

# Model Block Press Design

## Final Design Review

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*for CVBT Thailand*

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## Abstract

This project's goal is to redesign the Center for Vocational Building Technology (CVBT) BP9 earth block press, which makes 1/3 scale compressed earth blocks to build demonstration model homes in Thailand. The full-scale block press, the BP6, provides a sustainable and affordable technique for constructing habitable homes in Thailand. The BP9 serves as a tool to inform the public of the advantages of human-powered earth block presses through demonstration. The BP9 press design has multiple problems: it is too expensive to manufacture, there is too much friction when used, it has several weak points due to users unintentionally applying excessive force, and it cannot make channel or half blocks. Some experienced block press users were interviewed to gather opinions on what improvements and/or changes should be implemented in the new block press design. The main takeaway was that the press's structural supports should be reinforced or redesigned. This document also includes some other existing full-scale press designs. The main objectives for this project are to eliminate the weak points and to reduce the cost. A full redesign with an entirely different mechanism was decided upon, and this process is detailed in the document, as well as the details of the design itself. The manufacturing and design verification plan, as well as the timeline of this project, are also detailed in the document.

## 1.0 Introduction

CVBT is an organization in Thailand that promotes local production of construction materials. One of these materials is a compressed earth block, which is produced using a block press. In addition to full scale presses, they also have a 1/3 scale model, called the BP9. This press currently has issues that CVBT would like to improve upon. The Blockheads, which consist of three mechanical engineering students from Cal Poly San Luis Obispo, have been asked to mitigate or eliminate these issues. This Final Design Review will include everything from the Critical Design Review (provide relevant research, define the problem, describe the background of the problem in more detail, describe the design process used to select the current design, and explain how the design will resolve the issues of the BP9). In addition it will include a manufacturing, assembly, and test plan and final engineering drawings.

## 2.0 Background

### 2.1 Interviews

Three people who have used the block press extensively were interviewed. Dan Waldorf, an Industrial Manufacturing Engineering professor at Cal Poly, suggested improvements to the press box and the strengthening of the supports. Daniel Jansen, a Civil Engineering professor at Cal Poly, wanted a block press that could make a wider variety of blocks. Vaughn Thomas, who has used the block press to build full-scale houses in Vietnam and Indonesia, wanted a method of block compression that applied pressure from the top and bottom to create a denser block. He also wanted sturdier blades, which are used for forming half blocks.

### 2.2 Existing Designs

The CINVA Ram [Figure 1] was developed by Raul Ramirez in 1956 and is one of the oldest and cheapest manual soil press machines [1]. The CINVA Ram is made of steel and consists of a mold box, lever, yoke, and piston. The lever is rolled onto the lid of the box, actuating the piston through the yoke. When the lever is pressed down, the piston raises, compressing the soil mix and forming the block [2]. The blocks created are 29 x 14 x 9 cm. The CINVA Ram costs approximately \$230 [1].

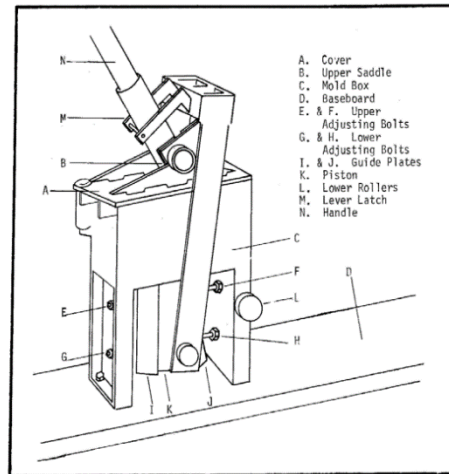


Fig. 1 - The CINVA-Ram Block Press and Its Parts

Figure 1. CINVA RAM Block Press [3]

The CETA Ram [Figure 2] was developed by Robert Lou Ma, a civil engineer, in 1976. The CETA Ram is an improvement of the CINVA Ram, due to its ability to make hollow-soil cement blocks. The process of making blocks consists of three steps: 1. Cover the box with the lid. 2. Pull the lever over the lid, allowing the piston to compress the block. 3. Pull the lever in the opposite direction to extract the block. The blocks created are 32.3 x 15.7 x 11.5 cm. In addition, there are two 6 cm diameter holes that run through the entire block. They are meant to hold steel rods, making the blocks more earthquake resistant when assembled. The CETA Ram costs approximately \$500 [4].

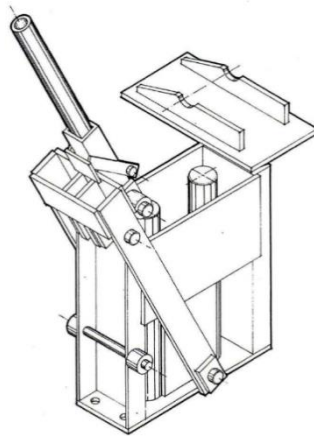


Figure 2. CETA Ram Block Press [4]

The Astram Soil Block Machine [Figure 3] was designed in 1980 by Professor K.S. Jagadish of the Centre for Application of Science and Technology for Rural Areas (ASTRA). It consists of a mold, a frame, and a toggle-lever mechanism. A lid is attached to the mold and can be locked in place when in the closed position. When the lever is in the vertical position, the base plate is at its lowest position, allowing for the mold to be filled. When the mix inside the mold is ready to be compressed, the lever is pulled down until it reaches a stop, indicating that the base plate has moved up 6 cm. The lid is then removed, and the lever can be pulled down further to eject the block. The Astram Soil Block Machine costs approximately \$540[1].



Figure 3. Astram Soil Block Machine [1]

The BP9 [Figure 4], created and used by CVBT in Thailand, is a 1/3 scale model of the BP6, a full sized block press. It is used to make blocks for model houses and souvenir paper weights [5]. More information about the BP9 can be found on the CVBT website.



Figure 4. CVBT BP9 [5]



Figure 5. CVBT BP6 [7]

In 2014, a Cal Poly senior project group designed the BP10 [Figure 6], a block press that makes blocks 1/4 the size of blocks made by the BP6 [Figure 5]. Like this senior project, the goals of the BP10 were to reduce the cost of making a smaller scale block press, reduce friction in the assembly, and eliminate weak points. Its design is very similar to the BP9, with a few adjustments, such as lowering the pivot point of the lever, use of cheaper materials, and less machining time [6]. During the current team's testing of the BP10, some flaws were discovered. Tolerances were not adhered to, as the assembly is loose, causing shakiness and instability. The lid pivot is also located poorly; during the compression phase, when the compression roller (eccentric) is moved over the lid, it is easy to over-rotate the roller, causing the lid to open and prevent full base plate compression. In addition, the soil mixture can easily get trapped inside holes and crevices in the press, which inhibits the compression and extraction phases. Finally, the lever pivot point is too low; the top of the base plate is not even or parallel with the top of the box when fully raised, causing the block to sit partially inside the box during the extraction step. This inhibits the ability to lift the block smoothly from the base plate without contacting any of the other sides of the press carriage. This inaccuracy in base plate height and parallelism means that the user has to grab and pull the block out of the box; the block is in contact with the press carriage on all four side walls. This is not ideal, because it is easy to break the wet and brittle block, as it has not yet been cured. These flaws will be relevant with regards to the final design, as it should eliminate the flaws in the BP9 as well as the BP10.

