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# Tensile Specimen Punch

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# Senior Project
# Tensile Specimen Punch

# By

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Central Washington University
Department of Mechanical Engineering Technology

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## Introduction

This project is to have a tensile specimen which made in the lab as its demand for MET 351 and 426 courses. Even though the current method still works very well but doesn't satisfy the user's demand. To be able to meet the demand, the requirement is to create more specimen as needed, and also need to upgrade the system to be enhanced. The specimen would be created by a combined punch and holding apparatus that be able to work in combination with an arbor press, which is placed in the lab room.

Motivation: As this issue comes from a significant demand of tensile specimen for users in the lab, the solution is to create more specimen in the lab. The motivation is finding out a way of making the specimen's process faster and safe.

Function Statement: A device is needed that will shape tensile specimens for use in the materials lab.

Requirements: This project must;

- Able to support the specimen on two perpendicular sides
- Ables to remove the desired material with ease to the operator; mechanical advantage
- Conform to ASTM E8 rectangular tensile test specimen
- Compatible with manual arbor press No. 2
- Use with aluminum 2024-T6 and steel 1040 CR sheet materials
- Complete action without the specimen moving
- Accept fixture for in by 3in blanks, at maximum 12 gauge thick
- Weight and Size Constraints
  - Must weigh less than 15lb
  - Must be smaller than 10 x 10 x 10 $in^3$
- No external clamping tools

Engineering Merit: Having a sense of understanding all the current information which have gained in IET 311 and 312, also MET 327 to be able to calculate the load, forces and moments required to punch through the material. Applying all information from MET 351 and 426 into process helps to calculate the shear forces of steel and aluminum.

Scope of Effort: This project contains the foundation which holds the specimen in a right place, and the punch that will remove the material.

Success Criteria: This project will be complete when the base and punch can be mounted to the arbor, the specimen can be supported on the base, and the punch can remove the desired material.

## Design and Analysis

Approach: The design of this project is to create a base that can hold a specimen, as well as having the punch attached for convenience to remove the desired material. This base will be able to be placed upon the arbor press, a specimen inserted, and material removed with ease and convenience.

Design Description: For the base there will be two perpendicular walls that the specimen will sit flush against, as well as a hole directly in line with the punch allowing the removed material to fall away. There will also be a punch that is desired shape for removed section from the specimen.

Performance Predictions: The desired performance of this device is to hold the specimen in place as the punch removes material. The arbor press will reduce the $11*10^6$ $lb_f$ for shear down to $9.9*10^6$ $lb_f$ applied by the operator

Description of Analyses: The specimen requires a force of number of pounds to shear steel, which is the stronger of the two materials used

Scope of Testing and Evaluation: To test this device must operate with little to no reaction motion in the specimen.

Analyses:

Design Issue:

- Making the walls geometry precise
- Hardening the punch
- Punch geometry

Calculated Parameters:

- The arbor press has to apply a force of at least number of lbs. to shear steel
- The operator has to apple a force of number of lbs. to the handle.

Best Practices:

- Follow safety standers to make the device user friendly so the operator does not hurt themselves

Device:

- Parts: the base needs to have a channel that can fit the specimen in without allowing the specimen to move. The side and the back need to have grooves that will prevent the specimen from lifting. The rails need to guide the punch without allowing it to move out of alignment.
- Shapes: the bottom of base will be at minimum, as long as the length of a normal specimen and as wide as the width of the specimen plus the punch. The back will be the same length as the bottom, and the side will be as long as the width of the bottom minus the thickness of the back. The height of the back and side are not specified, as long as they can fit in the arbor press.
- Conformation: the back and side will be attached with screws to both the bottom and each other, so the faces need to have the smallest deviation as possible.

- Device Assembly: the bottom will be where everything is mounted. The back and side will be attached with screws, both to the bottom and to themselves. The rails will be attached on either side of the relief hole, with the punch put between the rails. There will also be a way of attaching the structure to the foot of the arbor press, the design will be decided later.

- Technical Risk Analysis: the largest risk in this project will be harm to the operator, in the form of cutting or smashing of the hand. The harm will occur if the operates hand is caught under the punch or caught between the punch and the arbor rack as the arbor is being operated. Also, worth knotting that any harm done will be minimal, due to the fact that operator is also the one applying the force to the arbor press, leading to a release of force when harm is initially applied.

# Methods & Construction

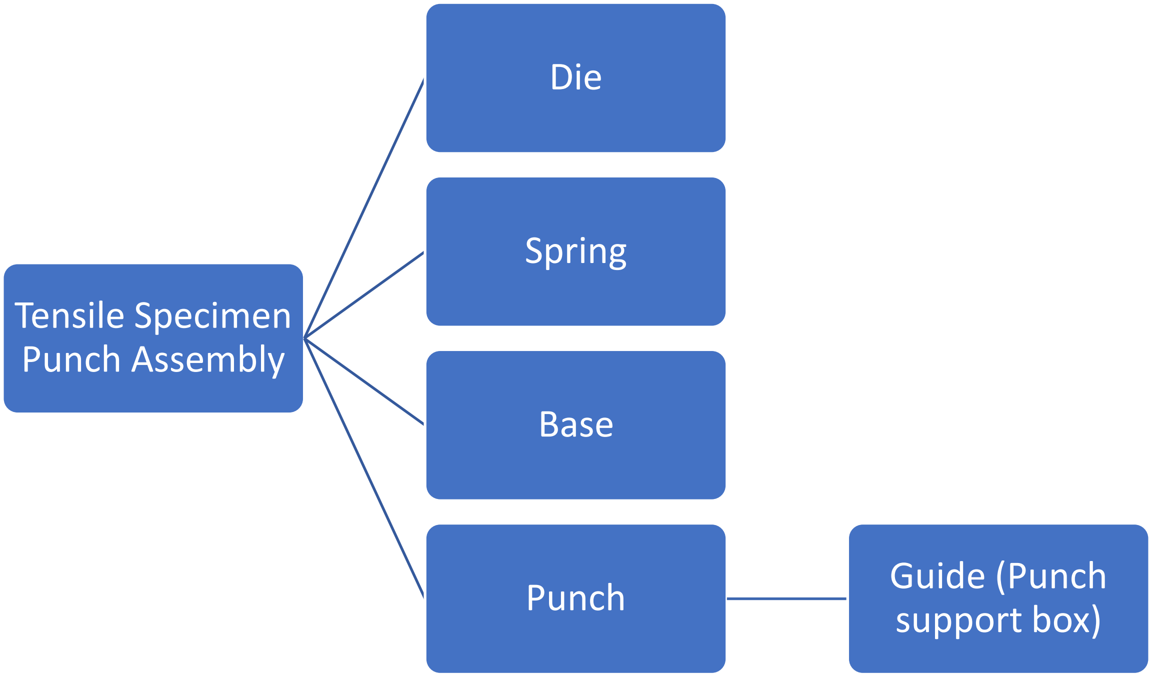
Methods: The project was conceived, analyzed, and designed at the Central Washington University Mechanical Engineering Technology department. Working within the constraints of our university resource, all the parts of the project will make in the machine room. By looking at Appendix B, all the pieces are shown.

Construction: Firstly, the base will be made from steel provided by Central Washington University Mechanical Engineering department. The milling machine will be the main machine for make the part. Cutting the 1018 steel into 5x5 inches square and the place the material on the table of the Bridgeport milling machine. Identify all the datum needed for the base. Using end mill cutting tool to cut the middle part of the material for reaching the final dimension and after that, also using the same tool to make all the radius or holes if needed on the bottom. Then, the die was created in the machine room and also from steel material. The guide (punch support box) will be designed to hold the die while punching the specimen. The punch support was the last to be created out of the steel material, the same as die and the base. All parts were made on the campus in the machine room under the professor's supervision.

The base and punch holder made from the aluminum in the machine room. The Bridgeport milling machine will be the main machine to do the part. 1/2 end mill will be the tool to do most of the components such as mill two sides of the holder or mill the centerline of the base. There were a lot of different holes and radius on the part, so choose the right end mill will fit each piece is necessary. The most difficulty was the dimension. In SolidWork might a perfect size for all parts, but in real life, the size not always accurate, sometimes the piece off by a thousandth. To solve those issues, which is to calculate the best move to go base on what dimension in real life is.

Description: The project creates because of the need to make tensile specimen tests in the lab for MET 351 and MET 426 courses. The project has two main parts, which are the base and the punch holder. The bottom will be the most important thing for the project. Two dies and two springs will be placed right in the middle of the base to help push the punch back to the first position. Use some screws or bolts to tight the die inside the base to avoid oscillating. The punch holder will support the punch to stable at one point without shaking. Connect the punch holder and the base with some screws on the outside. The problem is the reliability of getting the specimen cut both sides at the same time by having a way of making the sample get cut both sides at the same time and makes the process quick and easy on saving time.

## Drawing Tree and Drawing ID’s:




**Manufacturing Issues:** The main issues involved will be getting optimal punch design and the creation of the punch. The facilities that can use at this time do not have the knowledge or the capability to produce the punch. Another issue will be determining the dimension for the punch, die, and guide because the size needs to be adjustable when assembly the part. Last but not least, the area placing the spring to help the die return to the initial position after the process needs considering. Remember to contact whoever is in charge in the machine room at that time or contacting any industry representative for any issue and any information will be the best action to take. Seeking help or any advice from CWU’s professor or from mentor for this kind of project will also be a good idea to do.

