Final Report
Chip Drip
Warsaw, Indiana
April 24, 2017

Prepared by:

Cullan Magnuson
Dillon Craig
George Siddons
Gabe Powell

Cullan Magnuson - magncs01@students.ipfw.edu

Dillon Craig – craidj01@students.ipfw.edu

George Siddons – siddgb01@students.ipfw.edu

Gabe Powell – powega01@students.ipfw.edu

Mechanical Engineering Technology
IPFW
2101 E Coliseum Blvd.
Fort Wayne, Indiana 46805
(260) 481-6812 phone

April 24, 2017

Dear Professor Barry Dupen:

Thank you for the opportunity to provide you with a proposal for Engineering Services associated with Craig Welding and Manufacturing, located in Mentone, Indiana. In response to your request for a final report, we have reviewed the project and have developed the following scope of services associated with the project:

Project Purpose:
Any machine with a chip conveyor has to dispose of the metal chips as well as the machine oil used in the machining process. The purpose of the Chip Drip is to keep the machine environment as clean as possible and reuse as much machine oil as possible. When the chip hub is removed and the conveyor is off there is still oil dripping. A simple drip pan would retain the machine oil until the chip hub is returned. This could be a pneumatic, switch, or physical type of operation.

Project Function:
To develop a drip pan that swivels on the chip-discharging end of CNC machines to collect oil while chip tub is being used to dispose chips. The pan will also hold the oil for easy reuse.

Project Description:
The creation of the construction documents for Chip Drip located in Mentone, Indiana. Find a way to eliminate oil from dripping on the floor while the chip tub is being emptied. The oil collecting on the floors is a potential safety hazard as well as takes extra services to clean up the spilled oil.

Scope of Engineering Services:
Our scope of work for Mechanical engineering services associated with this project will include the following:

- Calculate detailed area of chips being ejected from machine.
- Create drawings of the Chip Dripping apparatus.
- Manufacture said design.
- Test and report based on conclusion of Chip Dripping apparatus.
- The testing we will record will compare the weight of oil saved with the pan compared to without the pan.

General Services:

- Services include evaluation of the existing project location and its mechanical and electrical systems as they pertain to the proposed work in the project.

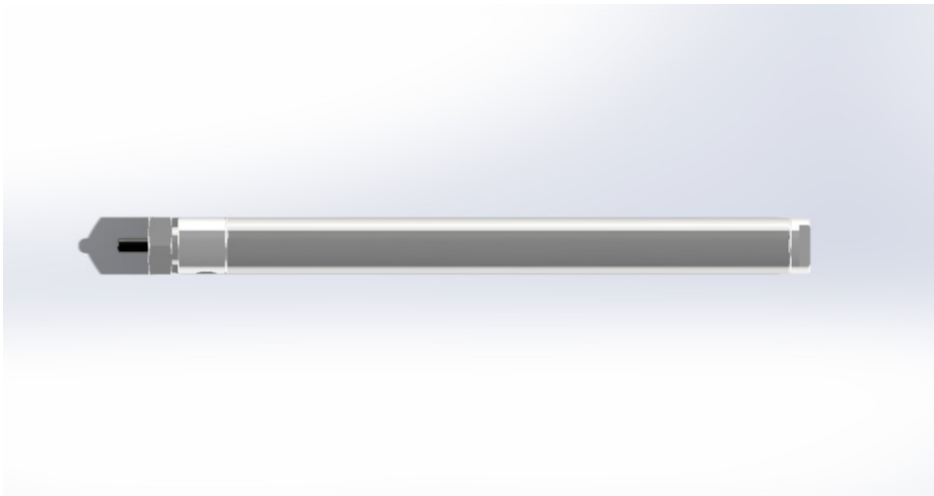
Drawings & Sketches:

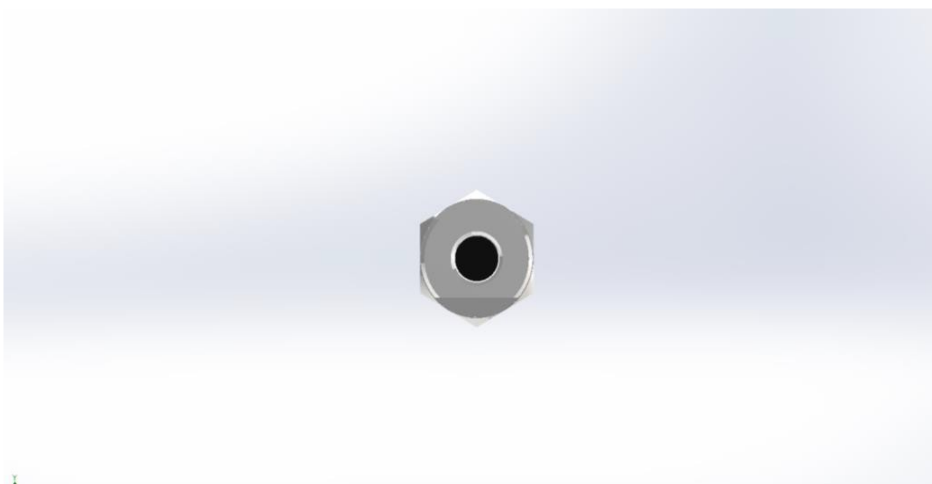
To help explain the Purpose, Function & Description below are the images of a swiss lathe that depicts the very idea we are trying to redesign. The location you are seeing is the chip conveyor discharge as well as the chip tub. The proposed function of the chip drip will attach on to the conveyor system to allow as stopper while the chip tub is being dispensed.

