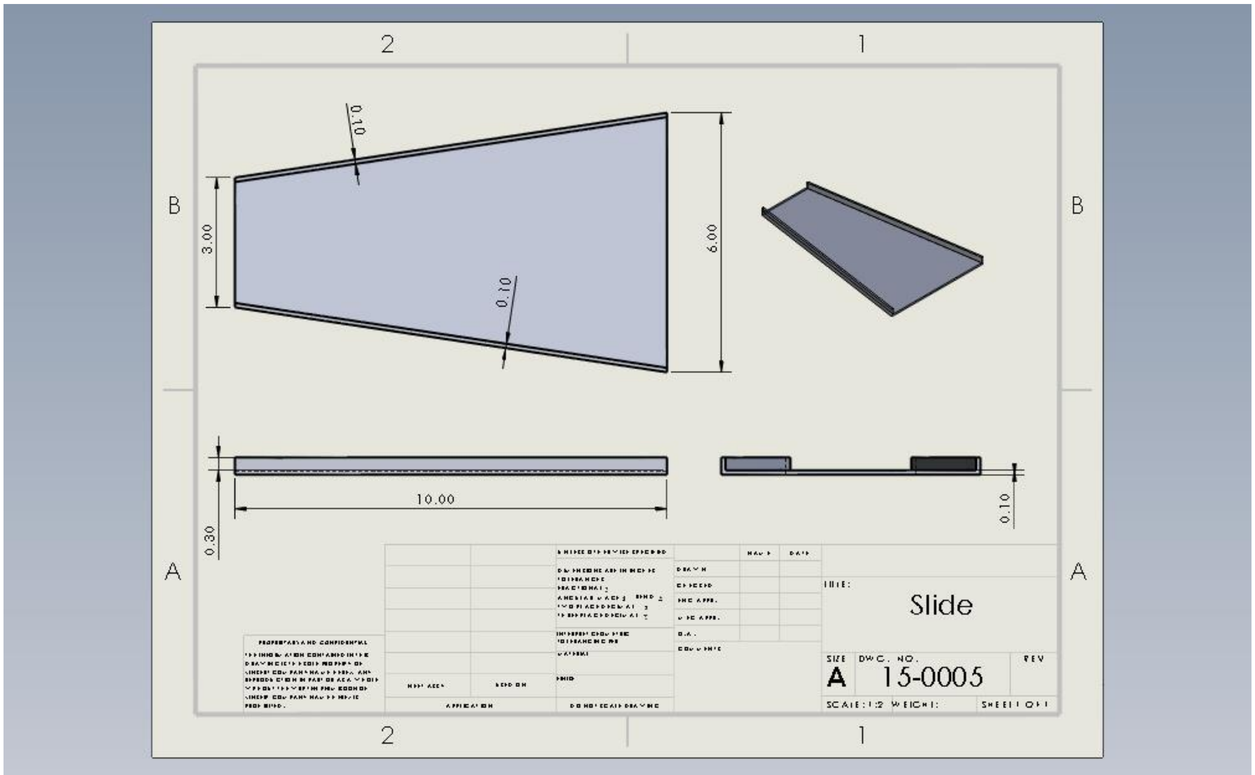
## B-2 Back Cover (15-0002)



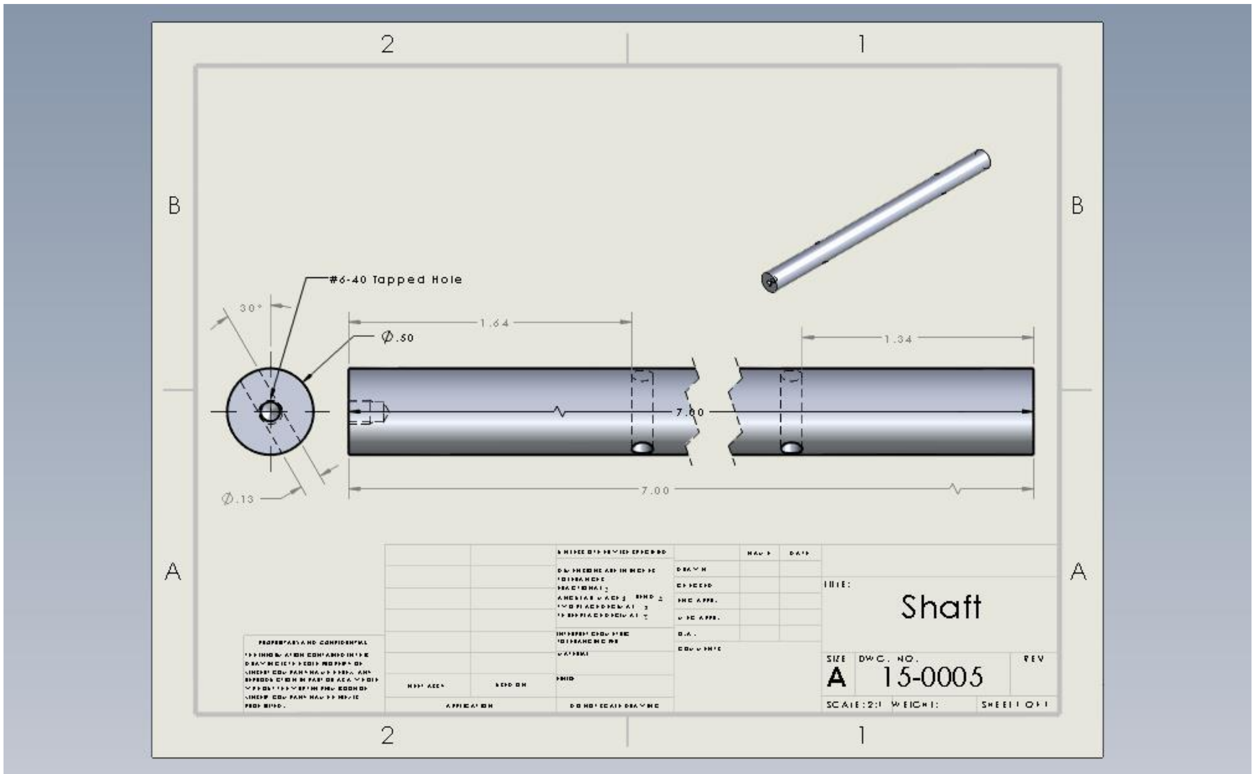
## B-3 Panel Housing (15-0003)