## Parts list and label

| Part lists and Budget | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| Senior Project's Title | | | Tensil specimen Punch | | |
| | | | | | |
| **Item Number** | **Item Description** | **Item Source** | **Price/Costs ($)** | **Quantity** | **Total Cost** |
| 1 | Base | CWU | 0 | 1 | 0 |
| 2 | Punch Holder | CWU | 0 | 1 | 0 |
| 3 | Punch | CWU | 0 | 2 | 0 |
| 4 | Die | CWU | 0 | 2 | 0 |
| 5 | Spring | Amazon | $10 | 4 | $40 |
| | | | | | |
| | | | Overal total costs | | $40 |

# Testing Method

## Introduction:
The primary testing method will be comparison of the calculated force to shear with the actual force to shear when attempted.

## Method/Approach:
The method used will just be to test shearing in the structure. Once an initial test has been completed then a force sensor will be used to find the force required to shear.

## Test Procedure:

1. Place the structure in the arbor press, making sure perpendicular with the side edges and line up.
2. Insert the specimen into the structure, making sure in proper place.
3. Lower the arbor press until the die made contact with the punch and the punch is lowered to the specimen.
4. Apply force to handle and continue shearing all the way through the specimen. Lift the handle when completed.

## Deliverables:
Force testing will be completed using a force sensor attached to the handle as a force is applied causing a shearing action. This force sensor must be able to register a force of at least 400 lb, which is the suggested max force that the specified arbor press can handle.

The method will use to test the project will be the arbor press. Place the structure right under the arbor press, and make sure everything lined up perfectly. After that, take a specimen put under the punch in the right spot. Lower the arbor press slowly until reach the surface of the sample. When the arbor press touches the upper surface of the specimen, then use hand to pull the handle downward with a considerable force to cut the specimen on both sides. After cutting both sides, slowly release the hook out of the handle, and the spring inside will push the punch back to the initial position and ready to cut again.

The tensile specimen punch will be using a force sensor attached to the handle as a force applied, causing a shearing action. The goal is to turn the raw sheet material into a specimen that can use in class. During the testing, there was some struggle that the device needs to fixed. The first thing is two punches made from 3D printing, so the result comes out was punch's size more significant than then reality. To fix the size of the punch, use the sandpaper to sand the punch until reach to the tolerance of the punch holder. If the blow is too big and not fit the punch holder, then the device cannot cut the raw sheet material. The other struggle is the die; two dies were made from 3D printing also. The problem with the die was the same as the punch. The size is more prominent than expected. But on the die, there were two circles where the screw comes in if using the sandpaper to sand the die to the correct dimension; it will work, after that, there will be no place for a screw. So the best option at this moment will get a new 3D printing of the die to make the die fit perfectly with the base and easy to create a shear force to cut the raw sheet material.

# Budget/Schedule/Project Management

## Proposed Budget:

For this project the main costs will be for the material used to make the base, back, and side, but given that the school will provide most of my materials my overall cost will be nothing. The only other cost will be the screw used to hold the parts together, but the screws used in the Machine Shop, on the Punch project can be used. The punch material has already been provided. The arbor press that will be used is already provided and is yet another saved cost.

The support and the punch holder will make out from aluminum in the machine shop. 3D printing is the best way to do the punch at this moment because of the delay in ordering material. All the screws or nuts can find in the machine shop. The spring might need to consider ordering online if the school does not have any spring left. All the processes will do on the campus, so there will not outside costs to make the parts.

At this point, the process of making the device pretty much finished. The project does not cost a lot; the only cost will be for the spring and the rest of the material provided by the CWU machine shop. For the testing cost, mostly trying to cut the paper by using hand to push a punch down. The base and the punch holder made by a milling machine in the machine shop. The punch and die made by 3D printing. Besides the cost of the spring, there is nothing extra charge for the device, mainly value provided by the machine shop.

| Part lists and Budget | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| Senior Project's Title | | | Tensil specimen Punch | | |
| | | | | | |
| **Item Number** | **Item Description** | **Item Source** | **Price/Costs ($)** | **Quantity** | **Total Cost** |
| 1 | Base | CWU | 0 | 1 | 0 |
| 2 | Punch Holder | CWU | 0 | 1 | 0 |
| 3 | Punch | CWU | 0 | 2 | 0 |
| 4 | Die | CWU | 0 | 2 | 0 |
| 5 | Spring | Amazon | $10 | 4 | $40 |
| | | | | | |
| | | | Overal total costs | | $40 |

## Labor:

This project mostly will be on campus, with the only exception being if the construction of the punch is outsourced to the industry representative. All of the creation and construction of this project will be completed in the machine shop.

## Proposed Schedule:

In next quarter, which is the Winter quarter, the project will be created the assembly. The multiple different pieces that need to be created are the base, back, side, punch, and rails. The first part created will made the same way. Then the punch will be made, possibly by whoever the industry representative suggests or on campus, which will most likely take the most time. The last part to connecting everything together by the end of quarter.

Winter quarter, all the parts are needed to be ready for assembly until now. Not 100%, but at least need to prepare about 50% of the process. There were some manufacturing problems during the process, so this project is kind of behind with the schedule, such as part drawing, material selection, etc. The main issue is the delay in the redesign of the drawing and ordering the material. Because of that delay, so the whole process is standing in one place. Should take action on determining which is the best drawing and which equipment will use for the part to avoid manufacturing issues.

## Project Management:

- **Human Resources:** Triet Huynh will be doing the creation and construction. Another HR may include Dr. Johnson, Matthew Burvee, and Professor Pringle.
- **Physical Resources:** Machinery in the machine shop used will be the lath with the 4-jaw chuck, the milling machine with ½ in end mill, the drill press, and the tap
- **Soft Resources:** Matweb, Greenerd, American machine tools.

# Discussion

## Design Evolution:

The design for this project is based on a drawing from Dr. Johnson. The design sufficiently holds and supports the specimen while the material removed. The main concern addressed with the plan is to keep the specimen in place and try to punch the object both sides at the same time, without wobble, allowing for the most accurate result. The apparatus was not chosen due to the fact that would be more cost-effective to buy the already made device instead of creating one from scratch, making the initial design the more desirable path to take.

## Project Risk analysis:

The most considerable risk in this project is that the desired material is not removed and the time. With the design of this project, the punch will be able to remove material, leading to the desired outcome. In such, this project will work by the way the punch designed. Last but not least, lack of expert skills in production processes such as machining is potential risk factor.

During the process, the current design's result does not come out with the expectation. The die and the punch are very complicated to make. Redesign the whole thing is needed. The first problem which is cannot use the CNC machine to make the part, so all the radius or some point that cannot do manually needs removing. Secondly, which is the material, tool steel was considered to use for the project, but that is hard for making part manually, so switching to the different content would be the best idea. Redesign the project and talk to the advisor to find out which good for the project is beneficial to make it a success.

## Successful:

The success of this project attribute to the vast engineering knowledge in project management and planning, material science, mechanical design using AutoCAD and SolidWorks engineering software, heat transfer, and production. The most important design requirement is that the specimen is to stay in place without moving while the material is removed. The specimen is supported in all directions, not allowing to move sideways, front to back, or up and down, also be not able to spin, rotate, or rock in any direction and also the specimen get cut both sides at the same time. These restrictions lead to the desired, precise, repeatable outcome. Some of the challenges experienced in designing the punch, material selection, and analysis all the force needed, that gave the ability to work more carefully with the tight schedule and appropriate with the time.

The base and the punch holder are ready to be assembled. Two punches and die will use 3D printing to make next week. During the process, there were many manufacturing issues such as the dimension not right, the drilling hole not in the correct position, etc. All the holes on the base are 0.25 diameter, so use 1/4 end mill to do. The 1/4 end mill is very thin and easy to brittle in half, so while milling the hole need to take natural and do not create a massive pressure on the end mill to avoid damage. The most common issue with the milling machine is the chip. While using the Bridgestone Milling Machine, there will be a lot of chips, even though milling the small or colossal material because the chip is flying out many so hard to focus on the dimension of the part. Using palm to remove the disk is a proper way, but the chip does not remove 100%. Some will stick on the piece.

During the testing process, every part is working fine; the testing result is above average. But there was one thing that needs to consider, which is a spring. Spring will place under the punch and help to push the punch back to the position after cut the raw material. The problem is sometimes after pushing the punch back to the area, how come spring is falling out from the base. Sometimes works ok but very few times, the spring was shaking and started to fall out of the plate. An adjustment on how to place the spring into the base without wiggling is necessary. On the other side, the rest of the device is working fine. Nothing needs to change on the gadget beside the spring; the only thing change is changing the way to make the instrument more efficiently.

During the process, there were two issues with the device. The first issue, which is the base because the relief channel made on the bottom, was not significant and deep enough to allow the punch to go down. The punch support to go down 1/3 of the height to cut the material, but the punch did not reach that level. The second problem happens with the base also. When assembly, the bottom, and the punch holder together. The dimension of the channel of the support and the punch holder were the same. The proportion of the punch holder was more significant than the channel, so the punch could not go all the way down to cut material. The blow was stuck halfway because of the C channel was too small. Those two problems need to fix to make the device working.

## Project Documentation

All project documentation can be found in the Appendix of this proposal; the documentation includes drawings, analyses, schedule, parts/budget lists, safety hazard forms, etc. If reference material is needed, please refer to the Appendix of this engineering report.

## Next Phase

The next phase of this project is the construction of this machine. The build process will begin in the beginning of winter quarter. The process will begin with manufactures parts for the project and order parts that also required for the project. Once all the parts/materials are finished, the process of assemble will begin. During spring 2020 will be tested process. All requirements need to be meet.

## Conclusion

This project comes from a need to have tensile specimens made in the lab as they are needed for the MET 351 and 426 classes. The current method is to create several at once and use them as needed. While this process works well enough, does not keep up with the demand, so a solution is to be able to create specimen on demand, in the lab. For this proposed solution the specimen would be created using a combined punch and holding apparatus that can work in combination with an arbor press, which is in the lab room. This project will securely hold a specimen in place without letting the object move as the punch removes the desired material. Going off the design of this project the goal will be achieved with ease and repeatability.