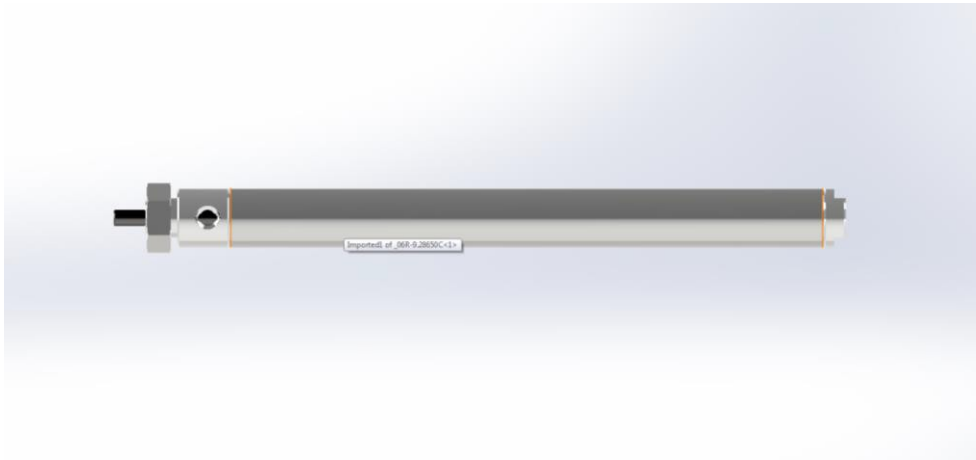
Current Status Of Machine:

Proposed Cylinder:

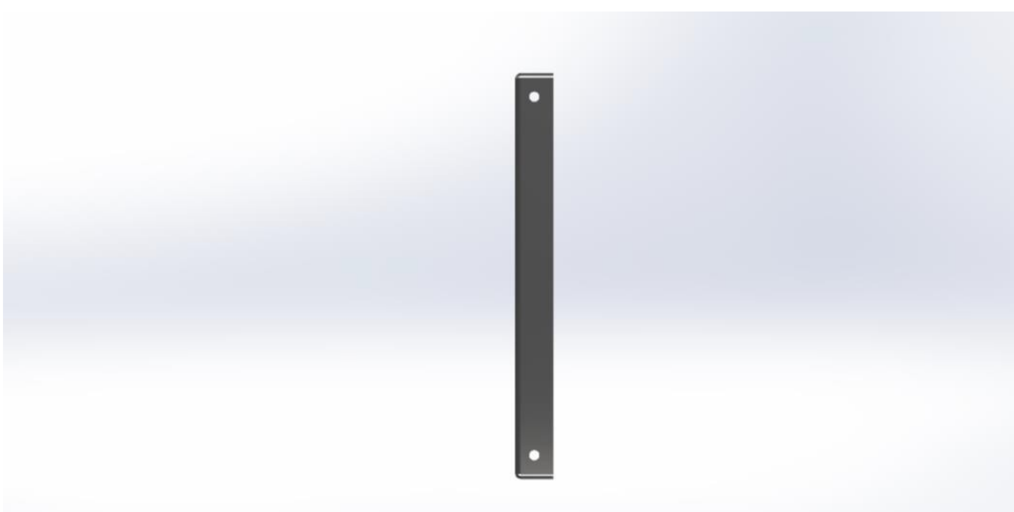
We began by calculating the specific cylinder below by using the equations later listed in this progress report. We were able to pin point the exact size not buying too big of a cylinder and wasting money, and not under sizing the cylinder too much so it will not operate.