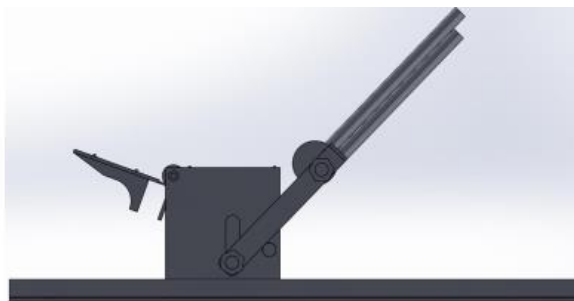


Figure 6. CVBT BP10 [6]

## 3.0 Objectives

### 3.1 Problem Statement

CVBT's miniature block press, the BP9, currently has multiple problems: it is too expensive to manufacture, there is too much friction when used, it has several weak points due to users unintentionally applying excessive force, and it cannot make channel and half blocks. The objective of this senior project is to design a 1/4 scale block press that addresses the problems of its predecessors. This will be accomplished by reducing the number of moving parts, choosing more cost-efficient methods of manufacture, adding a method to create channel and half blocks, and implementing a method of reducing excessive force by the user.



### 3.2 Boundary Sketch

Figure 7 is the boundary sketch, a visual representation of which materials, objects, and systems are either available and under the team's control and which are out of the team's control. The objects within the box represent those that can be manipulated, and those outside represent the opposite. As can be seen, soil moisture level and mixture, previous CVBT block press designs, and generic bamboo are available and can be easily manipulated and utilized. The strength of the user, the tools used for manufacturing, and the specific materials of the press, however, are objects outside of the team's control. In other words, the team is constrained to specific materials and tools that are used in the CVBT workshop.

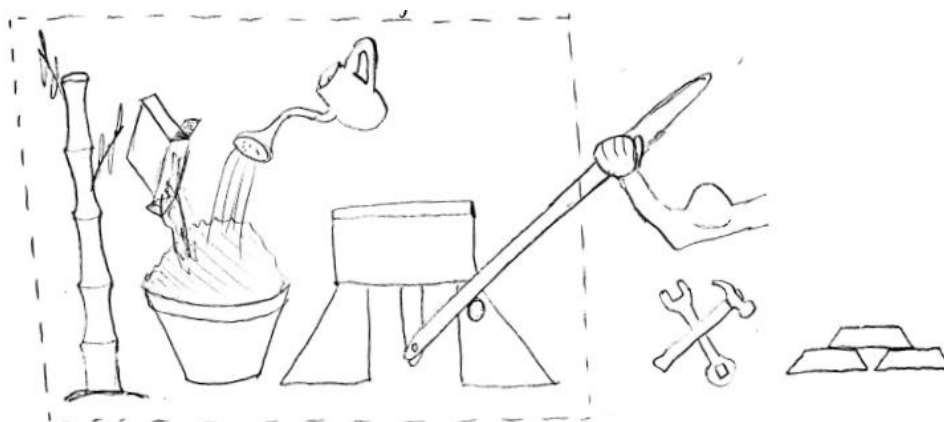


Figure 7. Boundary Sketch

### 3.3 Customer Wants and Needs

The newly designed block press is expected to be safe, easy, and inexpensive to manufacture (total cost to manufacture: 2000 Baht or ~\$62) given the tools available in the CVBT workshop in Thailand, intuitive to use, have a lifespan of at least 60,000 blocks (5000 blocks per house, 12 houses), and have detailed models and drawings for ease of manufacture. It is necessary that the weak points on the existing BP9 design are either reinforced or redesigned. These weak points include binding in the press carriage, bending of the handle-eccentric interface, and high friction in the press carriage. The new design must be able to create 1/4 scale full, half, and channel blocks that will be used to build model homes or as souvenir bricks. This also necessitates a list of appropriate soil mixes depending on what type of block is being pressed. The main characteristics of the soil to be focused on are color, texture, mixability, compressibility, ease of ejection from the press, and ease of lifting from the press without breakage. It is desired that bamboo is included in the new press design because it is beneficial to the environment.

### 3.4 Quality Function Deployment (QFD)

The QFD table in Appendix 1 compares the customer requirements to the engineering specifications in order to make obvious the level importance of each proposed design feature. It appears that the most important design challenges will be to reinforce weak members on the existing BP9 block press design and to make sure that the user somehow does not exceed the yield strength of the press. These tasks will in turn create a more durable press. Following closely behind in importance is the manufacturing technique, which is directly related to cost.

### 3.5 Engineering Specifications

The engineering specifications are shown in Table 1 below where “Risk” represents how difficult it will be to achieve each specification (L=low, M=medium, L=Large) and “Compliance” represents how each specification will be achieved (I=inspection, T=testing, A=analysis, S=similarity). Here are short descriptions of each specification and their difficulty of implementation:

- 1/4 scale: The desired scale compared to the full scale BP 6
- Steel: Main material used to build press that is easily acquired
- Life: Amount of press cycles until a component fails
- Limit to max force: A way to prevent the user from overexerting force and damaging the press. This will be much more of a design challenge because the preexisting BP9 does not include this feature.
- Manufacturable in-house: Part manufacture and assembly must be done using the tools available in CVBT’s machine shop
- Method of reinforcing structural members: Strengthening or redesigning weak points on previous BP9 press design. This will be a challenge, as it could entail a complete redesign of the BP9, and numerous tests.
- Appropriate soil mixture: Creating and experimenting with different soil/clay/cement mixtures that satisfy color, texture, mixability, compressibility, ease of ejection, ease of lifting without breakage. This will be a difficult challenge because of the many factors that can be adjusted to create a functional mixture. Many tests will be needed.
- Block production time: The time required to pack the soil, compress, and extract the block formed
- Inserts for mold: inserts or “frogs” that can be quickly added and removed from the press in order to create full, half, and channel blocks. Ideas for these inserts already exist for the BP9 and the full scale BP6.
- Ability to upscale: The processes to manufacture the 1/4 scale model should be repeatable on full size parts