# Acknowledgements

Thanks to Central Washington University – Mechanical Engineering Department for providing this challenging project to insist on the real world of Mechanical Engineering. This is the opportunity for people who are choosing Mechanical Engineering as a major to have a clear vision about what the essential requirements for the mechanic. Also, delivering a special thanks to Dr. Johnson, Professor Pringle, and Professor Choi to mentor and gives useful advice/ recommendation for this important project.

# References

Mott, Robert L. *Machine Elements in Mechanical Design*. Pearson Education, 2013.

# Appendix A – Analysis

## Analysis 1 - Force Analysis

Triet Huynh | APPENDIX A | Greensheet | 1

Analyzing the force need to shear

Material: Steel 1020 + 1040

| Steel | Shear-strength | Modulus | |
|---|---|---|---|
| 1020 | | 10400 | ksi |
| 1040 | | 11600 | ksi |

G = shear modulus

Shear Modulus equation:

$$\text{shear modulus} = \frac{\text{shear stress}}{\text{shear strain}} = \frac{F/A}{x/y}$$

$$G = \frac{Fy}{Ax} \iff F = \frac{GAy}{x}$$

$$\frac{y}{x} = \tan\theta = 0$$

$\theta$ = small as possible

$\Rightarrow \tan\theta \approx 0$

$$\iff F = GA$$

Area: use ASTM E8 Rectangular - Standard Specimen Sheet - type

Area = (length of the section + 2(fillet)) x thickness

= (2.25 in + 1.57 in) x 0.25 in

= $\underline{0.955 \text{ in}^2}$

$r_{fillet}$ = 0.5 in

Assume $r_{fillet} \approx \frac{1}{2}C$ for the total length of both fillets

$C = 2\pi r$

$= 2\pi(0.5)$

$= 3.14$ (in)

$C = 3.14$ in

$\frac{1}{2}C = \underline{1.57 \text{ in}}$

Force = GA

= 11600 ksi x 0.955 in²

= $\underline{11078 \times 10^3}$ (lb)

Force = GA

= 10400 ksi x 0.955 in²

= $\underline{9932 \times 10^3}$ (lb)

## Analysis 2 – Arbor press force

Triet Huynh | APPENDIX A | Greensheet | 2

The handle length will be 13 in

(The force need to applied at 11 in, when the punch approaching to the object's surface)

The motion of hand $= 2\pi(L) = 2\pi(11) = 69.115$ in

The arbor press's force required to shear $= 11 \times 10^6$ lb

$$\text{The ratio} = \frac{\text{the motion of hand}}{\text{the piston travel}} = \frac{69.115\text{ in}}{6.25\text{ in}} = 11.058$$

Force applied to the punch by hand to shear

$$F_h = \frac{\text{Force to shear}}{\text{the ratio}} = \frac{11 \times 10^6 \text{ lb}}{11.058} = 994718 \text{ lb}$$

The hand force is depend on the length of the handle

If the handle is short, there will be more hand force applied to the punch

If the handle is long, there will be less hand force applied to the punch

## Analysis 3 – Pressure Requirements

Triet Huynh | APPENDIX A | Greenshat | 3

### Pressure Requirements

Perforating pressure $= S \times T \times L$

$= 10400\text{ksi} \times 0.25 \times 2.25$

$= 10400 \times 10^3 \times 0.25 \times 2.25$

$= \underline{5850000}$ (psi)

Stripping pressure = Perforating pressure × 10%

$= 5850000 \times 10\%$

$= \underline{585000}$ (psi)

Bending pressure $= \dfrac{(S \times 0.166 \times T^2)}{(T + \frac{R_1}{2} + \frac{R_2}{2}) \times L}$

$= \dfrac{(60500 \times 0.166 \times 0.25 \times 2)}{(0.25 + \frac{0.875}{2} + \frac{2.5}{2}) \times 2.25} = \underline{1151.89}$ (psi)

Pad pressure = Bending pressure × 1.5

$= 1151.59 \times 1.5$

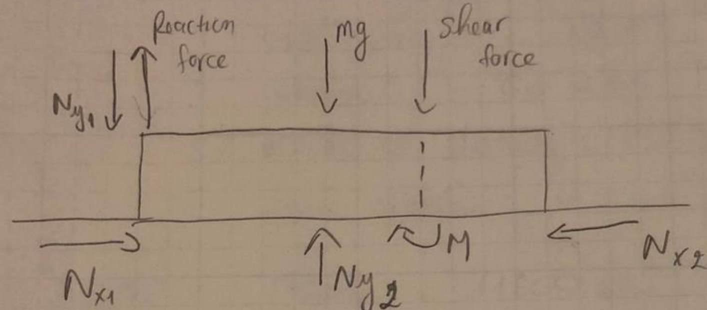
$= \underline{1727.835}$ (psi)

# Analysis 4 – Reaction Forces

| Triet Huynh | APPENDIX A | Greenshat | 4 |
|---|---|---|---|

**Reaction forces**

$$\theta = \tan^{-1}\left(\frac{F}{GA}\right) = \tan^{-1}\left(\frac{11078 \times 10^3}{11600\ ksi\ (0.955\ in^2)}\right) = 45^\circ$$




$\Sigma F_x = 0$

$\Leftrightarrow F_x = F_{N_1} - F_{N_g} = 0\ (lb)$

$\Sigma F_y = 0$

$\Leftrightarrow F_{shear} + ~~F_{N_1} - F_{reaction}~~ - F_{N_g} = 0$

$\Leftrightarrow 11078 \times 10^3\ lb - F_{N_g} = 0$

$\Leftrightarrow F_{N_g} = 11078 \times 10^3\ (lb)$

$\Sigma M_O = 0$

$\Leftrightarrow F_{shear}(x) + F_{N_g}(x) + F_{reaction}(x) - F_{N_1}(x)$

$\Leftrightarrow 11078 \times 10^3(0) + 11078 \times 10^3(0.25) + (0)$

$\Leftrightarrow 2769500\ (lb \cdot in)$

## Analysis 5 – Material Selection and Heat Treatment

Triet Huynh | APPENDIX A | Greensheet | 5

**Material Selection:**

**Steel 1020:**
- Modulus = 10400 Ksi
- Tensile Strength = 129 Ksi
- Yield strength = 72 Ksi
- Hardness = 62 HRC
- Modulus of elasticity = $30 \times 10^6$ psi
- Shear modulus = $11.5 \times 10^6$ psi

**Steel 1040:**
- Modulus = 11600 Ksi
- Tensile strength = 113 Ksi
- Yield strength = 87 Ksi
- Hardness = 262 HB

**Heat treat**

Annealing: heated at 870°C – 910°C followed by a period of holding for a specific amount of time

Carburizing: heated between 880°C – 920°C in a suitable carburizing atmosphere

Core Refining: heated at 870°C – 900°C until the temp remains constant

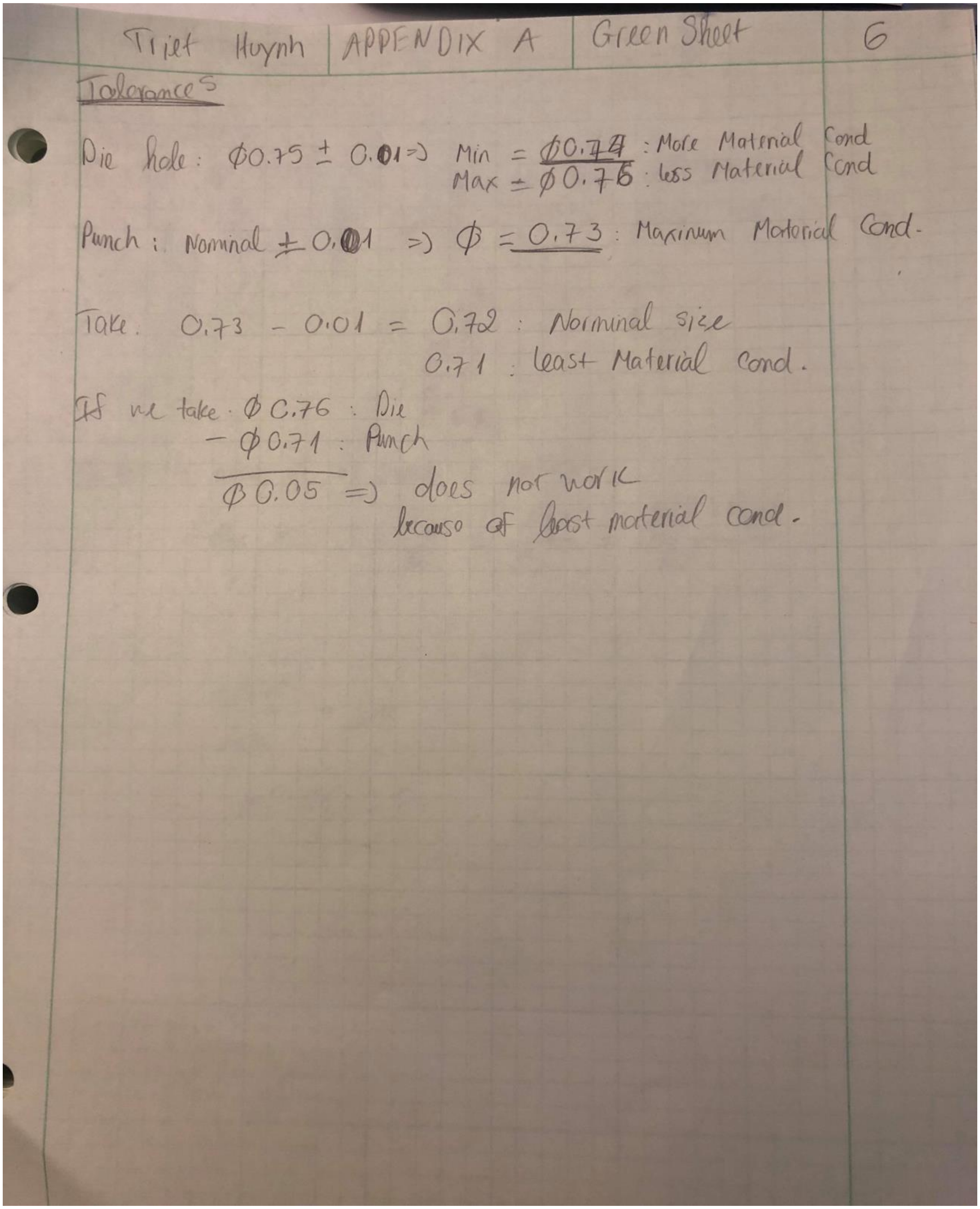
Tempering: heat at 150°C – 200°C for certain time