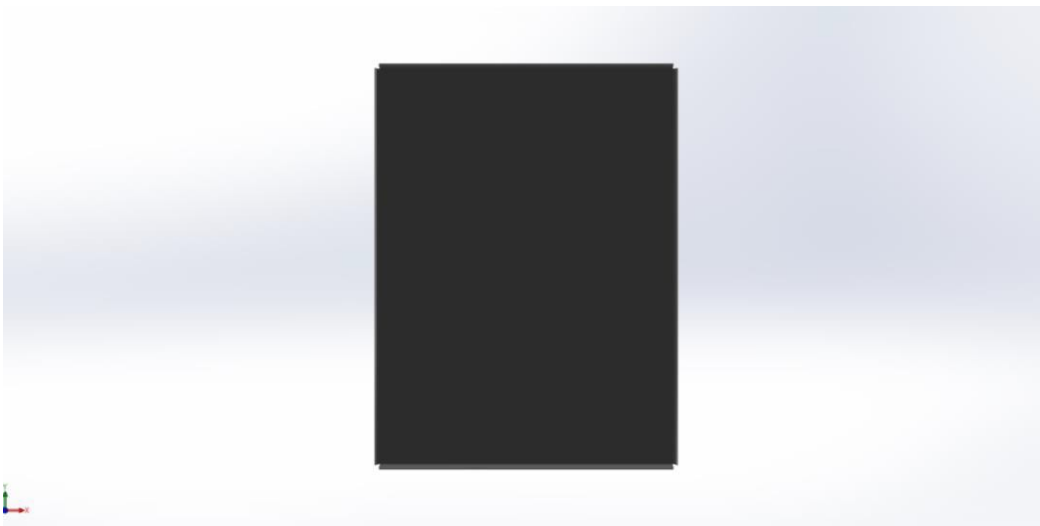


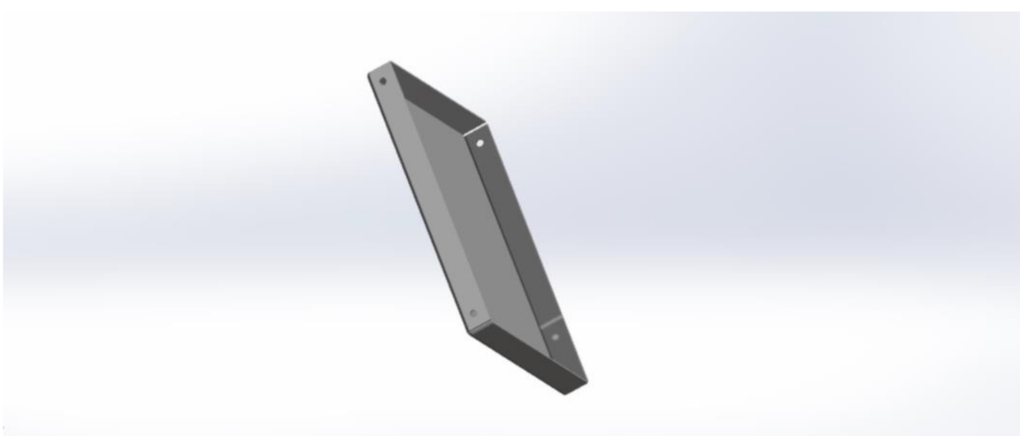


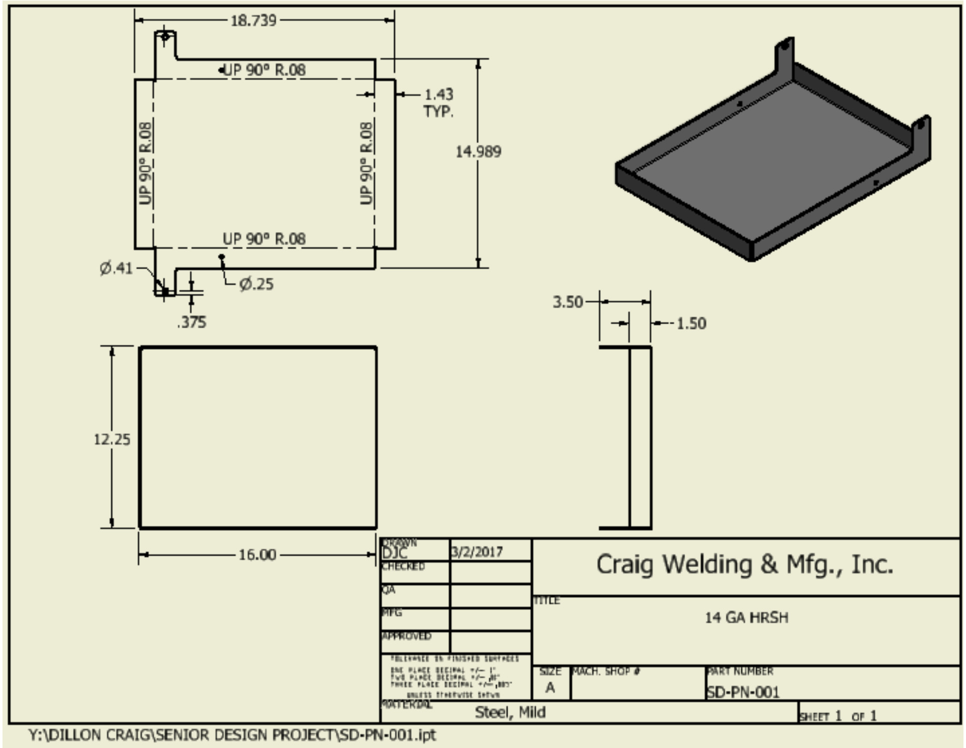


Proposed Tray:
The tray below is a 12x16x2” sheet metal tray that will be welded together on the corners to allow for a non-leaking seal. This tray weight was also calculated in with the selection of the cylinder.









Pan Manufacturing Process Operations:

- Engineering
- Laser
- Form/Bend
- Manufacturing (Weld)

In order to begin the design process of the drip pan component, we had to determine the dimensions of the conveyor output, which the pan attached to in the final assembly. These dimensions were 12x16 inches. Therefore, we made the OD dimensions of the pan to be 12.25x16 inches. In the first prototype the legs of the pan were separate pieces; however, to simplify the design, process, and functionality of the pan we made it all on pieces. Instead of creating two points of rotation there would only by one.

Engineering:

Initial concerns in design were material type and material thickness. The weight of the pan played a crucial role in the functionality and calculations that we performed. For the pan, we decided to use 14 gauge (.075) hot-rolled sheet steel. This material was cost and strength effective for what we were aiming to achieve. We began drawing the pan using the program inventor. In inventor, the basic square was drawn and faced to the material thickness. Next was to add the flanges around all edges of the pan; which would later be upright at 90 degree angles with a .015 gap on the corners. This gap is critical for later welding operations. Next step included adding a two inch extrusion to the back of the pan for the legs. A final cut was made in the legs for the holes to mount the pan to the conveyor and location holes to attach the pneumatic assembly. The pan file was then dropped into the assembly file to verify that it would work as desired.

Laser:

After the pan had been verified, a flat pattern of the pan was created and exported as a dxf file. This file is what the laser reads to cut out the parts. The material was placed on the laser platform and the file was selected to be cut out. Typically when running multiple parts of the same material and thickness, the parts are nested within the sheet to reduce scrap. Cut out time was roughly two minutes. The cost of laser time is $2.50 per minute at Craig Welding & Manufacturing. The pan then moved on to the next operation, form/bend.

Form/Bend:

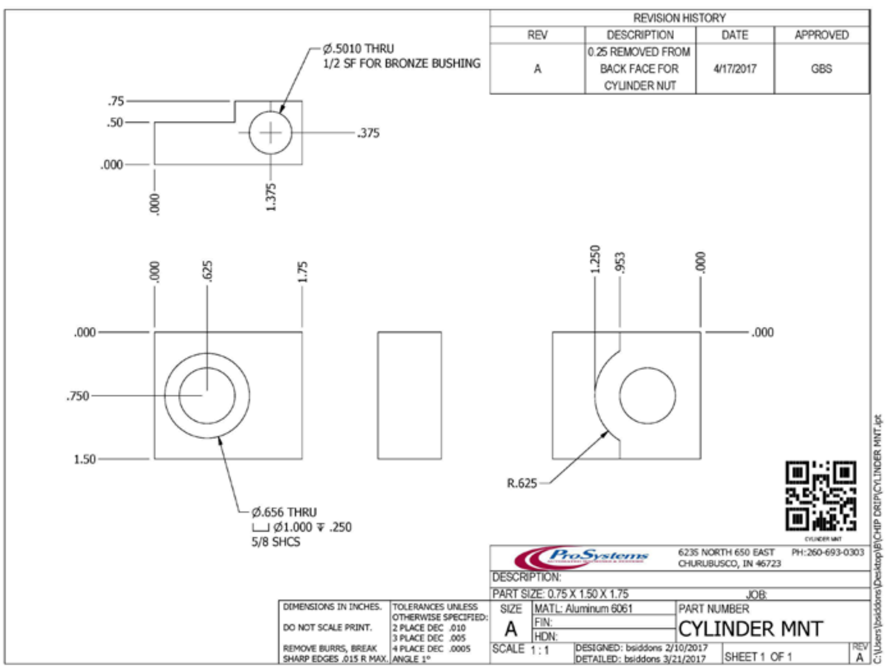
At form/bend the press was prepared with the correct dyes to bend the flanges upright at the desired radius. The side flanges were bent first and then the ends. This operation took about 15 minutes to complete. After the form operation, the pan was moved to the manufacturing or weld stage.