Table 1. Engineering Specifications Table

Spec. #	Specification Description	Requirement or Target	Tolerance	Risk	Compliance
1	1/4 scale			L	I
2	steel	1010 or 1020		L	I
3	life	60000 cycles	Min	M	T,A,S
4	limit to user max force			H	T,I
5	manufacturable in-house			L	I
6	reinforcing structural members			H	T,A
7	appropriate soil mixture			H	I,T
8	block production time	<20 seconds	Max	H	I,T
9	inserts for mold			M	I,T,A,S
10	ability to upscale			L	I,T,A,S

## 4.0 Concept Design

### 4.1 Considered Designs

The design process began with two brainstorming sessions. The objective was to brainstorm possible concepts that could compress a block of soil (with defined length and width dimensions) in the vertical direction. After the brainstorming sessions, concepts that were too time consuming, complex, or unrealistic to implement were discarded. This left five pressure concepts and three extraction techniques that could be converted to actual designs. Figures 8 through 13 provide visuals and descriptions of the top five concepts.

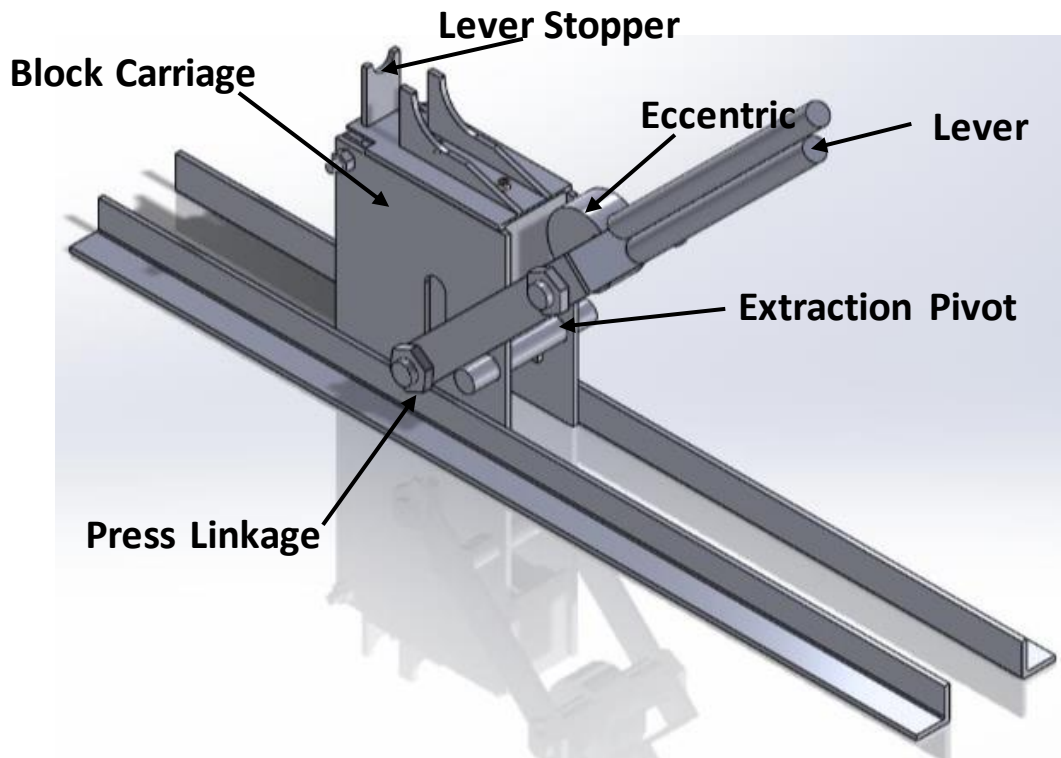


Figure 8. Traditional Press and Lever and Pivot Extraction (CVBT BP10) [6]

The BP10 applies the traditional press method and the lever and pivot extraction method shown in Figure 8. This is by far the most common design for pressing and extraction of compressed earth blocks, as the research indicates. CVBT's BP6, BP9, and BP10 all incorporate the basic principles of what is shown above. The basic process is as follows: The soil mixture is loaded into the block carriage and the lid is closed. The lever is rotated to the left over the top of the block carriage to vertical (lever is perpendicular to the press lid). The eccentric contacts the curved tracks located on the top of the lid. The lever directly connected to the eccentric should then continue to be rotated over the top of the block carriage until reaching the lever stopper (lever is parallel with the lid of the press). This second rotation should cause the press linkage to rise upwards and compress the block. To extract the block, the lever is rotated back over the top of the press and placed back in its starting position. The lid can then be lifted, exposing the top of the block to the air. The lever is rotated downward, pivoting about the extraction pivot. This causes the press linkage to rise once again. This time, the press linkage rises until the block is fully exposed to the air on five sides (excluding the bottom).

Because this design is so historically reliable, the team considered keeping its basic features and improving them through structural reinforcement and improved manufacturing and assembly procedures. During the narrowing process, it was decided that designing a new and unique style press was more desirable than improving upon the “old, tried and true” design; an original press design brings a new perspective on how to most efficiently press a brick with only human power, hopefully inspiring future innovation.

Figure 9 shows a simple design which would be compressed directly by hand and extracted via a removable base. This design was intended to be especially simple and inexpensive to manufacture. The process is as follows: The soil mixture is loaded into the block carriage. Then the lid is pressed down onto the soil by hand, using the handle attached to the lid. The lid is removed, and the sides of the block carriage, which are all one piece, are lifted off. The block is then lifted off the base. This design, while being very inexpensive, would be ineffective. CVBT indicated that a similar design had been attempted and did not work out well. This is because without mechanical advantage, it is difficult to press the block by hand. In addition, it is difficult to control the amount of force and the distance the block is pressed.