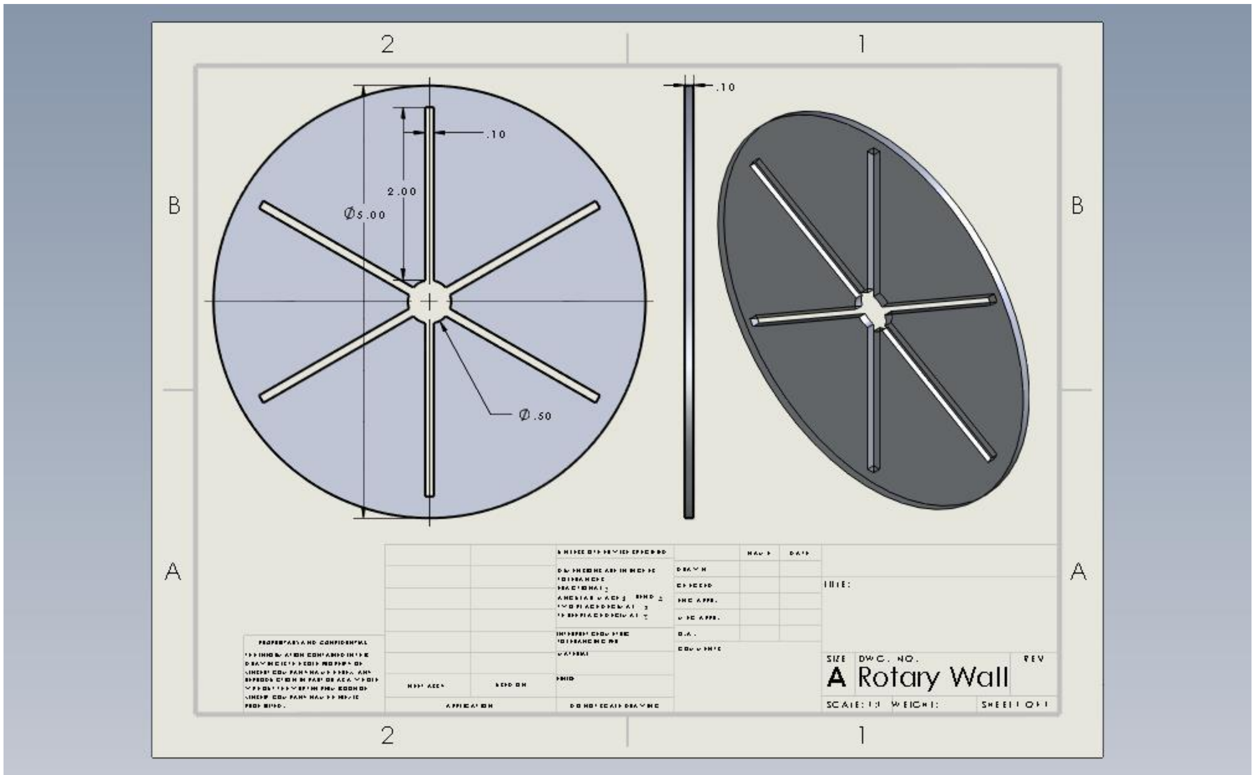
## B-4 Slide (15-0004)