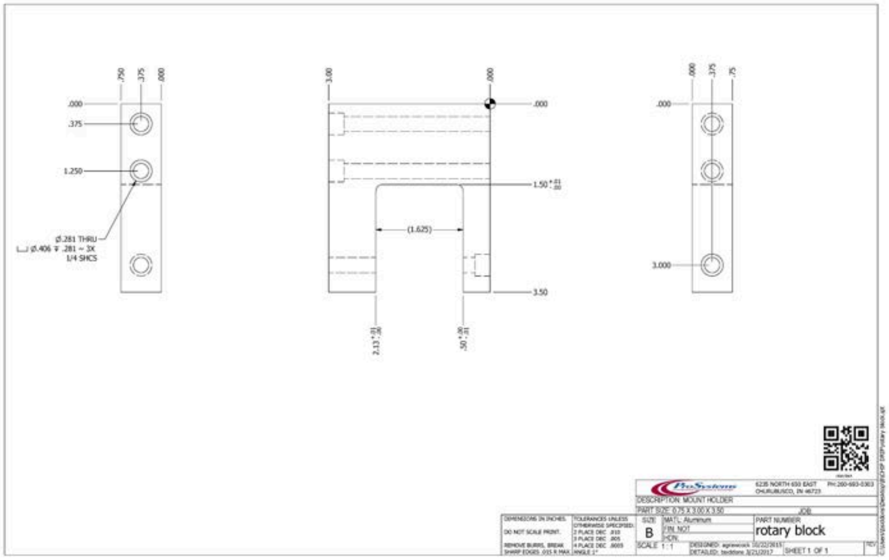
Manufacturing:

The pan needed welded at the corners, buffed, and deburred so there was not any sharp edges. This being one of the concerns of the customer. Edges needed to be free of sharp edges so that employees operating the unit would not be injured. This completed the operations building the pan.

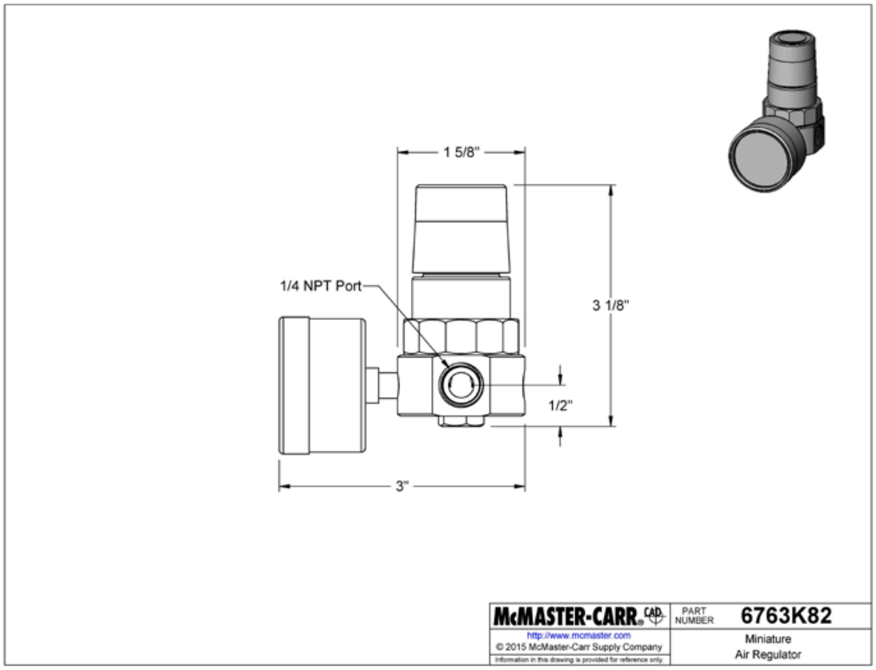
Proposed Connecting Pieces:

The miscellaneous pieces we had to create to join the chip drip together were pieces we machined out of aluminum scrap. The two pieces shown below are the two pieces that we used to mount the cylinder to the pan itself. More detail in the pictures to follow.