Normalizing: heat at 890°C – 940°C until the temp remains constant

Stress Relieving: heat at 650°C – 700°C until the temp remains constant

Case hardening: heat at 760°C – 780°C until the temp remains constant

## Analysis 6 – Tolerance



Triet Huynh | APPENDIX A | Green Sheet | 6

Tolerances

Die hole: $\phi 0.75 \pm 0.01$ => Min = $\phi 0.74$ : More Material Cond

Max = $\phi 0.76$ : less Material Cond

Punch: Nominal $\pm 0.01$ => $\phi = 0.73$ : Maximum Material Cond.

Take. $0.73 - 0.01 = 0.72$ : Normal size

0.71 : least Material Cond.

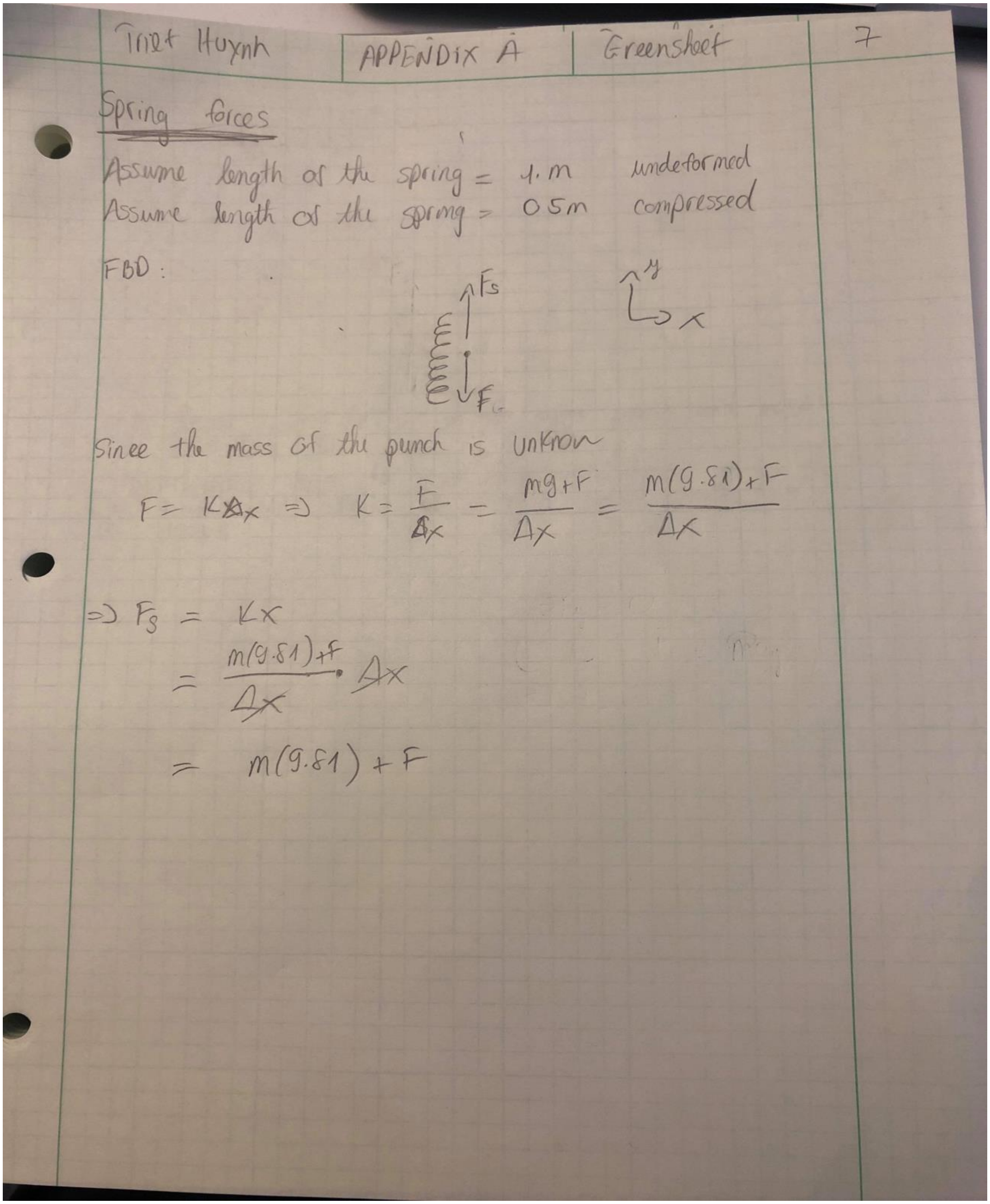
If we take $\phi 0.76$ : Die

$- \phi 0.71$ : Punch

$\phi 0.05$ => does not work

because of least material cond.

## Analysis 7 – Spring force



| Triet Huynh | APPENDIX A | Greensheet | 7 |
| --- | --- | --- | --- |

Spring forces

Assume length of the spring = 1 m undeformed
Assume length of the spring = 0.5 m compressed

FBD:



Since the mass of the punch is unknown

$$F = K\Delta x \Rightarrow K = \frac{F}{\Delta x} = \frac{mg + F}{\Delta x} = \frac{m(9.81) + F}{\Delta x}$$

$$\Rightarrow F_s = Kx$$

$$= \frac{m(9.81) + F}{\Delta x} \cdot \Delta x$$

$$= m(9.81) + F$$

## Analysis 8 – Dimension Base Thickness

| Triet Huynh | APPENDIX A | Greensheet | 8 |
| --- | --- | --- | --- |

**Dimension Base Thickness**

Channel in base:

width = 0.5 ± 0.005

height = 0.25 ± 0.005

length = > 8 in

wall:

- The height must be fit in the arbor press and must be less than 5in
- The thickness must be more than groove goes in to the wall. Recommended should be 2 or 3 time more than the groove

## Analysis 9 – Cutting Forces

Triet Huynh | APPENDIX A | Green Sheet | 9

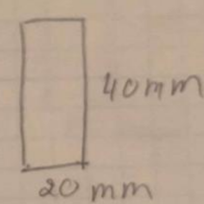
**Cutting forces**

Cutting forces = P = SLT

S = shear strength = 110000 Psi

L = perimeter of the object

Assume the object need to cut is




L = C = (x + y) x 2

= (20 + 40) x 2

= 120 (mm)

= 1.2 (m)

Assume sheet thickness = 1mm

P = SLT

= (110000)(1.2)(0.01)

= 1320 (N)

