**Reflection**

Success

This section will give a list of all of the things that went successfully last semester. Overall, the team had a very successful semester, but could have done better with planning and setting realistic goals.

- Team stayed friendly and professional with each other
- Team had consistent communication with clients
- Team stayed professional and friendly with clients
- Team did well on all assignments
- Team has finished all CAD work
- Team has a working BOM
- Team has a plan to get parts ordered
- The most expensive part of the machine has been bought.
- Poba Engineers are happy with final design
- All team members have learned a lot about the project, and all team members are very involved

Areas for Improvement

This section will list all areas for improvement. While having a successful semester last semester, there are still some areas for improvement.

- · Parts have not been ordered
  - **(1) Team will have meeting with Poba Medical during Week 2 to finalize ordering parts**
- Team had to fully redesign Radial Expansion Tester multiple times
  - **(2) Team will contact Poba more often to make sure design is up to standard**
- Tasks often were not delegated evenly
  - **(3) Project manager will put more time and effort into evenly distributing tasks, as well as making sure tasks work well with everyone's strengths**
- Work often got done "last minute"
  - **(4) Team will make sure to get started on large assignments earlier to maximize the amount of time being used.**
- Team set extremely unrealistic goals at beginning of semester
  - **(5) Team will have clearer communication with the client in order to set better goals.**
- Some team members are still not trained for shop hours
  - **(6) Michael will sign up for NAU Machine Shop training and set a note on his phone to remember**
- Teams prototype was nonfunctional
  - **(7) Team will create a prototype using professional parts**
- Team missed a few "weekly" clients' meetings
  - **(8) Team will contact Poba by Wednesday**
- Team still has a very basic understanding of stepper motors and drivers
  - **(9) Michael will use the self-learning assignment to dive into Arduino and learn how to run stepper motors.**

Remaining Design Efforts

This section will give a list of the remaining design efforts. Due to the effort of the team last semester, this list is very short.

- Change the pneumatic cylinder size to properly move the digital micrometer.
- Order parts from BOM
- Confirm spacing and mounting position of micrometer with clients

## Gantt Chart

This section will discuss the Gantt chart that was created for this assignment. This gantt chart shows all the work that needs to be done before the first hardware check, and the dates that the team wants to have these things completed.

| Milestone description | Category | Assigned to | Progress | Start | Days |
|---|---|---|---|---|---|
| **Radial Expansion Tester Design** | | | | | |
| Order parts with Poba | Milestone | Team | 50% | 1/14/2022 | 1 |
| Build Skeleton | High Risk | Mike/Vergil | 10% | 1/21/2022 | 3 |
| Attach Micrometer | Med Risk | Noah | 10% | 1/23/2022 | 1 |
| Individual Learning | Med Risk | Team | 10% | 1/10/2022 | 21 |
| Build Heater Nozzle | Med Risk | Vergil | 0% | 1/24/2022 | 10 |
| Build Movement System | High Risk | Mike | 0% | 1/21/2022 | 14 |
| Time for Adjustments | Low Risk | Team | 0% | 2/3/2022 | 4 |
| Hardware Check 1 | Milestone | Team | 0% | 2/7/2022 | 1 |