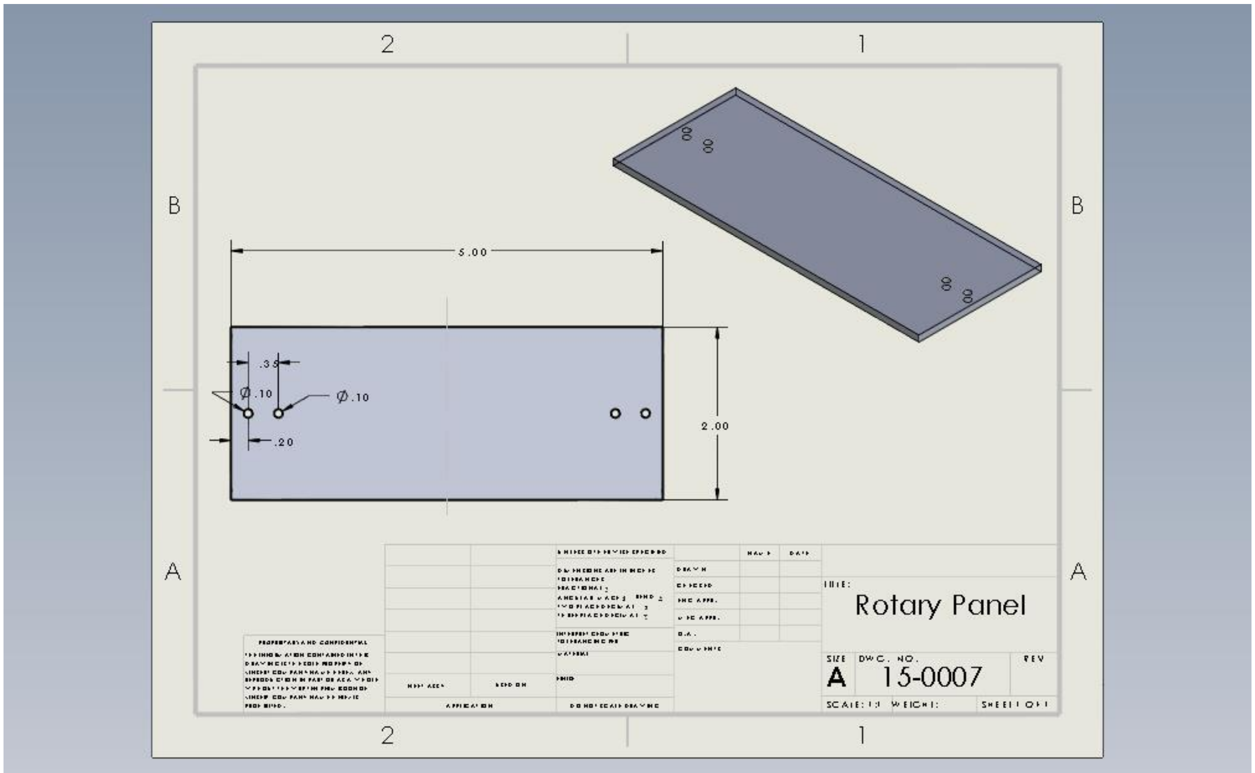
## B-5 Rotary Shaft (15-0005)



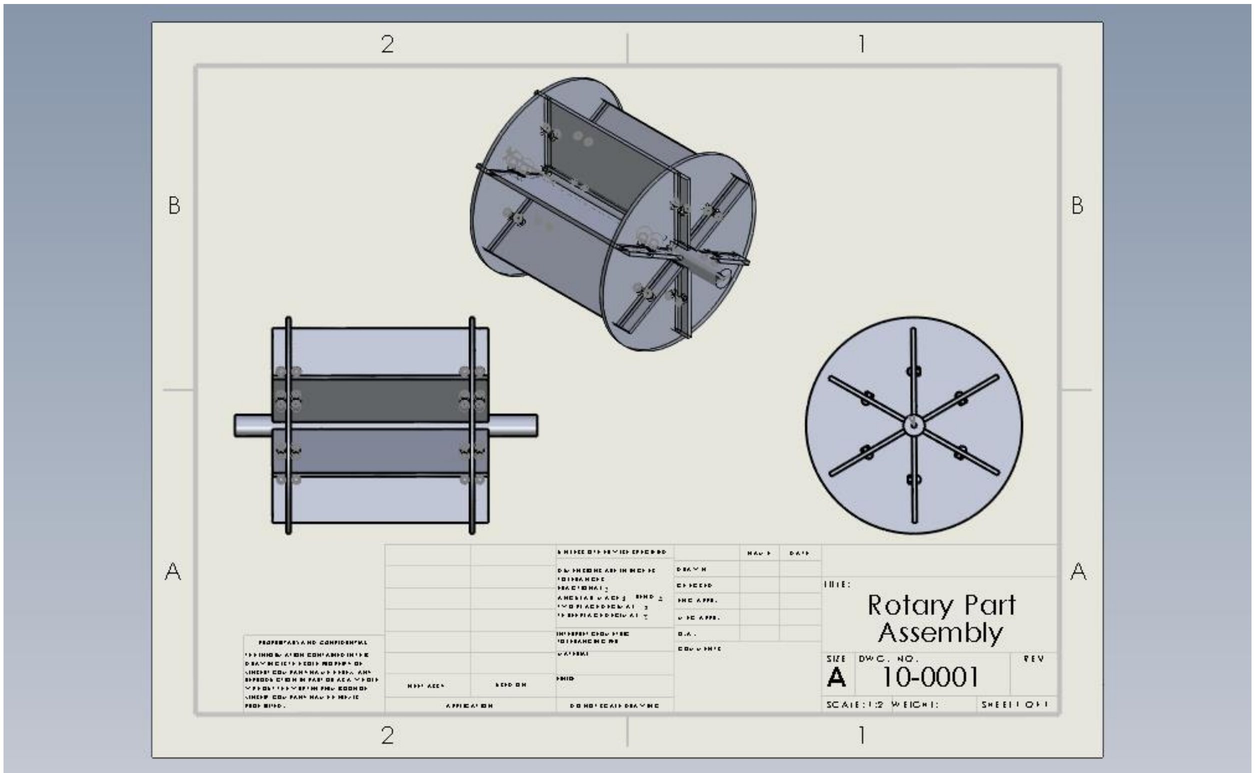
## B-5 Rotary Wall (15-0006)