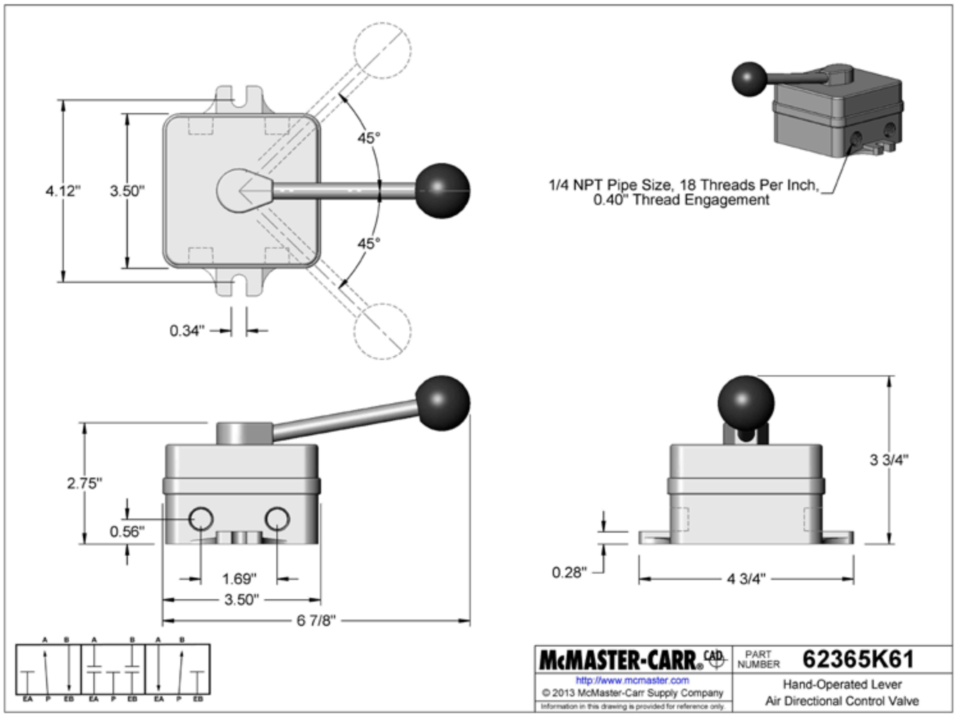




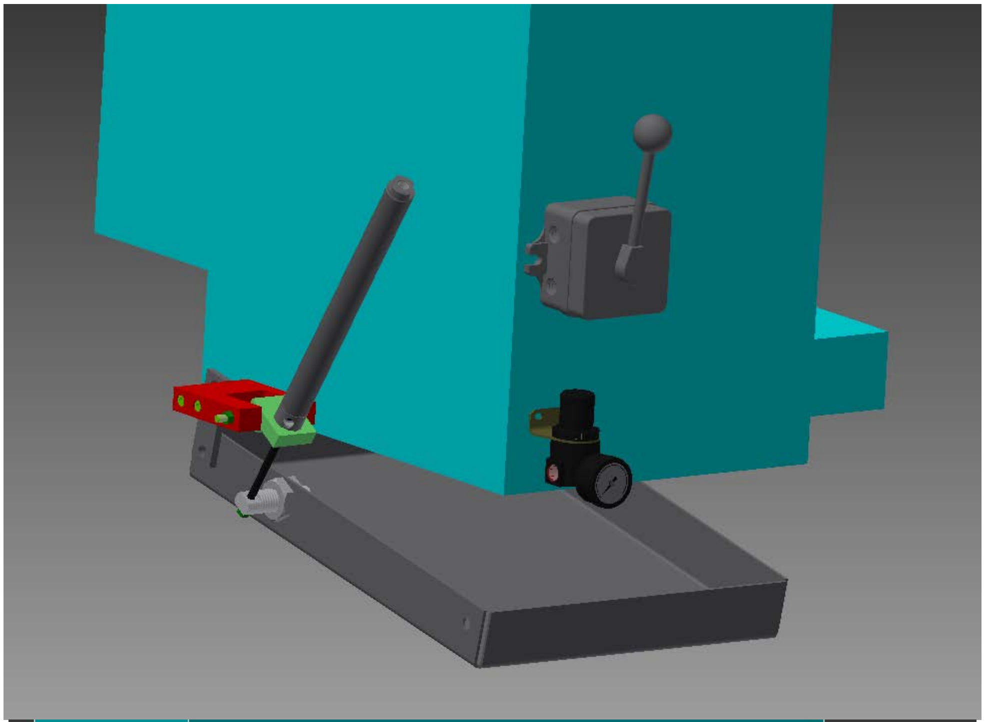
Proposed Regulator:
We selected a regulator, based on the calculated air pressure we were going to need to operate the cylinder. The values needed to take into consideration the size system we would be hooking up to as well which is a 100 pound pressure line. From these two values we were able to select the appropriate pressure regulator which is shown in the figure below.

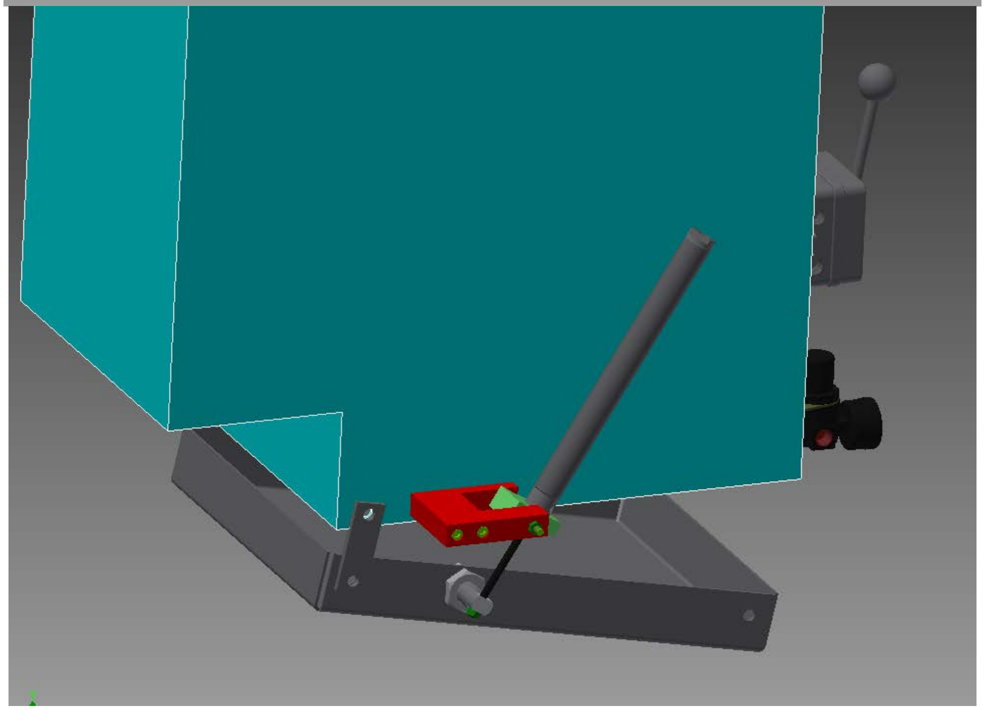


Proposed Actuator:
The last piece to the assembly was the actuator, we needed a 4way 3 position pneumatic actuator to operate the cylinder up, down and a constant neutral.



Proposed Assembly:
We modeled the end of the chip chute in cyan, with the proposed cylinder, tray and pneumatic switch shown as well. We plan to fabricate the tray with a laser cutting machine that will also fold each side of the tray to minimize on welding. The pan will be hinged from one side of the CNC chute to allow for a pivot point. The cylinder will then connect to the yellow rod in the pan, allowing for the pan to expand and retract. The pneumatic controller will be installed on the front of the cnc machine, or the same side as the control panel. While the cylinder will be installed on the back side, out of common sight. Once we fabricate the tray, we will be able to assemble the cylinder and switch after, with testing to follow.