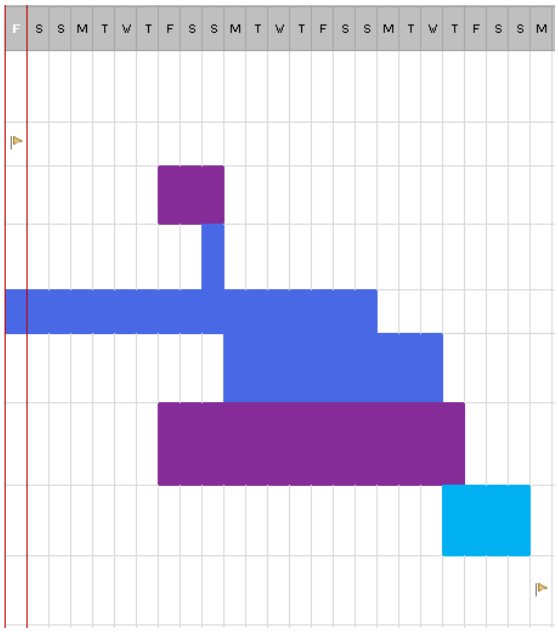



*Figure 1: Gantt Chart*

The first thing that the team needs to do is finish ordering the hardware for the machine through Poba. A convenient aspect about this item is that the team is ordering most of the hardware at once, so they will quickly go from about 20%-50% done to 100% done. Poba has also purchased a digital micrometer, eating most of the team's budget.

The team will then create the “skeleton” of the Radial Expansion Tester, which will give them a base plate to work off of. The team will then attach the micrometer, and build the heater nozzle. The movement system will then be implemented, and if all goes according to plan the team will have a few days for adjustments. The team also needs to complete their individual learning assignments in this timeframe.

## Purchasing Plan

The most up to date BOM can be found in the excel document included in the submission. Unfortunately, one of the team’s most used vendors, McMaster-Carr, does not provide manufacturer information for their products so the manufacturers are listed as unknown.

All purchasing for this project is being conducted through Poba. Because of this, the team's purchasing plan revolves around convincing Poba to order parts and no dates for when parts are ordered can be set in stone. At the moment, the only thing that has been purchased and delivered is the micrometer. In the last client meeting, Poba promised to begin purchasing everything from the provided BOM, however the team has not yet received confirmation that anything has been ordered.

Purchased Items:

- Keyence Laser Micrometer


Further Planning:

- Team needs confirmation that parts have been or will be ordered.
- Team needs to determine in what order the device will be assembled based on lead times and shipping times.
- Team should look for secondary vendors for parts that have a long lead or shipping time.

Action Items - Purchasing:

1) **Meet with Poba in week 2 to confirm parts have been ordered.**
2) **If parts have not been ordered, find out why and how to convince Poba to order parts.**
3) **Find secondary vendors for parts that may take too long to arrive.**

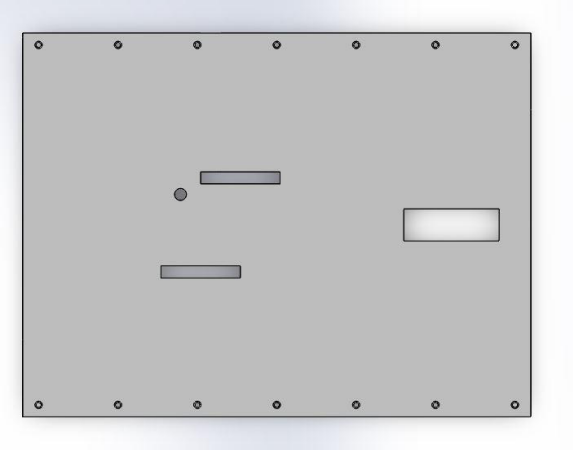
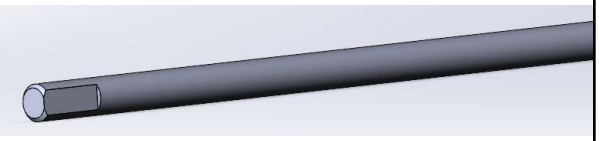
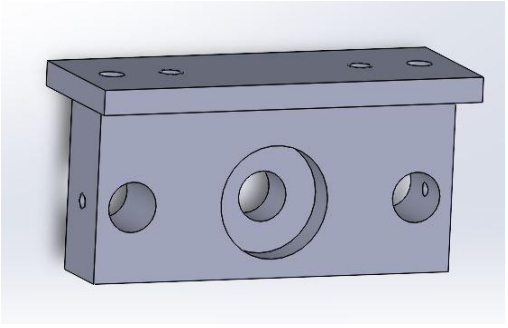
## Manufacturing Plan