## Analysis 10 – Cutting Clearances

| Triet Huynh | APPENDIX A | Greensheet | 10 |
|---|---|---|---|

Cutting clearance

$$\text{Cutting clearance} = C \times S \times \sqrt{\frac{T_{max}}{10}}$$

Assume thickness = 0.5 mm

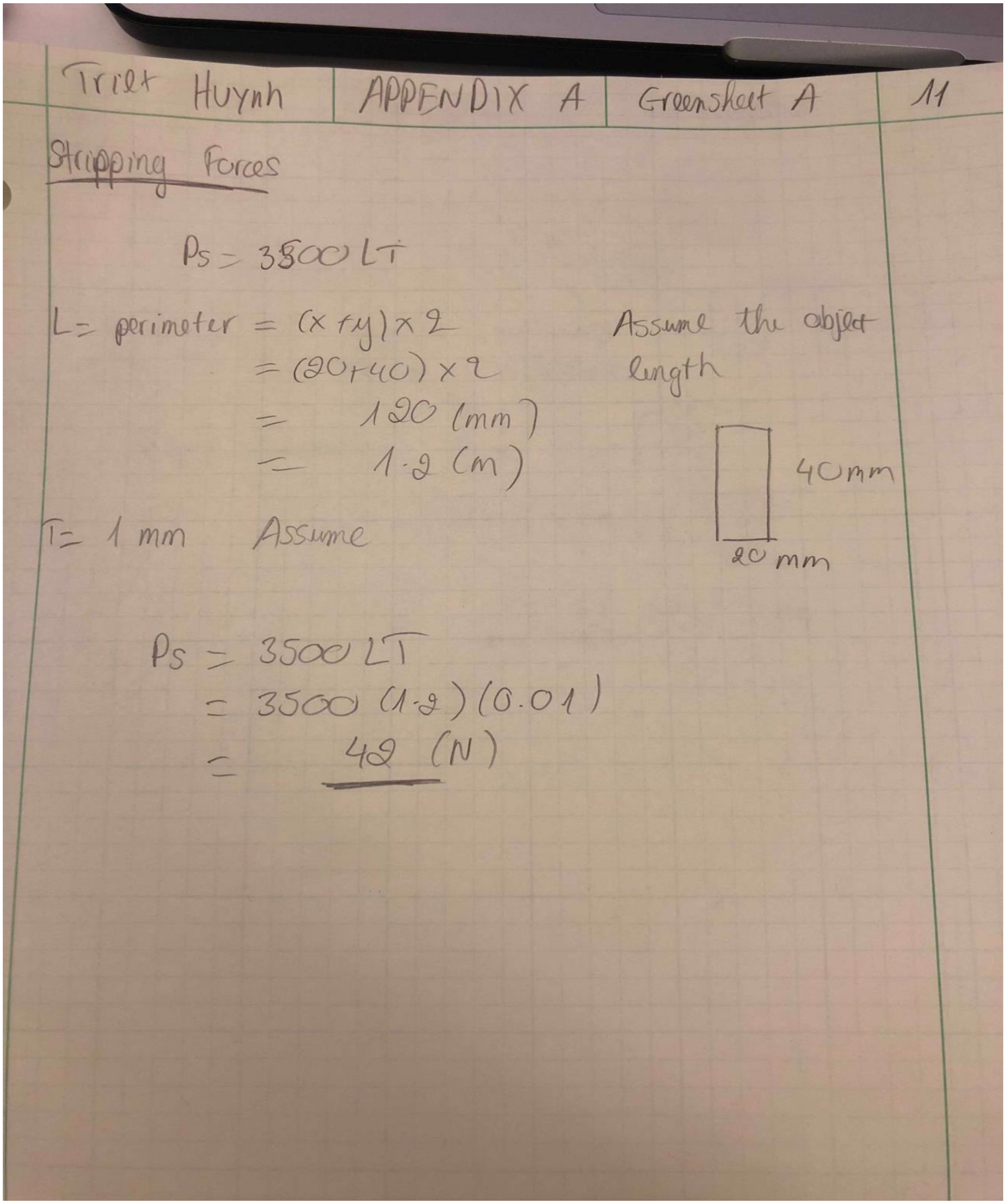
C = 0.005 for accurate component
0.01 for normal component

$$\text{Cutting clearance} = C \times S \times \sqrt{\frac{T_{max}}{10}}$$

$$= (0.01)(0.5\,mm)\sqrt{\frac{110000}{10}}$$

$$= 0.524\ mm/side$$

## Analysis 11- Stripping Forces



Triet Huynh | APPENDIX A | Greensheet A | 11

Stripping Forces

$P_s = 3500\,LT$

$L = \text{perimeter} = (x + y) \times 2$

$= (20 + 40) \times 2$

$= 120\ (mm)$

$= 1.2\ (m)$

Assume the object length

40mm

20 mm

$T = 1\ mm$ Assume

$P_s = 3500\,LT$

$= 3500\,(1.2)(0.01)$

$= \underline{42\ (N)}$

## Analysis 12 – Bending Forces

Triet Huynh | APPENDIX A | Greensheet | 12

**Bending forces**

C => Coefficient of Bending

$$P = \frac{C \times B \times t^2 + t_{max}}{L}$$

Assume: sheet thickness = 5 mm => L = 10 × S

= 50 (mm)

=> C = 1.33

Assume the material is stainless steel

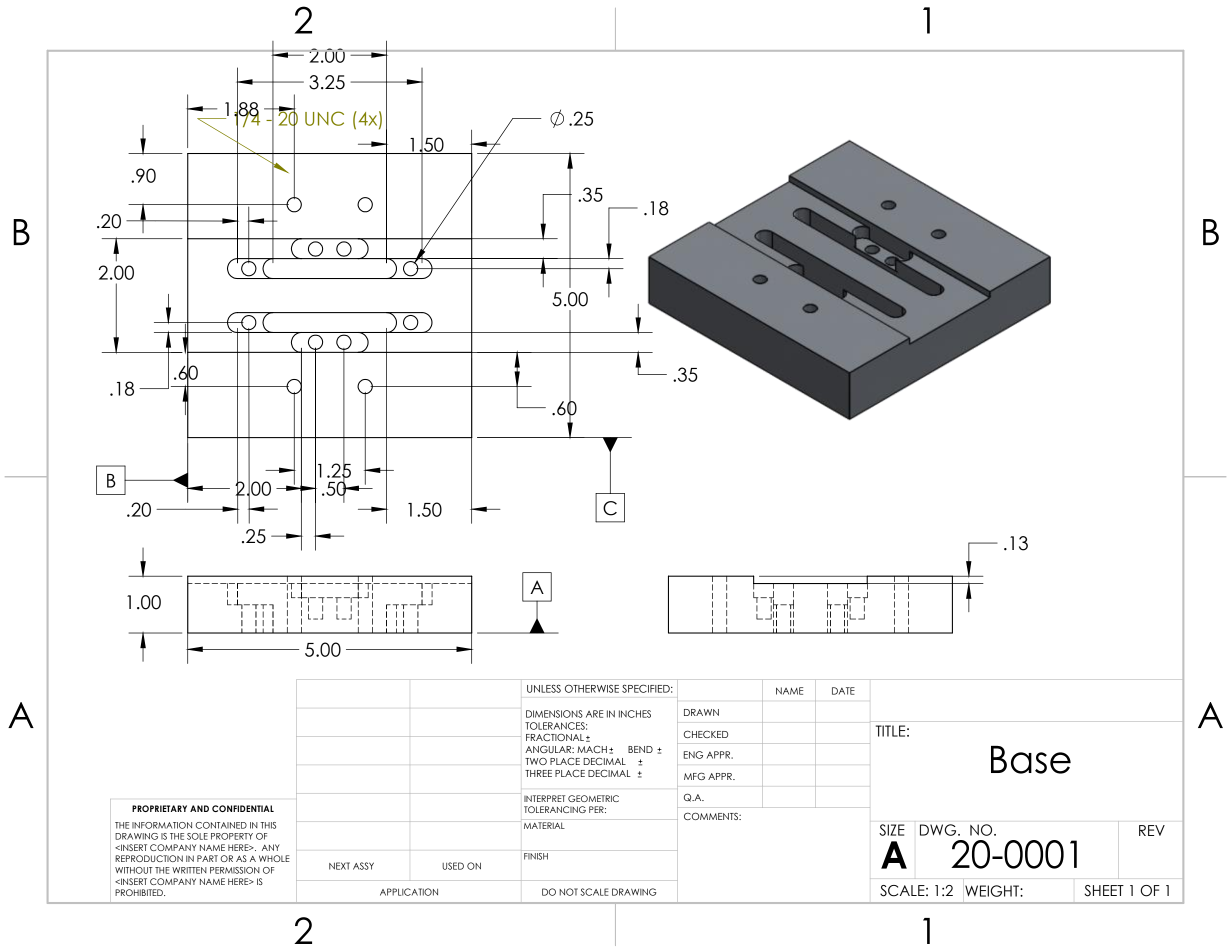
$$P = \frac{C \times B \times t^2 \times t_{max}}{L}$$

$$= \frac{(1.33)(1.75)(5mm)^2 \times 465\,MPa}{50mm} = 5411.43\ (N)$$

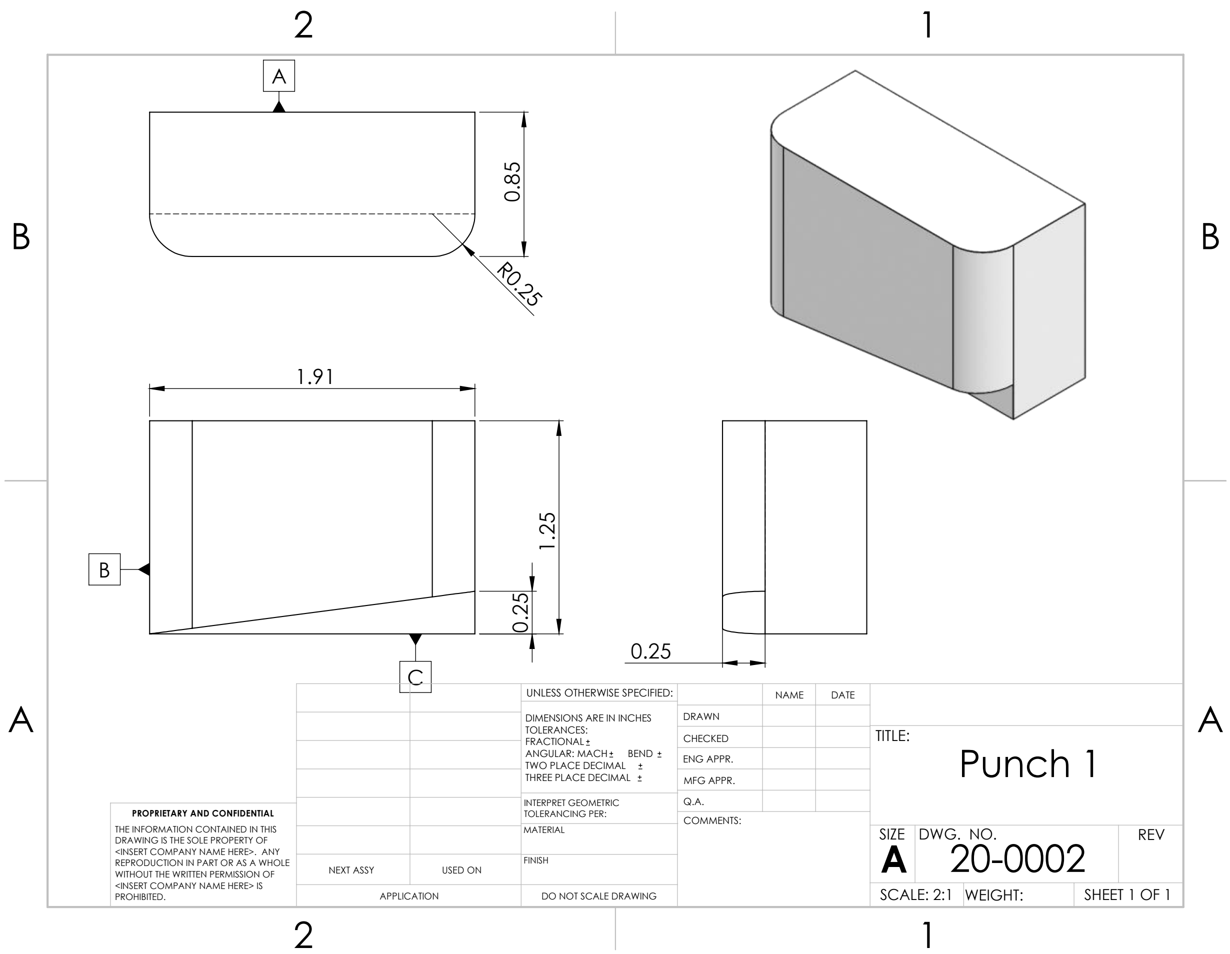
Tensile strength of stainless steel = 465 MPa