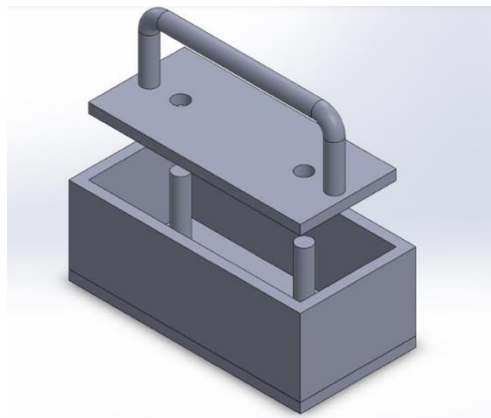


Figure 9. Hand Press and Removable Base Design

A third design that was considered is the Astram Block Press design [Figure 10], which incorporates a similar concept to that of the traditional block press, with a few differences. The process is as follows: First, the lid is latched closed externally using a locking mechanism instead of rotating the lever over the lid (latch not shown in figure). The lever is pulled down, rotating about the pivot. This causes the base plate to rise, compressing the mixture against the closed lid. When the mixture is fully compressed, the lid is opened, and the lever is pulled down further, raising the base plate until it is flush with the top of the box, allowing the block to be easily removed. A foot pedal in place of a hand lever was also considered as a design innovation for ease of use. There are several flaws to this design, however. The first is that it is very easy to damage the lever. Without a mechanism to warn users from over rotating the lever, it would be very easy to bend the lever during compression. Another issue that arises is that there is nothing stopping the lever from sliding back down to its starting position when the user is unlatching the lid between the pressing and extracting steps of the process. The point of this press was to make the press/extraction process into one fluid, single step, so if the lever returns to its starting position between the two main steps, then the purpose has been defeated.

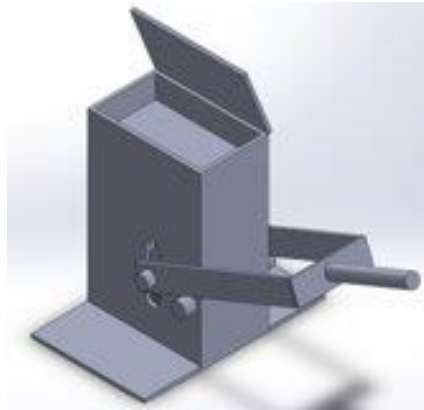


Figure 10. Astram Block Press Design

Figure 11 was named the “floor pump crank” design because of its similarities to a bicycle floor pump. This press uses an eccentric attached to a rotating crank to compress the soil. The crank is able to be lifted in a slot in order to extract the block. The procedure is as follows: The soil mixture is loaded into the block carriage and the lid is latched shut (latch not shown in figure). The eccentric’s lowest point should be in contact with the base plate/eccentric interface initially. The crank is then rotated 360 degrees in either direction which causes the base plate to rise, guided by the base plate guides, pressing the soil mixture into the underside of the lid. The block is now compressed. The lid is unlatched and opened at this point. To extract the block, the crank extensions are lifted, and the crank slides up the slot, lifting the base plate and block to the top of the block carriage. The block is now exposed and can be carefully removed.

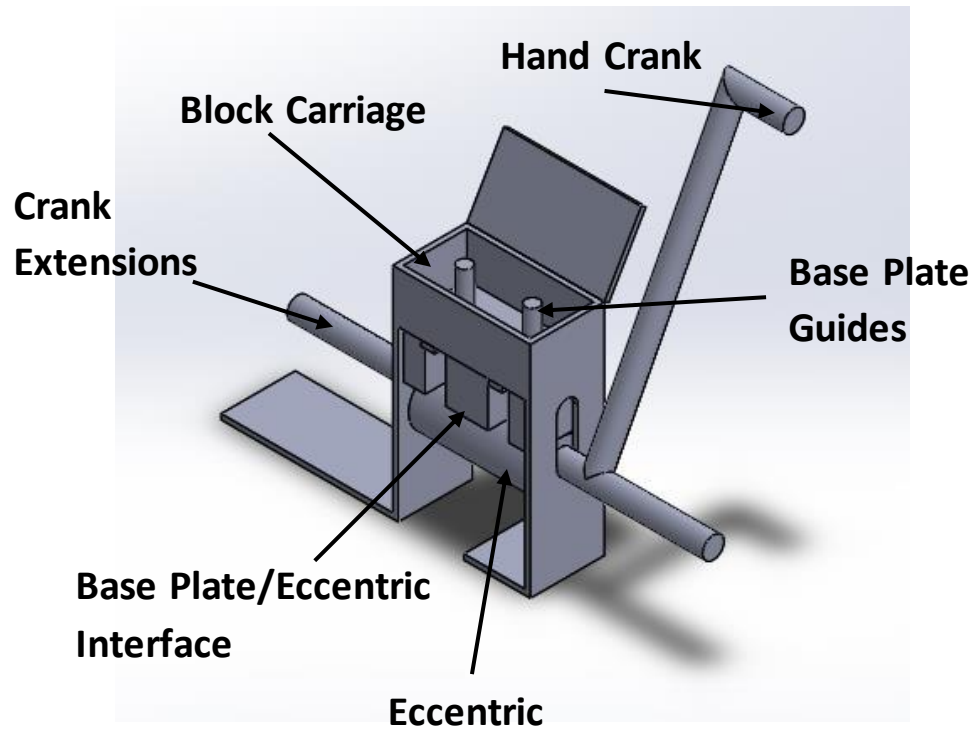


Figure 11. Floor Pump Crank Press (FPCP)

Figure 12 shows the internal components of the design. The Floor Pump Crank Press (FPCP) should be mounted to the corner of a table for ease of use. This is a limiting factor of this design, as it cannot be used on a floor or the middle of a table. This is because the lever arm is longer than the legs of the press, and the crank must be turned a full rotation. This could be solved by making the legs longer, but this would also necessitate larger feet in order to reduce the possibility of tipping. This design was at one point considered to be the final design, but the largest flaw with this design is that it will be a very poor design if up-scaled to full size because of the extraction method. Anything larger than a  $\frac{1}{4}$  scale block press necessitates mechanical advantage to extract the block. The floor pump crank press does not implement a lever for block extraction, making it an unrealistic design to up-scale. Therefore, another design was developed.