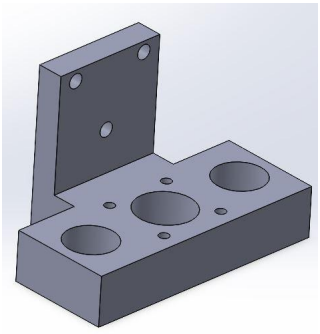
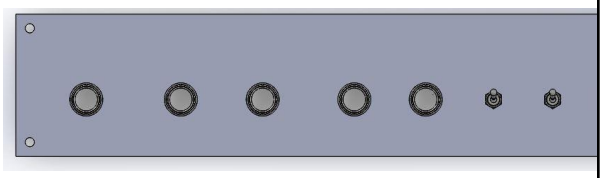
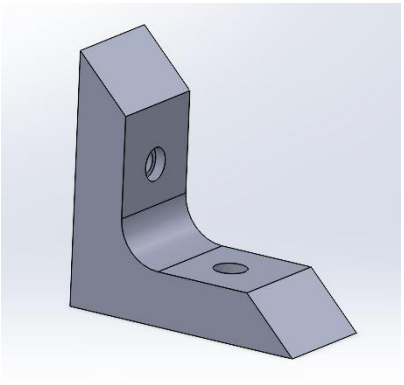
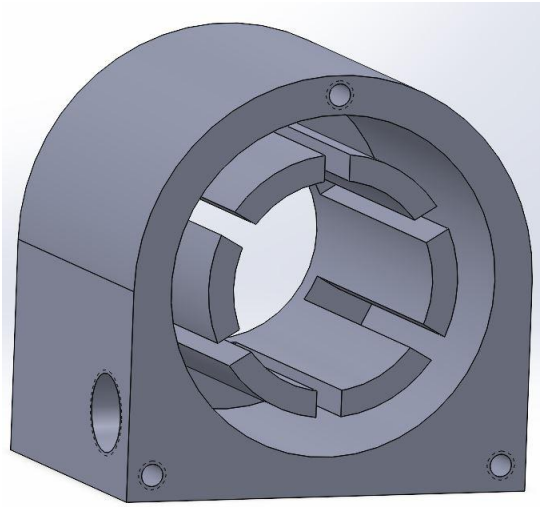
Since a large number of parts will need to be manufactured in addition to the extensive list of purchased equipment, separate tables for these are included below in order to keep the existing BOM concise and professional. First, a table containing all of the parts necessary for the team to manufacture is included below along with the respective materials they will be made from, a description of each, and a photo to serve as a reference. Following this table is a manufacturing plan which details the timeframe in which these items will be made, the quantity of each, which team member will be responsible for them, the process necessary, the estimated time and the location in which it will be made.

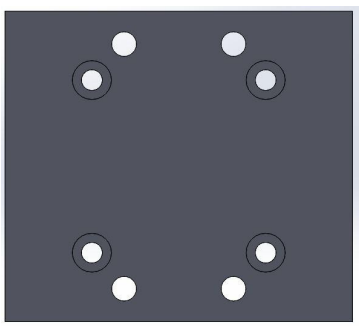
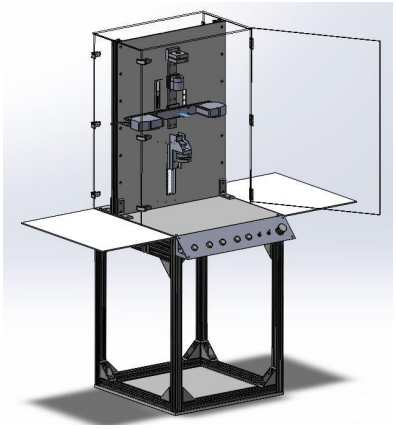
This tentative schedule is planned with the assumption that the raw material for each part will arrive before the scheduled date as well as any other parts necessary to test the fit and function of each of these. As such, a conservative plan is in place in which each team member is

responsible for the manufacture of one part per week so that in the event of an unforeseen setback during shipping or manufacturing there will most likely still be a number of parts which get completed in a timely manner.