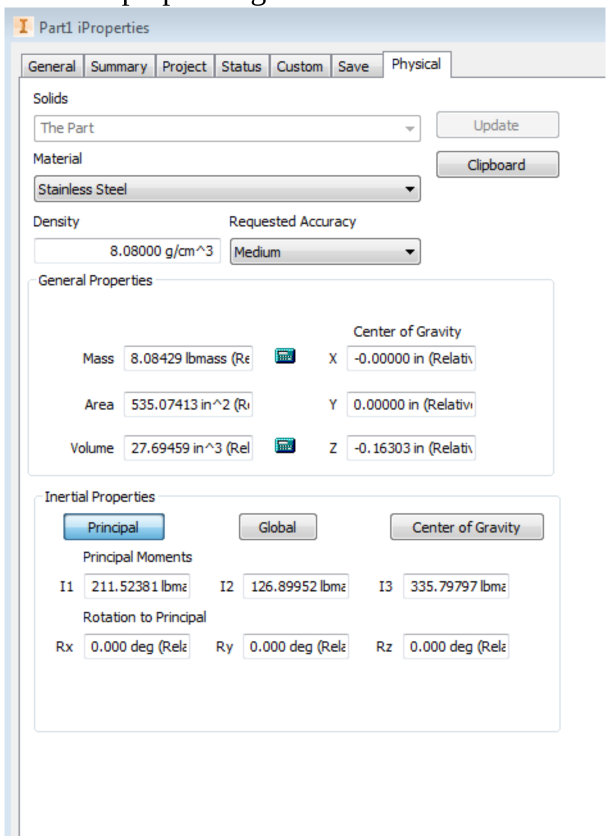


Final Assembly:

Once we received all the above pieces of equipment, and machined all of our parts we were then able to begin the assembly process. Below are the figures of the assembly mounted to a wood frame that will serve as the cnc chip chute. The final mounting will be done at the end of May.

Calculations:

The calculations were determined using both the information from the cylinder website, which is cited on the bibliography page. We also had to use our knowledge of statics and dynamics to help determine cylinder size, location and proper usage.



The piston force F can be calculated from the piston area A, the operating pressure p and the friction R using the following formulae:

Piston force (final pressure)

$$F = p \cdot A - R$$

$$F = p \cdot 10 \cdot \frac{d^2 \cdot \pi}{4} - R$$

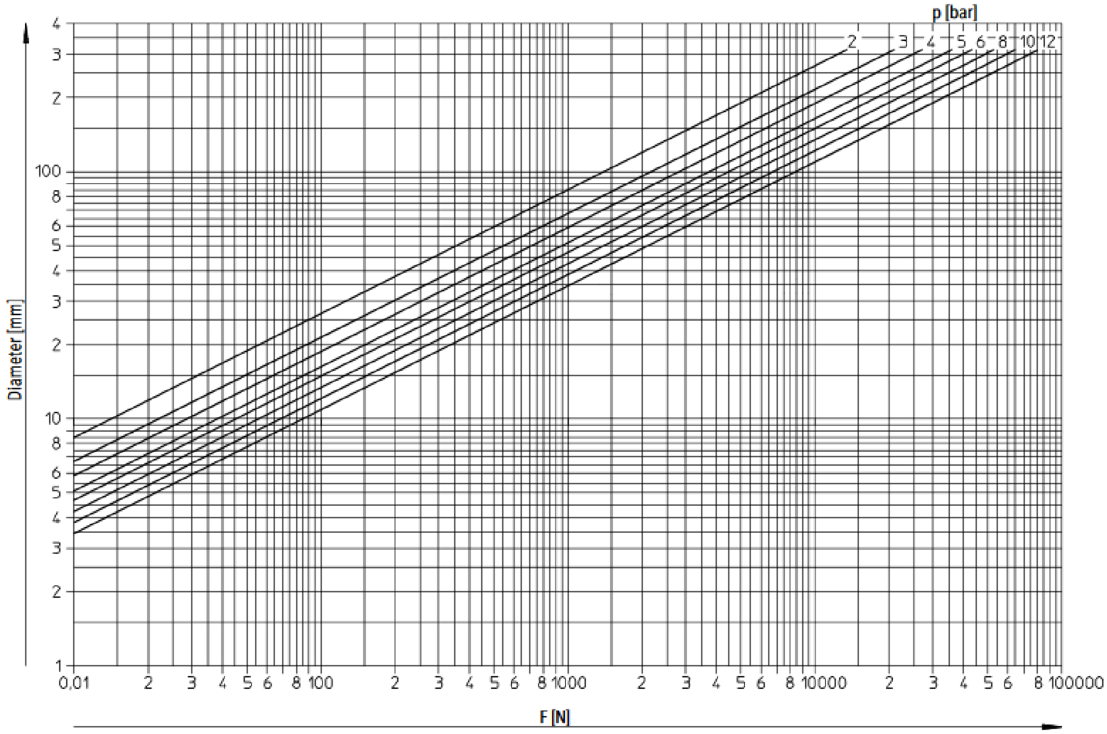
p	= Operating pressure	[bar]
d	= Piston diameter	[cm]
R	= Friction ~10%	[N]
A	= Piston area	[cm²]
F	= Effective piston force	[N]

Pressure/force graph

FESTO

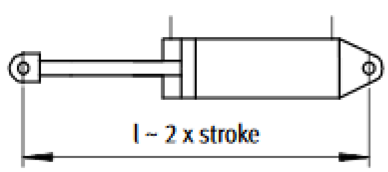
Operating pressure p as a function of piston diameter and force F

An allowance of 10% has been included for frictional force



$$F_K = \frac{\pi^2 \cdot E \cdot J}{l^2 \cdot S}$$

F_K = Permissible buckling force [N]
E = Modulus of elasticity [N/mm²]
J = Moment of inertia [cm⁴]
l = Buckling length
= 2x stroke length [cm]
S = Safety factor (selected value: 5)



Calculation air consumption using the formula

$$Q = \frac{\pi}{4} \cdot (d1^2 - d2^2) \cdot h \cdot (p + 1) \cdot 10^{-6}$$

Q = Air consumption per cm stroke [l]
d1 = Piston diameter [mm]
d2 = Piston rod diameter [mm]
h = Stroke [mm]
p = Operating pressure, relative [bar]