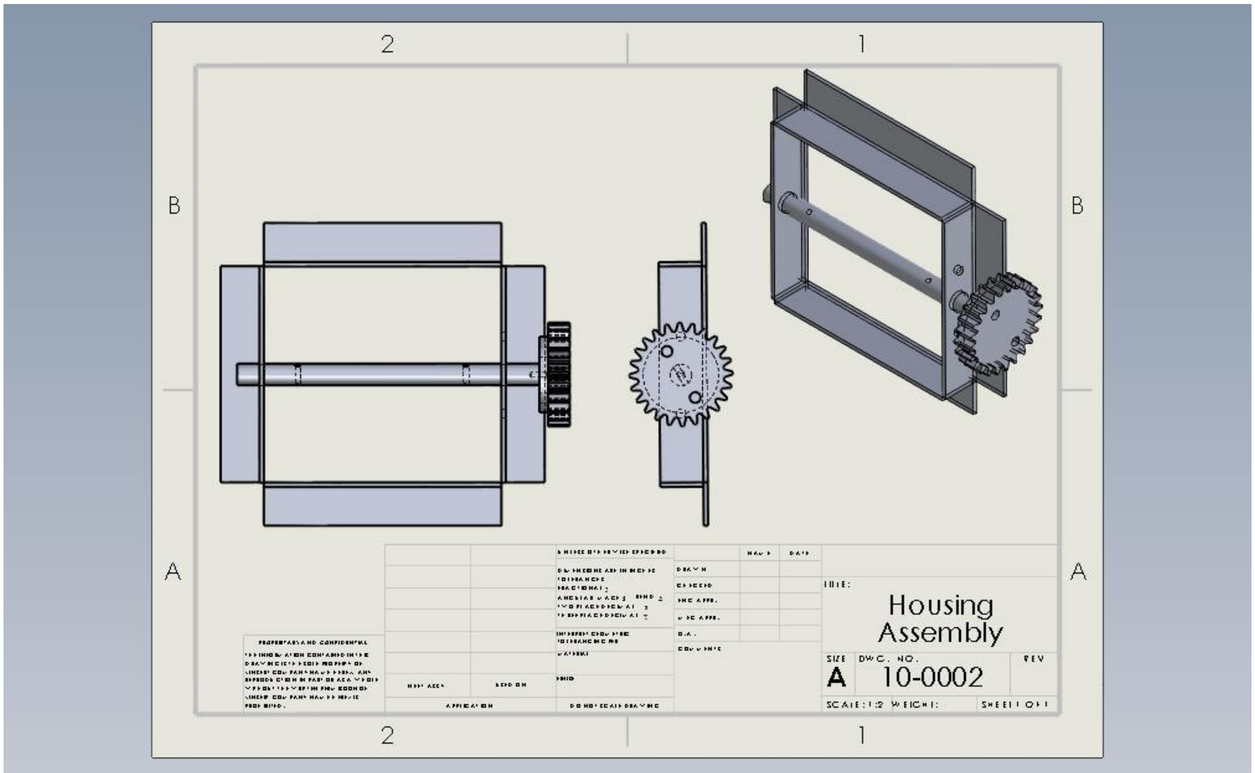
## B-5 Rotary Panel (15-0007)



## B-8 Rotary Part Assembly (10-0001)



## B-9 Rotary Housing Assembly (10-0002)



# Appendix C – Parts List and Costs

| PARTS LIST AND BUDGET | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SENIOR PROJECT TITLE _AUTOMATION OF PYROLYSIS_ | | | | | Price/Cost (US Dollars) ($ / hour) | | | | |
| Created by: Jim Lopez | | Last Updated: June 3rd 2020 | | | | Quantity (or hrs) | | | |
| ITEM ID | ITEM Description | Item Source | Brand Info | Model/SN | | | Cost: | Actual $ | URL |
| 1 | Bearing | McMaster-Carr | N/A | 1434K6 | 17.67 | 2 | $35.34 | **$35.34** | https://www.mcmaster.com/1434K6 |
| | | | | | | | | | |
| 2 | Dispenser | Amazon.com | ZevrO | KCH-06154 | 29.88 | 1 | $29.88 | **$29.88** | https://www.amazon.com/KCH-06153-Indispensable-Professional- |
| | | | | | | Tot Est.$ | $65.22 | $65.22 | Tot Act. $ |

# Appendix D – Budget Estimates

| **Part** | **Cost** | **Time to Order** |
|---|---|---|
| 2x Panel Motors | $80 | 1 week |
| 1x Dispenser Motor | $40 | 1 week |
| Dispenser | $40 | 3-10 business days |
| Slide Material | $15 | 1 week |
| Panel and Slide Material | $70 | 1 week |
| Motherboard | $50 | 1 week |
| Labor Costs | $50 | N/A |
| Testing | $50 | N/A |
| **Total** | $395 | 1-2 weeks |