# Appendix B – Drawings

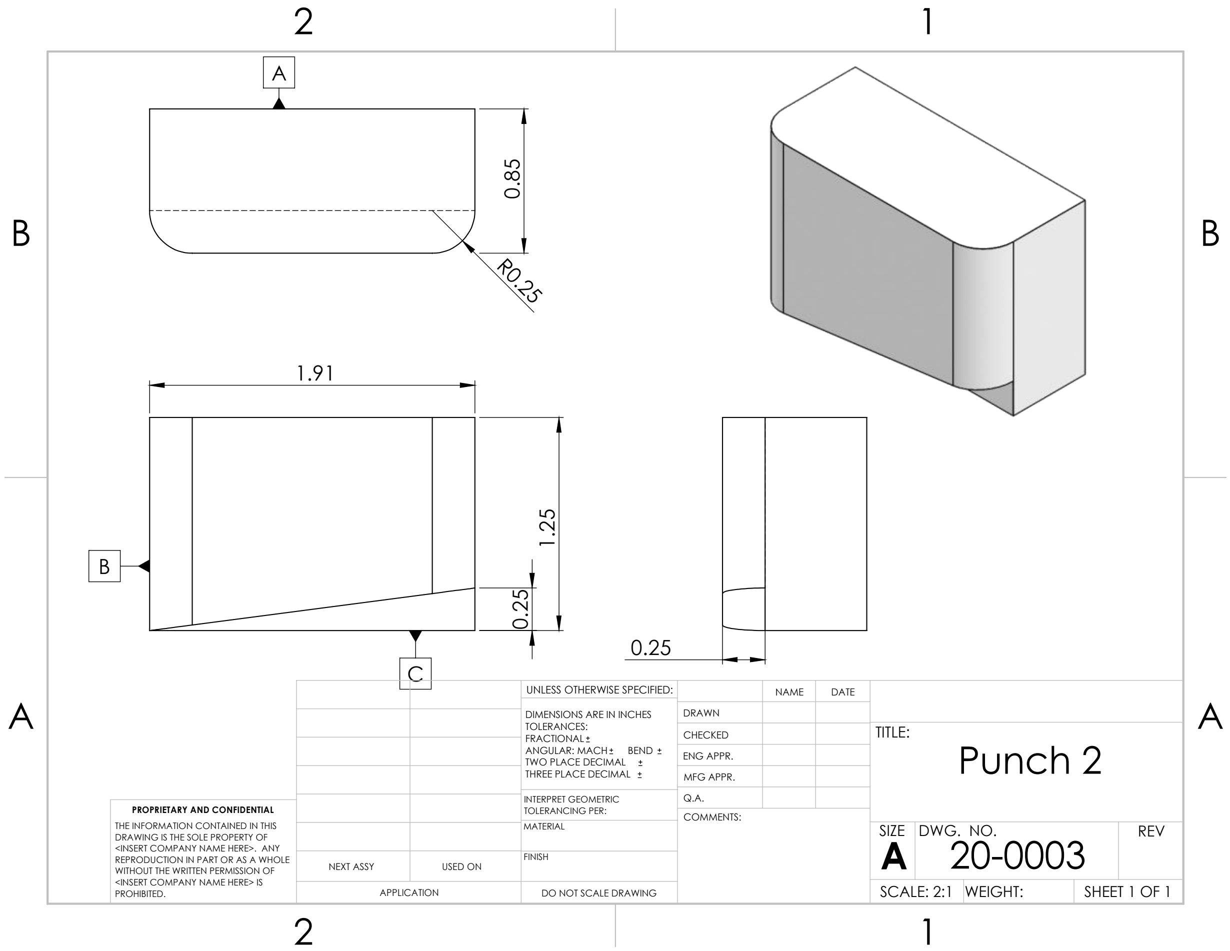
## Drawing 1 - Base



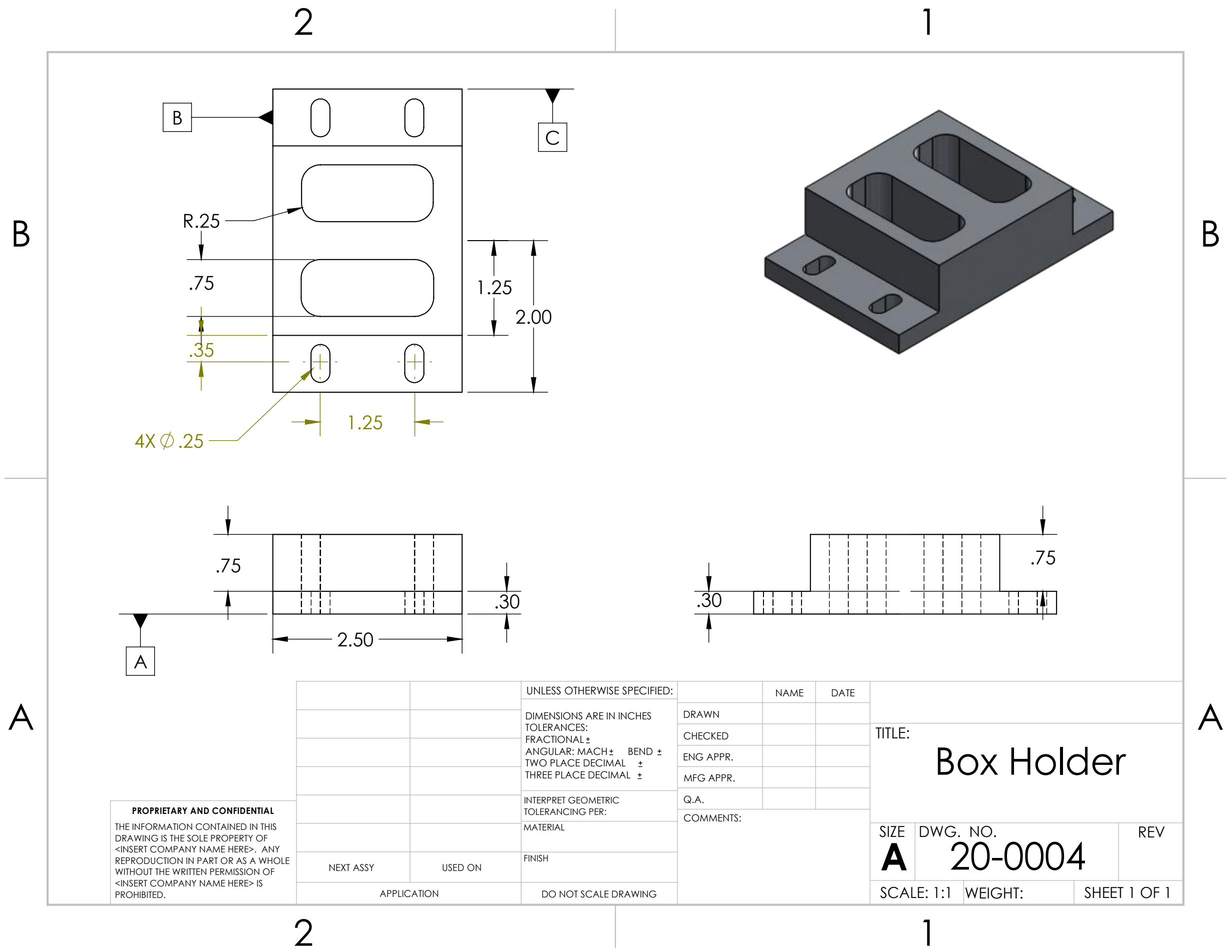
## Drawing 2 – Punch 1



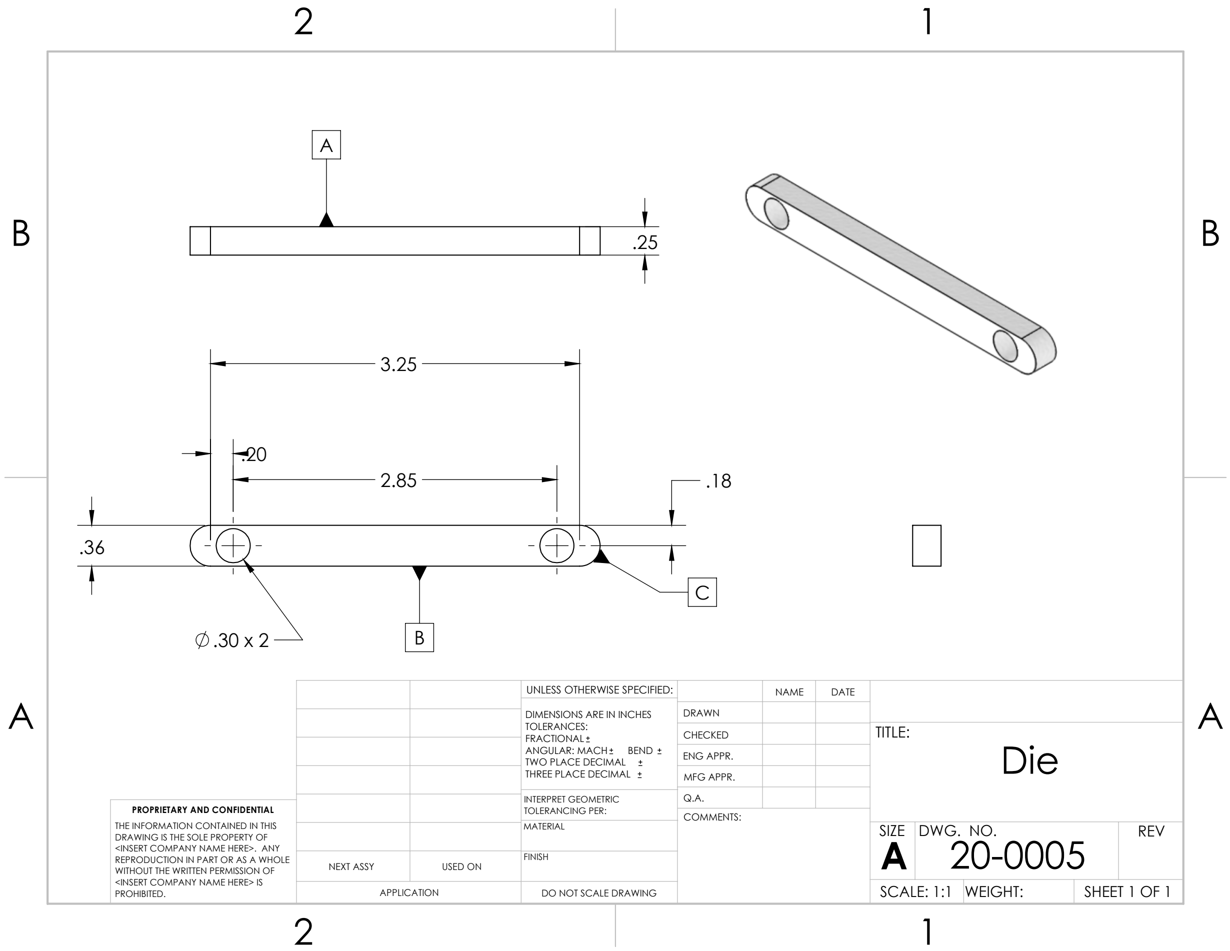
## Drawing 3 – Punch 2



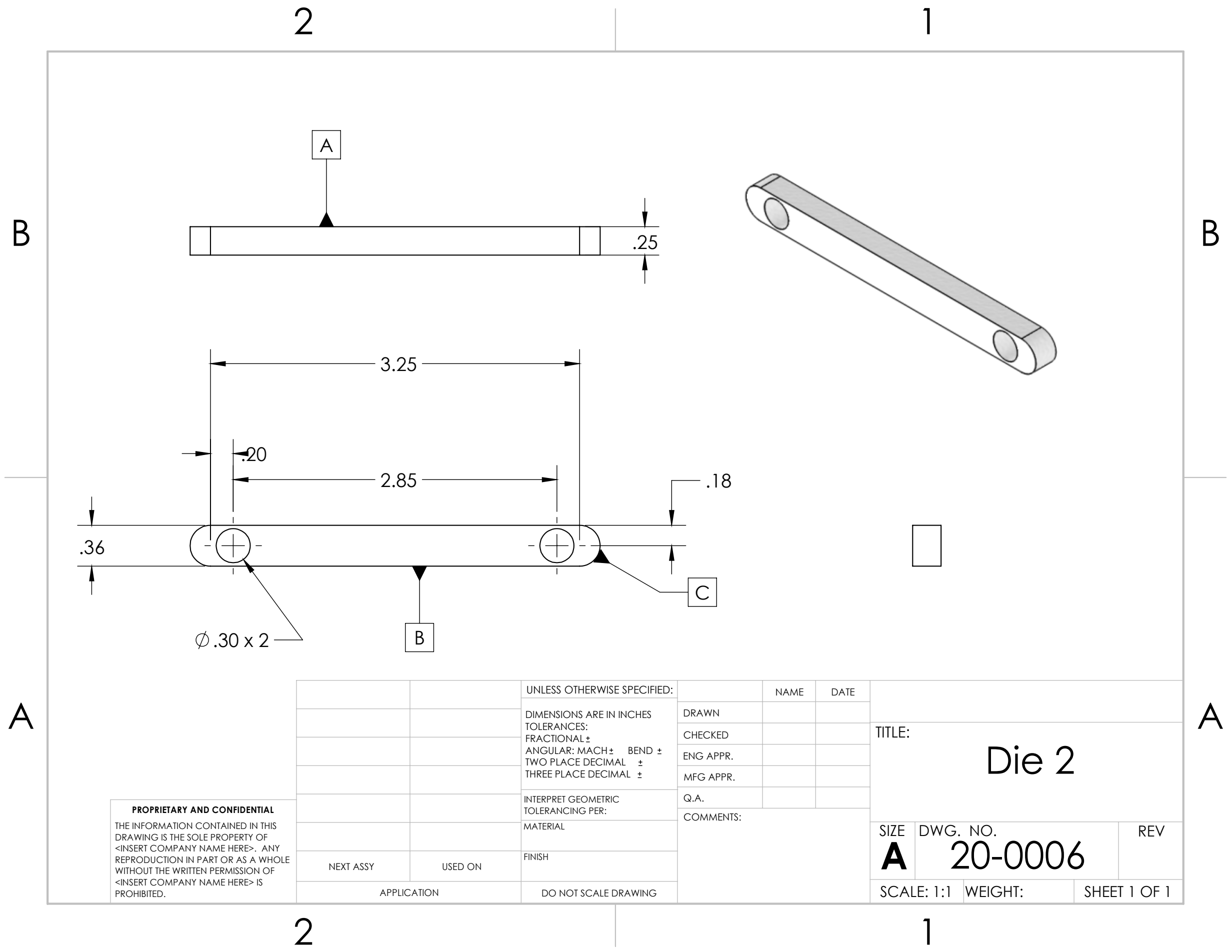
## Drawing 4 – Box holder



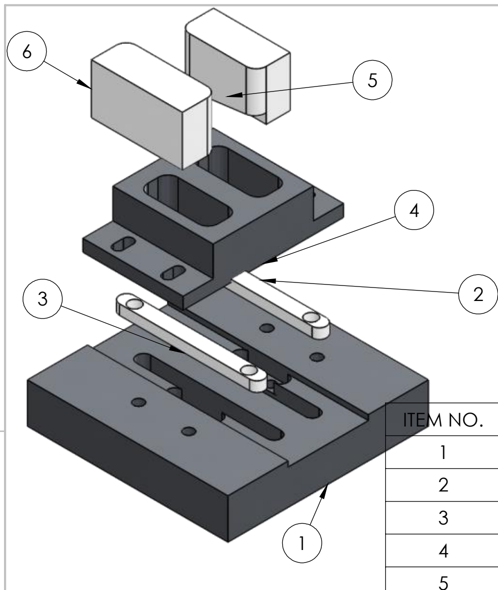
## Drawing 5 – Die



## Drawing 6 – Die 2



## Drawing 7 – Tensile Specimen Punch Assembly




| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | Base | 1100-H16 Rod (SS) | 1 |
| 2 | Die | ABS Plastic | 1 |
| 3 | Die 2 | ABS Plastic | 1 |
| 4 | Box | 1100-H16 Rod (SS) | 1 |
| 5 | Punch | ABS Plastic | 1 |
| 6 | Punch 2 | ABS Plastic | 1 |

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH

| | NAME | DATE |
|---|---|---|
| DRAWN | | |
| CHECKED | | |
| ENG APPR. | | |
| MFG APPR. | | |
| Q.A. | | |

COMMENTS:

TITLE: Assembly

SIZE A | DWG. NO. 10-0001 | REV

SCALE: 1:4 | WEIGHT: | SHEET 1 OF 1

NEXT ASSY | USED ON
APPLICATION
DO NOT SCALE DRAWING

## Appendix C – Parts List

| Part Name | Description |
| --- | --- |
| Base | Machined from Steel |
| Punch | Machined from Tool Steel |
| Die | Machined from scrap Steel |
| Punch Support: | |
| Back | Machined from scrap steel |
| Sides | Machined from scrap steel |
| Front | Machined from scrap steel |
| Screws | Cut to length |

# Appendix D - Budget

| | | | | | |
|---|---|---|---|---|---|
| **Part lists and Budget** | | | | | |
| | | | | | |
| **Senior Project's Title** | | | **Tensil specimen Punch** | | |
| | | | | | |
| **Item Number** | **Item Description** | **Item Source** | **Price/Costs ($)** | **Quantity** | **Total Cost** |
| 1 | Base | CWU | 0 | 1 | 0 |
| 2 | Punch Holder | CWU | 0 | 1 | 0 |
| 3 | Punch | CWU | 0 | 2 | 0 |
| 4 | Die | CWU | 0 | 2 | 0 |
| 5 | Spring | Amazon | $10 | 4 | $40 |
| | | | | | |
| | | | Overal total costs | | $40 |