Forward stroke:

$$Q = \frac{\pi}{4} \cdot (32\text{mm})^2 \cdot 500\text{mm} \cdot (6\text{bar} + 1\text{bar}) \cdot 10^{-6}$$

$$Q = 2.815\text{l}$$

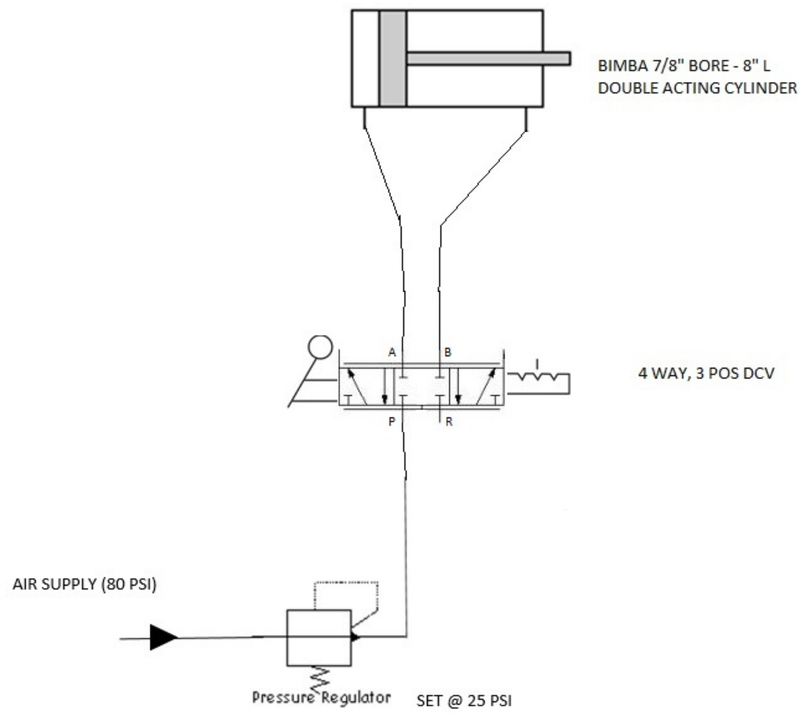
Return stroke:

$$Q = \frac{\pi}{4} \cdot ((32\text{mm})^2 - (12\text{mm})^2) \cdot 500\text{mm} \cdot (6\text{bar} + 1\text{bar}) \cdot 10^{-6}$$

$$Q = 2.419\text{l}$$

Air consumption per cycle:

$$Q = 2.815\text{l} + 2.419\text{l} = 5.234\text{l}$$



We also had to calculate how much the pan will weigh with it being full of chips and oil. The cylinder can lift approximately 15 pounds at 25 psi. We calculated we only need to lift 12.8 pounds based on the weight of a pan plus full load of oil and chips. Based on our calculations below the cylinder at 25 psi I should provide adequate pressure to raise and lower a full load of chips.

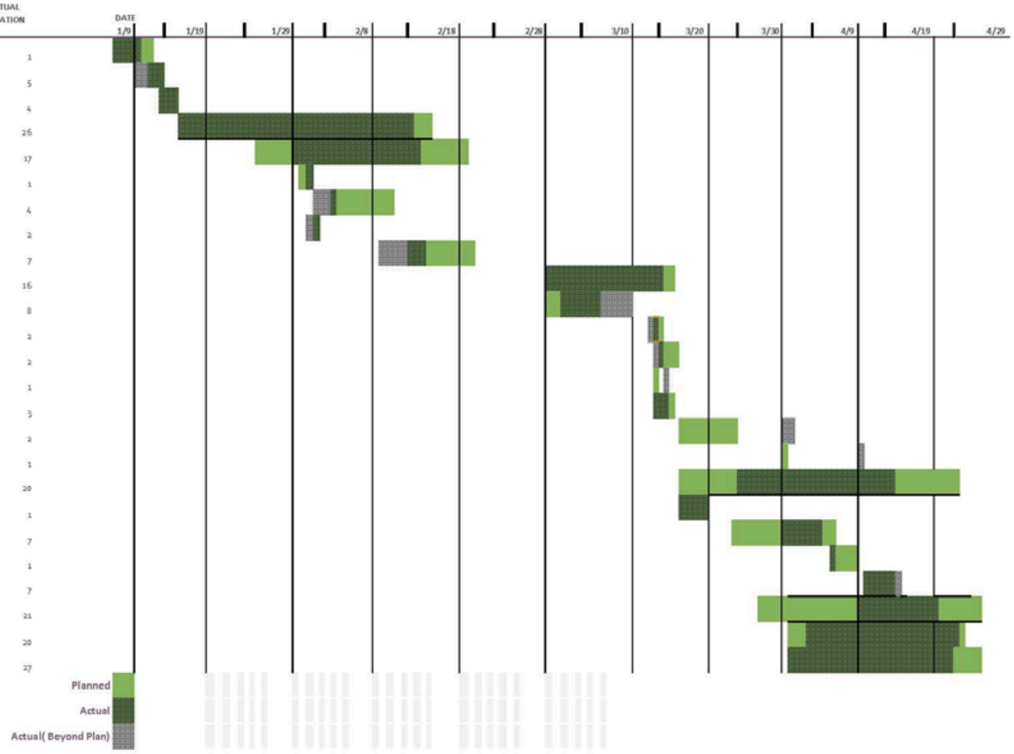
Cylinder dia (mm)	22.225				mpa		psi	
Surface area (in^2)	0.60132				1	.=.	145.038	
Plant Air Pressure (psi)	25							
force (lbf)	15.033							
force (N)	66.8702							
					newtons	to	lbs	
					2000		449.618	
					lbs	to	newtons	
					1		4.44822	

Lastly we need to calculate the velocity of the pan retracting and expanding at 25 psi to ensure proper safety. We will be using a hand operated lever air control valve to operate the tray up and down. The velocity will tell us if we need to ensure a automated kill switch so no operator can be hurt.