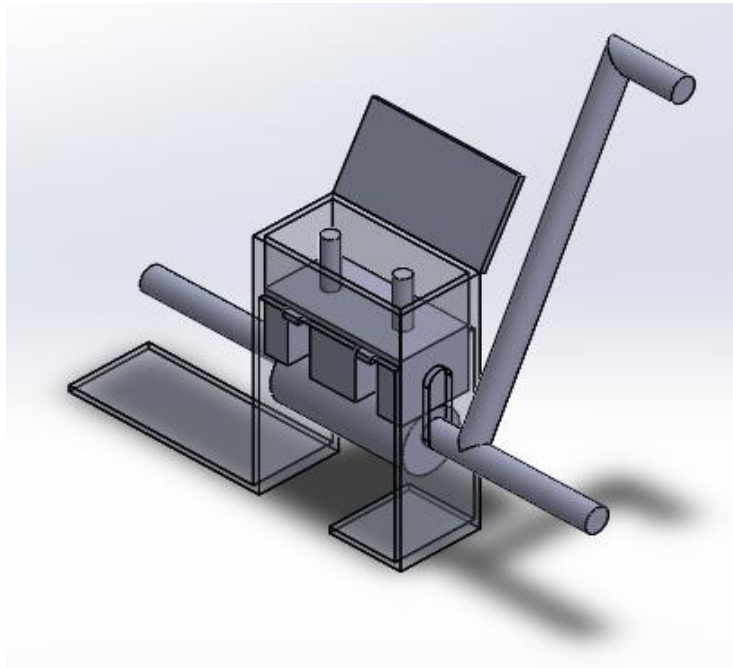


Figure 12. FPCP Internal Components

A similar concept to the floor pump crank press is the eccentric crank shaft press and big eccentric extraction method shown in Figure 13. This unconventional press and extraction technique involves a crank (rather than a lever) to apply enough force to both press and extract the block in one crank rotation. The process is as follows: The soil mixture is loaded into the block carriage and the lid is latched shut (latch not shown in figure). The hand crank is rotated clockwise, causing the press eccentric to contact the base plate/eccentric interface, thus lifting the base plate and pressing the soil between the lid and the base plate (base plate is located inside the block carriage and is the surface that the block sits on). At this point, the crank has been rotated 180 degrees, and the block has been fully compressed. The lid is unlatched and lifted. The crank continues its rotation clockwise, causing the big extraction eccentric to contact the base plate/eccentric interface. The small press eccentrics lose contact with the base plate/eccentric interface, and the extraction eccentric presses the base plate upward until it is flush with the top of the block carriage. The earth block should now be exposed to the air on five of its sides (excluding the bottom) and can be easily removed.

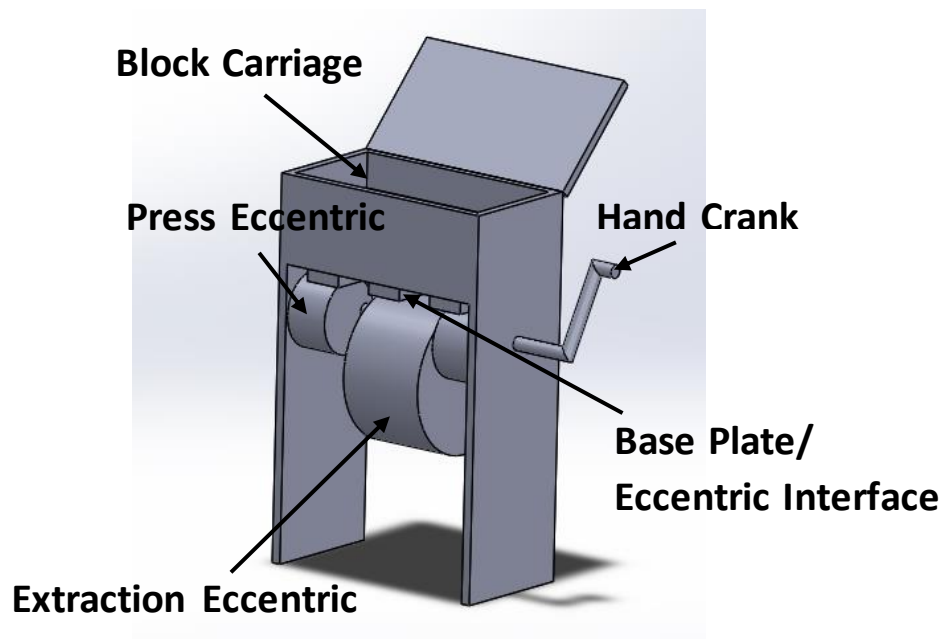


Figure 13. Eccentric Crank Shaft Press and Big Eccentric Extraction

This design was initially eliminated because calculations determined that the extraction eccentric would have to be too large to be feasible, but it was determined that these calculations were incorrect. After meeting with the sponsor and other discussions, it was determined that it would be preferable that the compression and extraction are done in separate motions. In addition, the interfaces and the eccentrics would have a lot of friction between them. Finally, it was decided that it was preferable to have the compression and extraction occur along one single cam profile rather than two separate eccentrics. Solutions to these problems resulted in the final design, which is detailed below.



Figure 14 shows a concept known as the cam crank. This method of compression and extraction implements ideas from the eccentric crank shaft press and big eccentric extraction of Figure 13 and from the FPCP of Figure 11. The procedure is as follows: While the base plate is located at its lowest point, the soil is added in the block carriage. The lid is closed and latched. The crank is then rotated 110 degrees counterclockwise until the lever tip contacts the working surface. This action compresses the soil as the wheels on the base plate are lifted by the cam profile. The lever is brought back to the center to relieve the lid of excess pressure. The lid can then be unlatched. The block surface is now exposed to the air, and the lever can be rotated 110 degrees clockwise. The larger end of the cam profile presses upward on the base plate wheels, and the block is lifted out of the block carriage. This design also incorporates a hinge and a latch, which had not been designed for any of the previous designs.

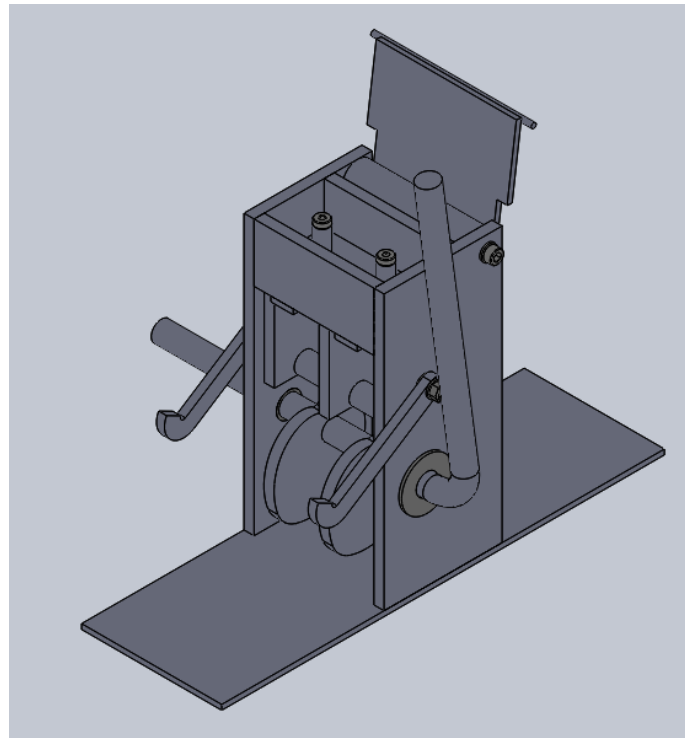


Figure 14. Cam Crank Press

#### 4.2 Design Selection

Pugh matrices were one of the methods used to determine the best design. As shown below, five press techniques and four extraction techniques were evaluated using this method. These diagrams bore out that the cam crank shaft was the best method for compression and extraction. As can be seen below, the eccentric crank shaft press technique was a close second behind the cam shaft crank. These two designs are very similar; however, the cam exceeds in productivity as the crank must not be rotated a full 360 degrees to press while the eccentric must. Because of this disadvantage in the eccentric crank design, it will not be able to be easily up-scaled to a full-scale press; the crank lever pivot must be located at a sufficient height to leave room for a 360 degree rotation of the lever. In addition to Pugh diagrams, concept models were used to decide among the designs. CVBT was also contacted to help evaluate the options. Through these evaluation methods, the cam crank shaft method was the chosen design.