# Appendix E - Schedule

PROJECT TITLE: **Pyrolysis**

Principal Investigator.: **Jim Lopez**

| TASK: ID | Description | Duration Est. (hrs) | Actua (hrs) |
|---|---|---|---|
| 1 | Proposal* | | |
| 1a | Outline | 3 | 1 |
| 1b | Intro | 3 | 1 |
| 1c | Methods | 3 | 1 |
| 1d | Analysis | 3 | 3 |
| 1e | Discussion | 3 | 2 |
| 1f | Parts and Budget | 3 | 2 |
| 1g | Drawings | 20 | 20 |
| 1h | Schedule | 3 | 2 |
| 1i | Summary & Appx | 4 | 2 |
| | subtotal: | 45 | 34 |
| 2 | Analyses | | |
| 2a | Pyrolysis Analysis | 0.5 | 0.5 |
| 2b | Output Analysis | 0.5 | 2 |
| 2c | Desired Conveyor Speed | 2 | 2 |
| 2d | Mass of Chip Overflow | 2 | 2 |
| 2e | Average Batch Size | 2 | 2 |
| 2f | Dispenser Speed | 2 | 2 |
| 2g | Friction on Inner Slide | 2 | 2 |
| 2h | Friction on Panel | 1 | 2 |
| 2i | Dispenser Motor Strength | 1 | 1 |
| 2j | Rotary Motor Strength | 1 | 1 |
| 2k | Chip Fall-Off From Panel | 1 | 1 |
| 2l | Chip Fall-Off From Conveyor | 1 | 1 |
| | subtotal: | 16 | 14.5 |
| 3 | Drawings and Assemblies | | |
| 3a | Top Cover | 3 | 10 |
| 3b | Side Cover | 3 | 10 |
| 3c | Back Cover | 3 | 10 |
| 3d | Front Cover | 3 | 10 |
| 3e | Rotary Panel | 3 | 10 |
| 3f | Rotary Wall | 3 | 10 |
| 3g | Rotary Shaft | 3 | 10 |
| 3h | Rotary Housing | 3 | 10 |
| | subtotal: | 24 | 80 |
| 4 | Proposal Mods | | |
| 4a | Project Robot Schedule | 3 | 1 |
| 4b | Project Robot Part Inv. | 3 | 1 |
| | subtotal: | 6 | 2 |
| 7 | Part Construction | | |
| 7a | Purchase Bearing and Dispenser | 2 | 1 |
| 7b | Build Rotary Panels | 4 | 5 |
| 7c | Build Shaft | 4 | 2 |
| 7d | Build Rotary Wall | 1 | 2 |
| 7e | Build Rotary Housing | 3 | 4 |
| 7f | Cut Gear Stock | 1 | 4 |
| 7g | Build L-Brackets | 1 | 3 |
| | subtotal: | 16 | 21 |
| 9 | Device Construct | | |
| 9a | Assemble Panels | 1 | 3 |
| 9b | Assemble Wall | 1 | 3 |
| 9c | Assemble Housing | 1 | 3 |
| 9d | Assemble Bearing | 0.5 | 3 |
| 9e | Edit Cover | 10 | 12 |
| 9f | Assemble Motor System | 1 | 3 |
| 9g | Take Dev Pictures | 1 | 0 |
| 9h | Update Website | 10 | 1 |
| | subtotal: | 25.5 | 28 |
| 10 | Device Evaluation | | |
| 10a | List Parameters | 1 | 1 |
| 10b | Design Test&Scope | 1 | 1 |
| 10c | Obtain resources | 1 | 2 |
| 10d | Make test sheets | 1 | 1 |
| 10e | Plan analyses | 1 | 1 |
| 10f | Instrument Robot | 1 | 1 |
| 10g | Test Plan* | 1 | 1 |
| 10h | Perform Evaluation | 6 | 6 |
| | subtotal: | 13 | 14 |
| 11 | 495 Deliverables | | |
| 11a | Get Report Guide | 2 | 1 |
| 11b | Make Rep Outline | 3 | 1 |
| 11c | Write Report | 5 | 5 |
| 11d | Make Slide Outline | 3 | 3 |
| 11e | Create Presentation | 4 | 18 |
| 11f | Update Website | 12 | 10 |
| | subtotal: | 29 | 38 |
| | Total Predicted Hours= | 174.5 | 232 = Estimated Total Actual Hrs |
| Labor$ | 100 | 17450 | |

# Appendix F – Expertise and Resources

Charles Pringle

Dr. Craig Johnson

Dr. John Choi

Personal Communications with John Lockleer

# Appendix G – Testing Report

# J.C.A.T.I. Automated Pyrolysis Testing Report

By

Jim Lopez

# Introduction

## Requirements

4. The Dispenser must be able to function in a consistent matter. Batches need to be within a 10% margin of error between each batch.
5. Must be able to move the Material Scraps from the Dispenser, through the Cover, and into a Collector.
6. The Device needs to be capable of moving all Material Scraps in the Dispenser through the Oven System autonomously.

## Parameters of Interest

4. Average Mass
5. Pass Rate
6. Pass Rate

## Predicted Performance

4. The Material in the dispenser is received from a Shredder which is another Group's Project. The Range of the Dispenser will depend on the consistency of the chip's sizes from the Shredder and the effectiveness of the Dispenser itself. The Range is predicted to be within 10% of the average batch size.
5. The Door Panels are slightly unsymmetrical which will result in uneven positioning; however, the Material should be dumped at the designated positions, albeit at varying angles. It's predicted the Device will *Succeed* however the Average efficiency might be anywhere from about 80% to 50%.
6. Based on the rough appearance of the Device and the Analyses found in the Overall Report, it is predicted that 70%-90% of the Material will pass through successfully.