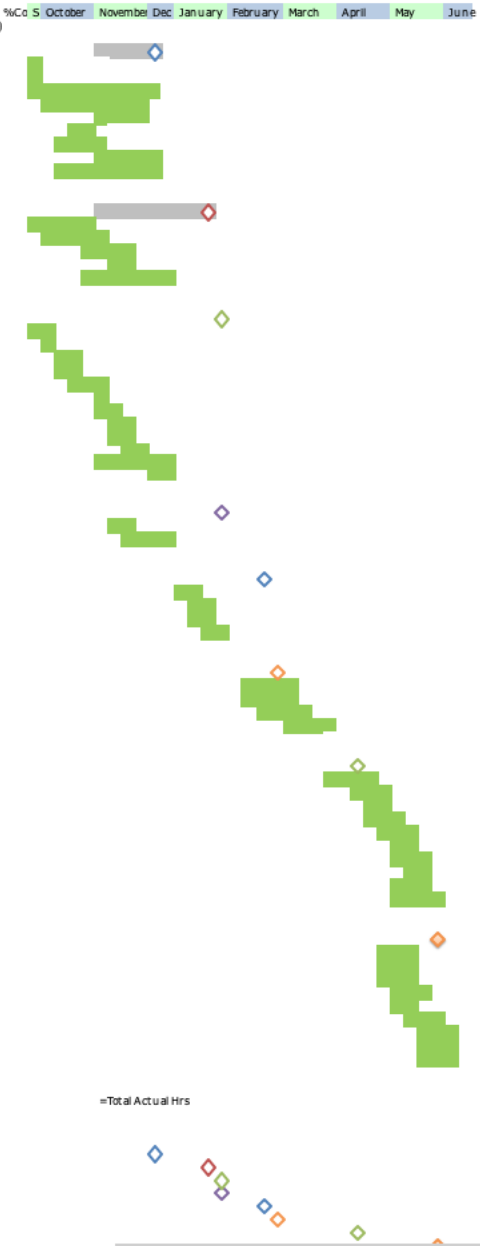
# Appendix E – Schedule

**DEFINE HOW THE STUDENTS SHOULD INDICATE STARTING EARLY/LATE AND FINISHING EARLY/LATE**
**X to indicate work**

**EXAMPLE** SCHEDULE FOR SENIOR PROJECT:
**NOTE: STUDENTS MUST MAKE THEIR OWN SCHEDULE!!!!!!!!!!!!!!**
PROJECT TITLE: Tensil Specimen Punch
Principal Investigator.: Triet Huynh

Note: March x Finals
Note: June x Presentation
Note: June y-z Spr Finals

| TASK ID | Description | Duration Est. (hrs) | Actu (hrs) | %Co |
|---|---|---|---|---|
| 1 | Proposal* | | | |
| 1a | Outline | 99 | 99 | |
| 1b | Intro | 99 | 99 | |
| 1c | Methods | 99 | 99 | |
| 1d | Analysis | 99 | 99 | |
| 1e | Discussion | 99 | 99 | |
| 1f | Parts and Budget | 99 | 99 | |
| 1g | Drawings | 99 | 99 | |
| 1h | Schedule | 99 | 99 | |
| 1i | Summary & Appx | 99 | 99 | |
| | subtotal: | 891 | ## | |
| 2 | Analyses | | | |
| 2a | Force Anal | 99 | 99 | |
| 2b | Reaction Anal | 99 | 99 | |
| 2c | Pressure Anal | 99 | 99 | |
| 2d | Dimension Anal | 99 | 99 | |
| 2e | Tolerance Anal | 99 | 99 | |
| | subtotal: | 495 | ## | |
| 3 | Documentation | | | |
| 3a | Introduction Punch Di | 99 | 99 | |
| 3b | Base part | 99 | 99 | |
| 3c | Punch 1 Part | 99 | 99 | |
| 3d | Punch 2 Part | 99 | 99 | |
| 3e | Box Holder Part | 99 | 99 | |
| 3f | Assembly part | 99 | 99 | |
| 3g | Base drawing | 99 | 99 | |
| 3h | Punch 1 Drawing | 99 | 99 | |
| 3i | Punch 2 Drawing | 99 | 99 | |
| 3l | Box Holder Drawing | 99 | 99 | |
| 3l | ANSIY14.5 Compl | 99 | 99 | |
| 3m | Make Object Files | 99 | 99 | |
| | subtotal: | ### | ## | |
| 4 | Proposal Mods | | | |
| 4a | Project Schedule | 3 | 3 | |
| 4b | Project Part | 2 | 2 | |
| | subtotal: | 5 | 5 | |
| 5 | Part Construction | | | |
| 5a | Manufacture Base | 99 | 99 | |
| 5b | Manufacture Die 1 | 99 | 99 | |
| 5c | Manufacture Die 2 | 99 | 99 | |
| 5d | Manufacture Box Holder | 99 | 99 | |
| | subtotal: | 396 | ## | |
| 9 | Device Construct | | | |
| 9a | Assemble Base | 99 | 99 | |
| 9b | Assemble Punch Holder | 99 | 99 | |
| 9e | Take Dev Pictures | 99 | 99 | |
| 9f | Update Website | 99 | 99 | |
| | subtotal: | 396 | ## | |
| 10 | Device Evaluation | | | |
| 10a | List Parameters | 99 | 99 | |
| 10b | Design Test & Scope | 99 | 99 | |
| 10c | Obtain resources | 99 | 99 | |
| 10d | Make test sheets | 99 | 99 | |
| 10e | Plan analyses | 99 | 99 | |
| 10f | Instrument Robot | 99 | 99 | |
| 10g | Test Plan* | 99 | 99 | |
| 10h | Perform Evaluation | 99 | 99 | |
| 10i | Take Testing Pics | 99 | 99 | |
| 10h | Update Website | 99 | 99 | |
| | subtotal: | 990 | ## | |
| 11 | 495 Deliverables | | | |
| 11a | Get Report Guide | 99 | 99 | |
| 11b | Make Rep Outline | 99 | 99 | |
| 11c | Write Report | 99 | 99 | |
| 11d | Make Slide Outline | 99 | 99 | |
| 11e | Create Presentation | 99 | 99 | |
| 11f | Make CD Deliv. List | 99 | 99 | |
| 11e | Write 495 CD parts | 99 | 99 | |
| 11f | Update Website | 99 | 99 | |
| 11g | Project CD* | 99 | 99 | |
| | subtotal: | 891 | ## | |
| | Total Est. Hours= | ### | ## | |
| Labor | 100 | ### | | |




=Total Actual Hrs

Note: Deliverables*
- Draft Proposal
- Analyses Mod
- Document Mods
- Final Proposal
- Part Construction
- Device Construct
- Device Evaluation

## Appendix G – Testing Report

| Task | Requirement | Actual | Success |
|---|---|---|---|
| Weight | Less than 15lbs | 10lbs | Yes |
| Cost | Less than $200 | Less than $100 | Yes |
| Production | Cut both sides of the specimen | Both sides cut at the same time | Yes |

## Appendix F – Expertise and Resources

Expertise in using all the machines in the machine room help a lot during the process. The more confident with the device, the more successful will be. Seeking help and receive any advice from a mentor is the priority thing on the way to be successful.

References:

Mott, Robert L. *Machine Elements in Mechanical Design*. Pearson Education, 2013.

## Appendix J – Job Hazard Analysis

| **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 application) | Task Description | Hazards | Controls |
|---|---|---|---|
| | Drilling holes | Flying Chips/Debris | Required MET 255, proper PPE (Eye protection) |
| | Boring holes | Flying Chips/Debris | Required training of machine, proper PPE (Eye protection) |
| | Saw the punch to the size dimensions | Injury from cutting action | Required training skill, proper PPE (Gloves) |
| | Place drill bits into spindle. | Sharp blades and drill bits. | Hold bit away from sharp edges. |
| | Clearing jammed drill bit. | Sharp, spinning blades. | Clear jam in the STOP position only or remove blade and clear jam with tool provided. |
| | Milling text blocks | Injury to hands from milling blades | Never disconnect safety shields from milling blades. |
| | | Hearing damage from noise of machine operation | Wear hearing protection, such as ear plugs, if operating machine for periods extending more than 10 minutes. |
| | | Possible eye injury from wire stitches thrown out by milling blade | Wear safety glasses during operation. |

# Appendix H – Resume


# TRIET HUYNH

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**triethuynh2402@gmail.com · LinkedIn Profile · Twitter/Blog/Portfolio**


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Professional, detail-oriented, motivated to drive projects from start to finish as part of a dynamic team

## EXPERIENCE

**2014 – PRESENT**

**CUSTOMER SERVICES,** HOANG PHUONG COMPANY

- Inventory Check
  - Monthly report
- Maintenances Service
  - Drilling machine
  - Grinding machine
  - Thermometer
- Sale
  - Construction materials

## EDUCATION

**SEPTEMBER 2013 - MAY 2014**

**HIGH SCHOOL DIPLOMA,** SAINT'S ANTHONY HIGH SCHOOL

**SEPTEMBER 2014 - JUNE 2018**

**ASSOCIATE OF SCIENCE DEGREE,** HIGHLINE COMMUNITY COLLEGE

**SEPTEMBER 2018 - PRESENT**

**MAJOR IN MECHANICAL ENGINEERING TECHNOLOGY,** CENTRAL WASHINGTON UNIVERSITY

## SKILLS

- 3D- Solid Work
- Basic Electricity
- Machining
- AutoCAD design
- Completed courses: fluid, static, thermodynamics, dynamics, metallurgy, plastics and composite