Table 1: Manufactured Parts Lists

| Part Name | Description | Material | Part Render |
|---|---|---|---|
| Base Plate | Provides a mounting surface for all major equipment and incorporates cutouts necessary for electrical and air supply lines | 6061 Aluminum |  |
| Ball Screw | Ball screw affixed to stepper motor driving moveable clamp. Needs ends turned down to sit inside id of bearings | Alloy Steel |  |
| Ball Screw Guide Rail | Gives support to the ball screw nut. Needs flats machined for set screws | 1566 Carbon Steel |  |
| Ball Screw Mounting Block | Mounts the ball screw bearings to the base plate and affixes the ball screw guide rails in place | 6061 Aluminum |  |

| | | | |
|---|---|---|---|
| Flange Nut Mount | Connects nut of ball screw to moveable base of clamp for the sealed end of the extrusion | 6061 Aluminum |  |
| Button Panel | Provides a mounting panel for all necessary buttons | 6061 Aluminum |  |
| Button Panel Brackets | Mounts the button panel to the front surface of the machine | 3D printed with PLA |  |
| Heater Nozzle | Directs hot air from the outlet of the duct heater and onto the outside of the extrusions | 360 Brass |  |

| | | | |
|---|---|---|---|
| Micrometer Mount Pad | Provides a mounting surface for the micrometer to be affixed to the linear guide rail | 6061 Aluminum |  |
| Enclosure and Side Tables | The enclosure protects the user from the loud sound of a popping balloon and the side tables were requested by the clients to give more table top space to the machine. | Polycarbonate/ ABS Plastic |  |

**Week 3: 01/23-01/30**

| Date | Part | Quantity | Team Member | Process | Estimated Time | Location |
|---|---|---|---|---|---|---|
| 01/29 | Base Plates | 2x | Vergil Sorg | Milling cutouts & mount holes | 5 hours | MSI machine shop |
| 01/30 | Lead Screw | 1x | Michael Bransky | Turning down ends for bearing ID | 2 hours | Nau machine shop |
| 01/30 | Ball Screw Guide Rail | 2x | Noah Keyes | Milling flat onto rail for set screws | 1 hour | Nau machine shop |

**Week 4: 01/31-02/06**

| Date | Part | Quantity | Team Member | Process | Estimated Time | Location |
|---|---|---|---|---|---|---|
| 01/31 | Ball Screw Mounting Block | 2x | Michael Bransky | Milling and mount holes | 3 hours | NAU Machine Shop |
| 01/31 | Flange Nut Mount | 1x | Vergil Sorg | Milling Complete | 3 hours | MSI Machine Shop |
| 02/05 | Button Panel | 1x | Noah Keyes | Fabricating Panel with cutouts | 3 hours | NAU Machine Shop |

**Week 5: 02/07-02/13**

| Date | Part | Quantity | Team Member | Process | Estimated Time | Location |
|---|---|---|---|---|---|---|
| 02/09 | Heater Nozzle | 2x | Vergil Sorg | Milling complete | 6 hours | MSI Machine Shop |
| 02/12 | Button Panel Brackets | 2x | Noah Keyes | 3D printing | 4 hours | NAU Maker Space |
| 02/13 | Micrometer Mount Pad | 1x | Michael Bransky | Milling Complete | 3 hours | NAU Machine Shop |

**Week 6: 02/14-02/20**

| Date | Part | Quantity | Team Member | Process | Estimated Time | Location |
|---|---|---|---|---|---|---|
| 02/19 | Enclosure Panels | 5x | All Teammates | General hand tool fabrication | 4 hours | Poba Medical |
| 02/19 | Side Tables | 2x | All Teammates | General hand tool fabrication | 1 hour | Poba Medical |

<u>Action Items : Manufacturing</u>

**1** Email to confirm purchase of raw stock from clients (01/17)
**2** Review dimensioning of parts starting with the ones which will be manufactured first
**3** Begin to formulate testing procedures for each subsystem and adjust geometry of parts accordingly
**4** Review mounting pad heights for micrometer, heating nozzle and clamps
**5** Change heating nozzle supply line cutout to slot