Gantt Chart:

Chip Drip

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION
Form Team	9-Jan	3	9-Jan	1
Project Selection	12-Jan	3	10-Jan	5
Write Proposal	15-Jan	4	15-Jan	4
Intial Design	19-Jan	29	19-Jan	26
Write Report #1	27-Jan	24	30-Jan	17
Draw Sketches	31-Jan	2	1-Feb	1
Complete Drawings	5-Feb	7	2-Feb	4
Create Parts List	2-Feb	1	1-Feb	2
Initial Calculations	14-Feb	7	10-Feb	7
Write Report #2	1-Mar	19	1-Mar	16
Required Calculations	1-Mar	10	3-Mar	8
Plan Testing	15-Mar	2	14-Mar	2
Update Prints	16-Mar	4	14-Mar	2
Order Parts	15-Mar	1	17-Mar	1
Fabricate Body	15-Mar	4	15-Mar	3
Assembly	20-Mar	7	1-Apr	2
Test Functionality	1-Apr	1	10-Apr	1
Oral Presentation Work	20-Mar	29	25-Mar	20
Divide Material	20-Mar	1	20-Mar	1
Create Powerpoint	25-Mar	14	30-Mar	7
Combine Sections	8-Apr	2	8-Apr	1
Rehearse Oral Presentation	11-Apr	6	11-Apr	7
Write Final Report	20-Mar	35	30-Mar	21
Extra Credit Poster Work	1-Apr	25	4-Apr	20
Prepare for final presentation	1-Apr	27	1-Apr	27



Ownership of Instruments of Service:
All reports, plans, specifications, computer files, field data, notes, and other documents and instruments prepared by us will be delivered to Craig Welding and Manufacturing in Mentone, Indiana.

Cost:
Our initial cost break down is shown below. We have access to the proper gauge sheet metal for free, so everything else is detailed below.

BIMBA

We Make Things Move™

A forward-thinking innovator, Bimba provides industry-leading pneumatic, hydraulic and electric motion solutions that are easy-to-use, reliable and ready for your engineering challenges.

Login | 1

Search pages or part numbers

All Products | Pneumatic | Electric | Hydraulic | Solution Centers | Our Company | Library | Support | Buy Online

Online Shopping

Home > Shopping Cart

Share

Shopping Cart
My Account
FAQ Page

Remove	Part #	Description	Price	Quantity	Total	Availability	Message
☐	068-D	Standard Carbon Steel Rod 7/8" Bore [06] Stroke: 8 Inch(s) Double Acting - Front Nose Mount [D] Bumpers Standard	$36.15	1	$36.15	03/28/2017	
		Note: All orders are shipped complete at the latest available date.		Sub Total:	$36.15	03/28/2017	

Update Cart | Checkout | Continue Shopping

McMASTER-CARR

air compressor regulators

Order

Purchase Order (optional)

Ships today

1		Hand-Operated Lever Air Control Valve Manual Return, 4 Ports, 1/4 NPT, with Closed Center 62365K61	1 Each	$206.64 Each	$206.64
2		PVC Tubing 1/4" ID, 3/8" OD 9446K41 Color ✓ ● Blue Length, ft. ✓ 25	1 Each	10.50 Each	10.50
3		Push-to-Connect Tube Fitting for Air Straight Adapter for 1/4" Tube OD x 1/4 NPT Male 5779K109	8 Each	3.08 Each	24.64
4		Compact Compressed Air Regulator Relieving, Aluminum Housing, 1/4 NPT 6763K82 Pressure Regulating Range, psi ✓ 0-25	1 Each	42.57 Each	42.57

+ Add a line

BILL OF MATERIALS

CHIP DRIP - 2017

ITEM	QTY	PART NAME	PART SIZE	MATERIAL	DESCRIPTION	MFG	FIN
1	1	PAN	12 GA X 12.00 X 16.00	STEEL	OIL CATCHING PAN		NONE
2	1	ROTARY BLOCK	0.75 X 3.00 X 3.50	AL 6061	SWIVEL MNT FOR CYLINDER		NONE
3	1	CYLINDER MNT	0.75 X 1.50 X 1.75	AL 6061	MNT BLOCK FOR CYLINDER		NONE
4	1	THREADROD	3/4 - 10 X 2.50 L	STEEL	SWIVEL MNT TO PAN		NONE
5	1	M4H210-06		PUR	M4H-Hand Lever Valve	MCMASTER CARR	
6	1	MSR 200-08		PUR	0-25 PSI MINI REGULATOR	MCMASTER CARR	
7	2	6391K127	1/4 ID X 5/16 OD X 1/2 L	BRONZE - PUR	BRONZE BUSHING	MCMASTER CARR	
8	3	SHCS 250 X 3250	1/4 X 3.25 L	STEEL	1/4 IN SHCS	MCMASTER CARR	
9	10FT	AIR TUBING	1/4 ID	PVC	BLUE PVC AIR LINE	MASTERKLEER	
10	1	068-D	8" STROKE X 5/8" BORE	SS - PUR	PNEUMATIC CYLINDER	BIMBA	
11	6	KQG2L07-N02S	1/4 NPT	SS 316	MALE ELBOW FITTING	SMC	
12	2	KQG2L07-N01S	1/8 NPT	SS 316	MALE ELBOW FITTING	SMC	

Personnel Assignments:

- Cullan Magnuson
    a. Design
    b. Assembly
    c. Testing
    d. Report Writing
- Dillon Craig
    a. Design
    b. Fabrication
    c. Assembly
    d. Testing
- George Siddons
    a. Design
    b. Ordering
    c. Assembly
    d. Testing
- Gabe Powell
    a. Design
    b. Drawings
    c. Assembly
    d. Testing

Conclusion:

The chip drip promotes a safe, clean working condition by eliminating oil and machined metal chips from falling onto the floor when the bin is full and needs to be removed for emptying purposes and does so in an efficient and seamless manner. Overall, the sponsor, Craig Welding, is content with the final apparatus, and will be implementing into their systems in the future.

Bibliography:

"Pneumatic & Mechanical Components Manufacturer | Festo USA." Pneumatic & Mechanical Components Manufacturer | Festo USA. N.p., n.d. Web. 19 Feb. 2017.

McMaster-Carr. (n.d.). Retrieved March 19, 2017, from https://www.mcmaster.com/