Table 2. Pugh Matrix for Compression Technique

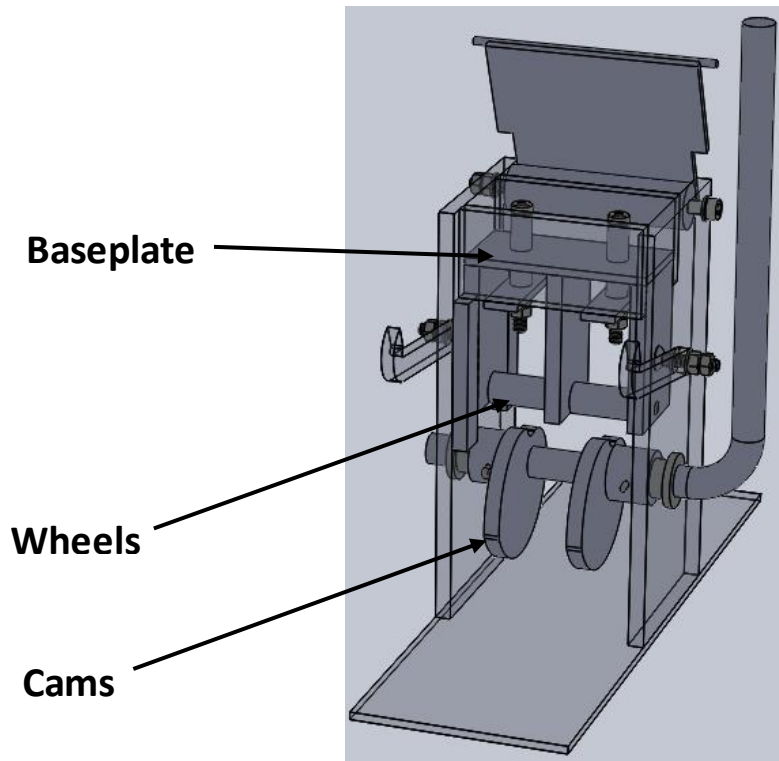
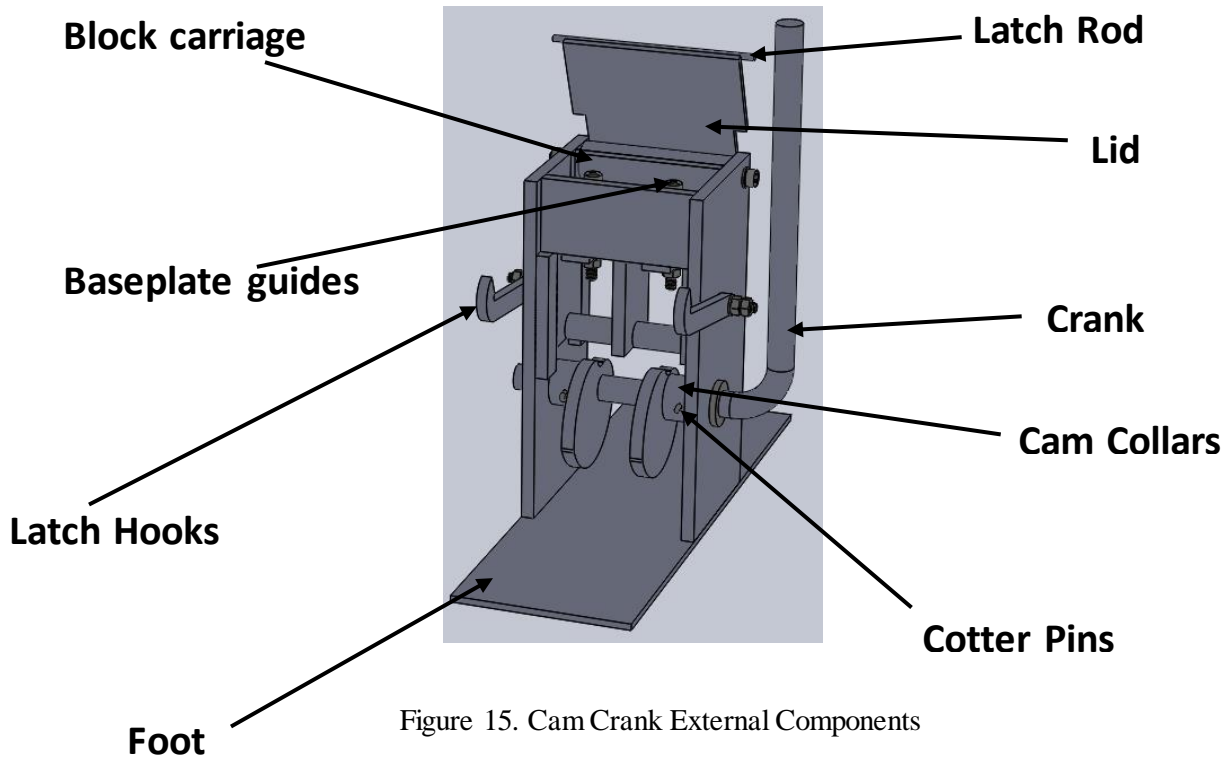
Requirements	Baseline (BP10)	Weight	Press Technique					
			Eccentric Crank Shaft	Traditional Press	Hand Press	Foot Pedal	Cam Crank Shaft	One Directional Rotation
Durable	0	5	1	0	1	-1	1	0
Easy to Manufacture	0	3	1	0	1	-1	-1	0
Easy to use	0	4	0	0	1	1	1	1
Safe	0	3	1	0	-1	-1	1	1
2000 Baht	0	2	1	0	1	0	1	0
Productivity	0	3	0	0	-1	1	1	0
Up-Scale Potential	0	3	0	0	-1	0	1	1
Bamboo	0	1	0	0	0	0	0	0
		<b>Totals</b>	13	0	5	-4	17	10