## Data Acquisitions

The data will be collected by using a Weighing Scale for each test. The data will be measured to the closest 0.1 gram.

# Method/Approach

## Resources

- Power Outlet (In case VEX battery dies)
- Carbon Fiber and Resin Composite scraps (Referred to as "Material" or "Scraps")

## Test Procedure Overview

So long as all the Resources listed above are supplied, the test can be performed anywhere.

## Operational Limitations

4. The Oven cannot be stopped unless the Cover is taken off.
5. The speed of the Conveyor cannot be changed unless the Cover is taken off.
6. The Panel does not rotate at the same angle as the Shaft, this is because the Panel is driven by a pin in the Shaft. However, the Pin is just scrap metal shoved into a hole.

The device should work as follows.

1. The Dispenser will activate and let out a set amount of Scraps.
2. The Scraps will fall onto the 1st Rotary Panel.
3. The 1st Rotary Panel will rotate to the next set position.
4. The Scraps will fall onto the Oven's Conveyor
5. The Scraps will stay on the Conveyor for as long as needed.
6. Once the Scraps get to the end of the Conveyor the Scraps will fall onto the Slide which leads to the 2nd Rotary Panel.
7. The 2nd Rotary Panel will rotate at a set time to a set position to allow the Scraps to fall into a Collector.

## Data Analysis and Presentation

The data was recorded in the Tables below.

# Test Procedure

**<u>Test1:</u>** The first test is very simple but necessary to determine functionality of device.

**<u>Steps:</u>**

6. First, fill the Dispenser with the Material.
7. Rotate the Dispenser knob to the next position to get a Batch worth of Material, collect and weigh the Material, then record the data.
8. Perform this test 3 times.
9. Calculate Average weight and Record in Table.
10. Compare all trials to Average weight and determine the Range. Record this value in Table.

**<u>Discussion:</u>**

--------------------------------------------------------------------------------------------------------------------

**<u>Test 2</u>:** The best way to test the Device is simple trial and error. The Device can be tested once built without turning on the Oven so that the Material can be used repeatedly without being ruined. All tests will be "Dry-Runs," which is a run without the use of the Heat or Gas that is normally used during pyrolysis, however the only function of interest is the device's autonomous ability.

**<u>Time to Complete 1 Cycle</u>**

About **<u>1 min</u>**.

**<u>Location and Resources:</u>** The test needs to be performed at CWU. The resources needed are Carbon Fiber Scraps (Scraps) and a power outlet for the Oven. The parts used in this test are a V5 Robot Brain, a device created for heating the scraps (an Oven), a Cover for the Oven (Cover), a Dispenser, 1st Rotary Panel, 2nd Rotary Panel, a Slide, and a bucket or anything that can be used to collect the Scraps once they are through the Device (Collector).

**<u>Steps:</u>**

7. First, fill the Dispenser with the Material.
8. Rotate the Dispenser knob to the next position to get a Batch worth of Material, collect and weigh the Material then record the data.
9. Return Material back to Front Door Panel then activate the Dry Run cycle.
10. Collect and weight the Material then record the data.
11. Take the Final weight and divide it by the Initial weight, this value is the Pass Rate. Record this value in the Table.
12. Repeat test 3 times and calculate average pass rate.

**<u>Risk:</u>** Since no Gas or Heat will be used for this test there shouldn't be any real dangers with the test with the exception of potential pinch points but the motors are not that strong so they shouldn't pose a threat.

**Discussion:**

-------------------------------------------------------------------------------------------------------------------

**Test 3:** The Device will be tasked with passing all Material in the Dispenser through the Oven and into the Collector and it must do all of this Autonomously.

**Time to Complete Test:**

About **1 min** per Cycle and about **10 min** per test.

**Steps:**

6. First, weigh the Dispenser and record the Data.
7. Next, fill the Dispenser with the material being tested, weigh the Dispenser again, and record the Data.
8. Activate the V5 Robot Brain and activate the Complete Code program. Press A to activate the Autonomous Mode. The device should work as follows.
   a. The Dispenser will rotate 3 times and let out the Scraps.
   b. The Scraps will fall onto the 1st Rotary Panel.
   c. The 1st Rotary Panel will rotate halfway to the next position, stop for a second, then rotate the remainder of the distance. This is to help shake the Scraps off the Panel.
   d. The Scraps will fall onto the Oven's Conveyor
   e. The VEX program will wait 50 seconds, the Scraps should get to the end of the Conveyor, fall onto the Slide, and be caught by the 2nd Rotary Panel in this time.
   f. The 2nd Rotary Panel will turn twice, and the Scraps will fall into a Collector.
9. Collect the Scraps from this trial and weigh them. Compare this value to the initial amount of Scraps to find the Pass Rate and Record this value in the Test 3 Table.
10. Repeat Test 3 times and then find the Average Pass rate.

**Risks:** Since no Gas or Heat will be used for this test there shouldn't be any real dangers with the test with the exception of potential pinch points but the motors are not that strong so they shouldn't pose a threat.

**Discussion:**

# Deliverables

## Parameter Values (results)

4. The Dispenser Batches were an average of [4.78] grams and each batch were within [20] % of this average.

5. The average amount of material that passed through is **[N/A] %**
6. The Device has an average pass rate of [N/A] %

## Calculated Values

First Test:

| | **Trial 1** | **Trial 2** | **Trial 3** | **Average** |
|---|---|---|---|---|
| **Batch Size** | 4.73 Grams | 6.16 Grams | 3.44 Grams | **4.78 Grams** |
| **Margin of Error** | 0.98% | 28.96% | 27.98% | **19.31%** |

Second Test:

| **Trial** | **1** | **2** | **3** |
|---|---|---|---|
| **Pass Rate** | 30.6% | 58% | 89% |
| **Pass?** | NO | NO | YES |

Third Test:

| **Date of Attempt** | **5/27** | **6/1** | **6/4** |
|---|---|---|---|
| **Pass Rate** | 9.60% | 42.02% | ??? |
| **Pass?** | NO | NO | ??? |

## Success Criteria Values

4. **Both Values above 80%**
5. **Pass more than 8/10 Trials. Average Value above 80%**
6. **Average of all Trials Margin of Error less than 10%.**

## Conclusions

# Report Appendix:

## Appendix G1 – Procedure checklist

**<u>TEST 1:</u>**

- ✓ Need a Weighing Device to measure the weight of the Material.
- ✓ Need to obtain at least a handful of Material
- ✓ Need Dispenser.

**<u>TEST 2:</u>**

- ✓ Need Device to be functioning but Programming and VEX system won’t be needed.
- ✓ Need a Weighing Device to measure the weight of the Material.
- ✓ Need to obtain at least a handful of Material
- ✓ Need access to a power socket to plug oven into.
- ✓ Need Cover.

**<u>TEST 3:</u>**

- ✓ Need Device to be fully functioning including Programming and VEX system.
- ✓ Measure the Weight of the Dispenser and record this as a constant value.
- ✓ Need a Weighing Device to measure the weight of the Material.
- ✓ Need to obtain enough Material to fill the Dispenser to 15% max capacity.
- ✓ Need access to a power socket to plug oven into.
- ✓ Need Cover.
- ✓ Need Collector to catch Material

## Appendix G2 – Data Forms

First Test:

| | Trial 1 | Trial 2 | Trial 3 | Average |
|---|---|---|---|---|
| **Batch Size** | | | | |
| **Margin of Error** | | | | |

Second Test:

| **Trial** | **1** | **2** | **3** |
|---|---|---|---|
| **Pass Rate** | | | |
| **Pass?** | | | |

Third Test:

| **Date of Attempt** | **5/27** | **6/1** | **6/4** |
|---|---|---|---|
| **Pass Rate** | | | |
| **Pass?** | | | |

# Appendix G3 – Raw Data

First Test:

| | **Trial 1** | **Trial 2** | **Trial 3** | **Average** |
|---|---|---|---|---|
| **Batch Size** | 4.73 Grams | 6.16 Grams | 3.44 Grams | **4.78 Grams** |
| **Margin of Error** | 0.98% | 28.96% | 27.98% | **19.31%** |

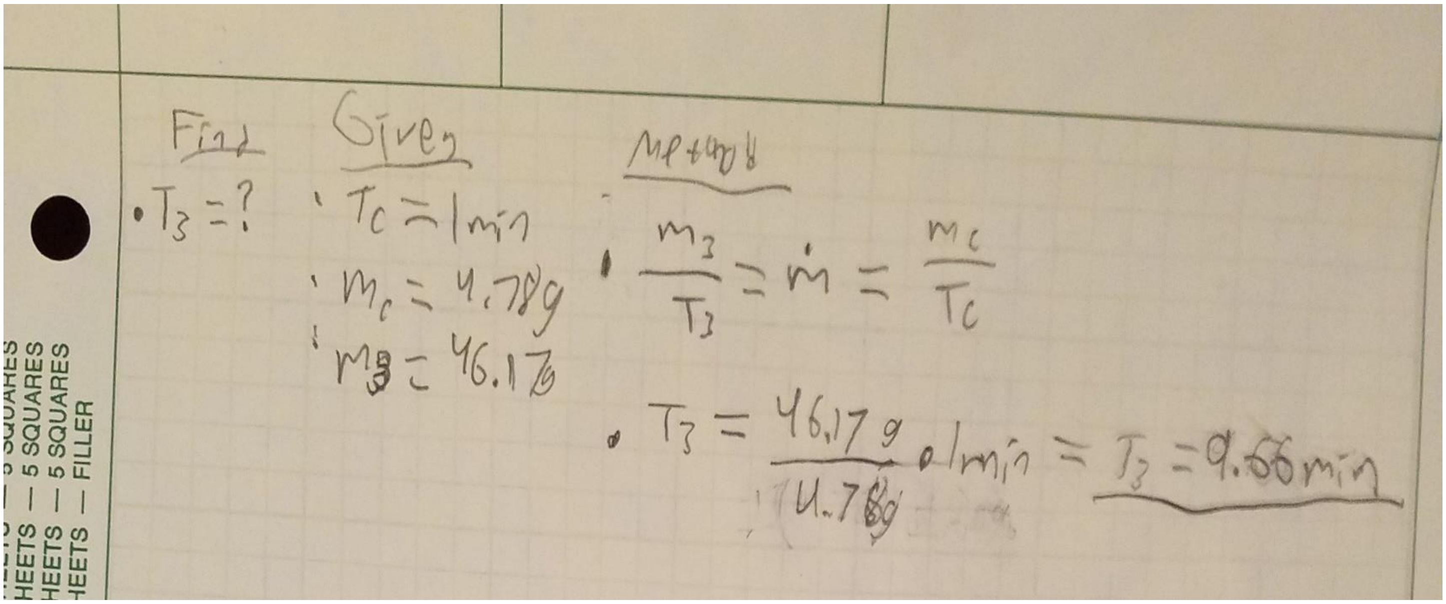
Second Test:

| **Trial** | **1** | **2** | **3** |
|---|---|---|---|
| **Pass Rate** | 30.6% | 58% | 89% |
| **Pass?** | NO | NO | YES |

Third Test:

| **Date of Attempt** | **5/27** | **6/1** | **6/4** |
|---|---|---|---|
| **Pass Rate** | 9.60% | 42.02% | ??? |
| **Pass?** | NO | NO | ??? |

## Appendix G4 – Evaluation Sheet




| Dispenser | | | | |
|---|---|---|---|---|
| **Test 1** | **1** | **2** | **3** | **Average** |
| **Mass Dispensed (grams)** | 4.73 | 6.16 | 3.44 | **4.78** |
| **Margin of Error** | 0.98% | 28.96% | 27.98% | **19.31%** |

| Hardware and Parts | | | |
|---|---|---|---|
| **Test 2** | **Trial 1** | **Trial 2** | **Trial 3** |
| **Pass Rate** | 30% | 58% | 89% |

| Automation | | | |
|---|---|---|---|
| **Test 3** | **1** | **2** | **3** |
| **Pass Rate** | 9.60% | 42.02% | ???% |

# Appendix H – Resume

## JIM LOPEZ

907 E 11th Ave ◆ Ellensburg, WA 98926 ◆ (253)343-3316 ◆ jim.lopez01@gmail.com

### PROFESSIONAL PROFILE

I am focused on accomplishing goals that I have established for myself. I am able to adapt to new environments, and experience with relating with diverse cultures. I have always been able to quickly learn new tasks and concepts.

### SKILL SUMMARY

- *Microsoft Office; Word, Outlook, and Power point.*
- *Interpersonal Skills*
- *Team player*

### PROFESSIONAL EXPERIENCE

**Phantom Fireworks – Runner, Maryland, WA** **June 2018 – July 2018**
*Deliver firework products to various vendors. Received orders from clients and handled money.*

- Received orders from over 60 vendors on site. Minimized wait time for deliveries on a consistent bases; made deliveries within 10 minutes of receiving the orders.
- Strong social skills to communicate with customers to ensure accuracy and speed with their orders. Received many compliments from the vendors due to my speed and professionalism.
- I was quickly able to adapt to my position, excelling in the daily tasks required.

**Subway – Pre-Closer, Graham, WA** **July 2017 – August 2017**
*Take care of Pre-Closer duties while serving customers. Cleaned and stocked the restaurant while serving customers all within my shift.*

- Ensured cleanliness of store during and after hour operations.
- Strong social skills to communicate with customers to ensure accuracy and speed with their orders.
- Able to work with others to achieve team goals.

### EDUCATION & CERTIFICATIONS

**Bachelor of Science–Mechanical Engineering Technology -- (Expected Graduation Date) 2020**

Central Washington University, Ellensburg, WA

**Associates of Science-- 2017**

Pierce College, Puyallup, WA

**<u>Activities</u>**:

Helped organize Community Summer volleyball program
Volunteer for Kids Night Out in community church.

# Appendix J

## JOB HAZARD ANALYSIS
## {Insert description of work task here}

| | |
|---|---|
| Prepared by Jim Lopez | Reviewed by:<br><br>Approved by: |

| | |
|---|---|
| Location of Task: | Hogue Technology Building, CWU, WA, USA |
| Required Equipment / Training for Task: | Proper operation of bandsaw. Operation of the drill press. Operation of electric spot welder |
| Reference Materials as appropriate: | Sheet Metal |

| **Personal Protective Equipment (PPE) Required**<br>(Check the box for required PPE and list any additional/specific PPE to be used in "Controls" section) | | | | | | |
|---|---|---|---|---|---|---|
| Gloves | Dust Mask | Eye Protection | Welding Mask | Appropriate Footwear | Hearing Protection | Protective Clothing |
| ☒ | ☐ | ☒ | ☐ | ☐ | ☐ | ☐ |
| Use of any respiratory protective device beyond a filtering facepiece respirator (dust mask) is voluntary by the user. | | | | | | |

| PICTURES (if applicable) | TASK DESCRIPTION | HAZARDS | CONTROLS |
|---|---|---|---|
| | **Start blower and saw.** | **Cutting fingers and hands.** | **Keep fingers and hands away from blade. Use push bar for smaller materials.** |
| | **Feed the drill with the feed.** | **Hand injury from the exposed pulley near the feed handle** | **Make sure a pulley guard is in place. Don't push the feed handle toward the pulley** |
| | **Depress foot pedal to activate welder.** | **Burning hands** | **Wear gloves.** |