Table 3. Pugh Matrix for Extraction Technique

Requirements	Baseline (BP10)	Weight	Extraction Technique			
			Big Eccentric	Sliding Crank	Cam Crank Shaft	Lever and Pivot
Durable	0	5	1	0	1	0
Easy to Manufacture	0	3	0	1	-1	0
Easy to use	0	4	-1	1	1	0
Safe	0	3	0	1	1	0
2000 Baht	0	2	0	1	1	0
Productivity	0	3	1	0	1	0
Up-Scale Potential	0	3	0	-1	0	0
Bamboo	0	1	0	0	0	0
		<b>Totals</b>	4	9	14	0

## 5.0 Final Design

Through extensive research, redesign, and discussion with the sponsor, the cam crank block press design was chosen as the final design as it best satisfies the customer requirements. Figures 15 and 16 detail the external and internal components of this design. By reducing the amount of moving parts and fasteners, this redesign achieves simplicity and durability. In addition to reducing part costs due to having fewer parts, design simplification also makes manufacturing, assembly, and disassembly easier, which reduces labor costs. Thus, the total product cost is reduced in both categories. All parts can be manufactured and assembled in-house (besides fasteners) which is a necessary design consideration as these presses will be produced in Thailand where access to specialized stock parts is limited. Also, unlike many of the other considered press designs, the cam crank press design has the potential to be up-scaled to a full-scale press. One reason is that the lever arm does not need to rotate 360 degrees, meaning that the lever does not need to hang off the edge of a table. Because a full-scale press would necessitate a lever length of at least 4 ft, it is important that the lever pivot point is located low enough so that the operator can always reach the end of the lever. This means that a lever that must rotate 360 degrees to complete a press cycle must also hang off the edge of a table to function thus raising the lever pivot point and making it very difficult to operate. The cam crank press design solves this problem by rotating a total of 220 degrees. Another unique aspect of this press design is the mechanism of attachment between the cam subassemblies and the crankshaft; cotter pins slide through the cam collar and crankshaft holes to fasten them together. This feature not only allows for simple assembly and disassembly for part replacement and repair but also acts as a fail-safe in the case of force overload. In other words, the cotter pins will shear off long before any of the other components will even bend. See Appendix 4 for a detailed description of how to use the cam crank block press design.



## 6.0 Manufacturing Plan

Because the CVBT Thailand workshop does not have easy access to purchasing stock parts (besides fasteners), all parts must be manufactured and assembled in-house. The Blockheads' techniques for manufacture and assembly may differ from those of CVBT Thailand; however, the press is designed and toleranced in such a way that allows for a wide range of tools to be used to complete the design. The Blockheads' manufacturing and assembly plans are outlined below. See Appendix 6 for parts reference.

### 6.1 Procurement

Most of the steel plate and steel rod will be purchased from Online Metals due to its cheaper cost compared to other steel-supplying companies. It should be noted that for ease of manufacturing in Thailand, the rods will be kept at their standard diameter; no turning is necessary. As a result, one rod will be purchased from McMaster-Carr. This is because even though rods bought from McMaster-Carr are more expensive than Online Metals, McMaster-Carr sells the desired diameter rod where Online Metals does not. In addition, all fasteners will be bought from McMaster-Carr because of its diverse assortment of fasteners. The total cost will be around \$63. For a full breakdown of the costs, see Appendix 6.

### 6.2 Manufacturing

#### 1. Side Walls\*

- a. Cut from 6.35mm plate to a tolerance of at most 2mm using bandsaw

Equipment: vertical bandsaw

#### 2. End Walls\*

- a. Cut from 6.35mm plate to a tolerance of at most 2mm using bandsaw
- b. Drill holes for lid hinge and cam shaft using drill press
- c. Drill countersink hole for dowel bolt

Equipment: vertical bandsaw, drill press

#### 3. Baseplate Guide Connection Pieces\*

- a. Cut from 3.175mm plate to a tolerance of at most 2mm using bandsaw
- b. Drill hole for baseplate guide using drill press

Equipment: vertical bandsaw, drill press

#### 4. Base Plate Extrusions\*

- a. Cut from 6.35mm plate to a tolerance of at most 2mm using bandsaw
- b. Drill hole for dowel using drill press

Equipment: vertical bandsaw, drill press

#### 5. Baseplate Guides

- a. Machine out 5.5mm hole from 12.7mm rod using lathe
- b. Turn rod diameter down to 8.5mm with a tolerance of at most 1mm using lathe
- c. Part a length of 30mm with a tolerance of at most 2mm using lathe

Equipment: lathe

#### 6. Lid\*

- a. Cut from 3.175mm plate to a tolerance of at most 2mm using bandsaw

Equipment: vertical bandsaw

### 7. Hinge

- a. Machine out 5.5mm hole from 22mm rod using lathe
- b. Turn rod diameter down to 19mm with a tolerance of at most 1mm using lathe
- c. Part a length of 75mm with a tolerance of at most 2mm using lathe

Equipment: lathe

### 8. Base Plate\*

- a. Cut plate from 3.175mm plate to a tolerance of at most 2mm using bandsaw
- b. Drill holes for baseplate guides using drill press

Equipment: bandsaw, drill press

### 9. Cam\*

- a. Tape full scale picture to 6.35mm plate
- b. Cut as close as possible to nominal dimensions using vertical bandsaw
- c. Clamp the two cams together using vise grips
- d. File or grind the excess metal to achieve the desired profile (it is important that both cams have the same exact profile)
- e. Drill hole for cam shaft using drill press
- f. More filing of cam profile may be necessary after full assembly and testing

Equipment: vertical bandsaw, file, drill press, grinding wheel

### 10. Camshaft

- a. Bend 12.7mm rod by placing it in a vice, heating a small section with oxyacetylene torch, and bending the rod by pushing the end of the rod until the bend is 90 degrees
- b. Cut off remaining length using chop saw
- c. Drill cottar pin holes perpendicular to the bend using drill press

Equipment: oxyacetylene torch, chop saw, drill press

### 11. Wheels

- a. Machine out a 5.5mm hole from 12.7mm rod using lathe
- b. Part a length of 27.9mm with a tolerance of at most 2mm using lathe

Equipment: lathe

### 12. Collars

- a. File surface where small hole will be drilled until flat
- b. Drill cottar pin holes using drill press
- c. Machine out a 12.7mm hole from 22mm rod using a lathe
- d. Part a length of 17mm with a tolerance of at most 2mm using a lathe

Equipment: file, drill press, lathe

### 13. Latch Hooks\*

- a. Drill bottom hole for latch bolt and top hole for lid-latch connection rod with drill press (the distance between these holes is the most important dimension)
- b. Tape full scale picture to 6.35mm plate

- c. Cut as close as possible to nominal dimensions using vertical bandsaw
- d. File or grind the excess metal to achieve the desired profile
- e. More filing may be necessary after full assembly is complete

Equipment: vertical bandsaw, drill press, file, grinding wheel

#### 14. Foot

- a. Cut from 3.175mm plate using a chop saw

Equipment: Chop Saw

\*A second option is to get a close cut using an angle grinder with a cutting wheel and then grind off the excess material on the grinding wheel for precision

### 6.3 Assembly

#### I. Subassemblies

##### 1. Body Subassembly

- a. Place side walls and end walls up against the wood block fixture
- b. Insert wood wedge until both side walls are firmly pressed against the wood block
- c. Use a single clamp to firmly press end walls into the end faces of the wood block
- d. Use MIG welder to tack all walls in place
- e. Place baseplate guide connection pieces in wood block grooves and MIG weld tack them in place
- f. Remove the tacked body from the wooden fixture
- g. Complete the body by MIG welding all tacked exterior t-joints and butt joints (no welds inside of the block carriage)
- h. MIG weld the foot to the base of the end walls

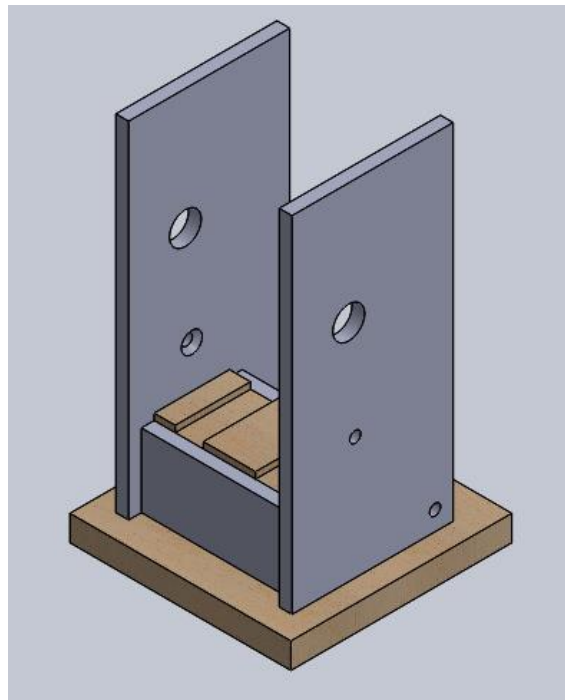


Figure 17. Side and End Walls Placed Against Wood Block

**2. Baseplate Subassembly**

- a. Clamp base plate extrusions to the baseplate
- b. MIG weld all t-joints

**3. Lid Subassembly**

- a. Clamp hinge to lid so that the faced side of the cylinder is coincident with the lid surface
- b. Clamp lid-latch connection rod to the top of the lid
- c. MIG weld hinge and lid-latch connection rod to lid

**4. Cam Subassembly**

- a. To orient cams, slide the two cams and collars onto the cam shaft and insert cottar pins through pin holes in collars and pin holes in shaft
- b. Rotate cams to the correct orientation making sure that they are matched with each other
- c. Using vise grips, clamp collars to cams
- d. Remove cottar pins and MIG weld collars to cams

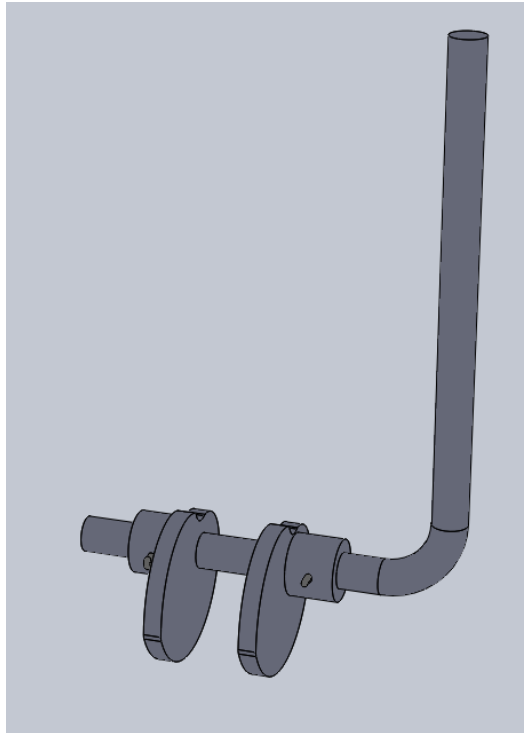


Figure 18. Dimetric Cam Subassembly Setup for Welding

## II. Full Assembly

### 1. Cam Shaft to Body

- a. Insert bushings into the shaft holes in the end walls of the body
- b. Insert cam shaft into cam shaft hole in end wall and the two cams (welded to the collars) in line with the cam shaft holes so that the cams can be slid onto the cam shaft
- c. The cam shaft should exit out the opposite end wall cam shaft hole
- d. Align the cottar pin holes in the collars with the pin holes in the cam shaft as pictured in Figure 18. Insert cottar pins.
- e. It is crucial that this assembly is done first

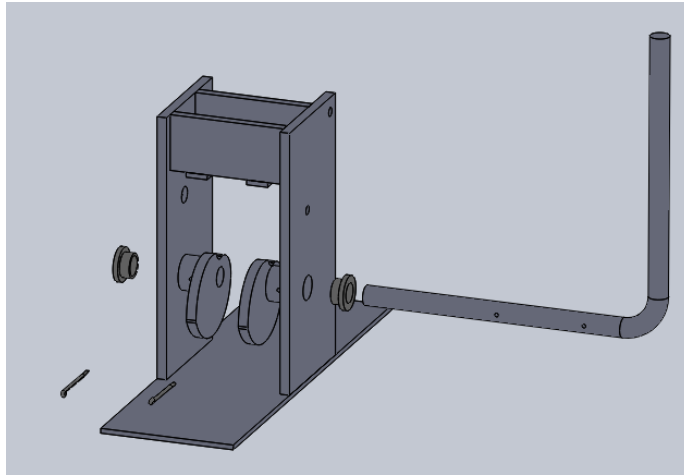


Figure 19. Dimetric Assembly of Cam Shaft and Body



## 2. Baseplate to Body

- a. Slide baseplate into block carriage of the body
- b. Align dowel holes in base plate extrusions with dowel holes in the end walls
- c. Hold wheel in line with dowel holes and insert dowel through dowel holes and both wheels in their respective locations
- d. When the dowel is fully inserted, the baseplate should be free to drop in the block carriage
- e. It is crucial that this assembly is done second

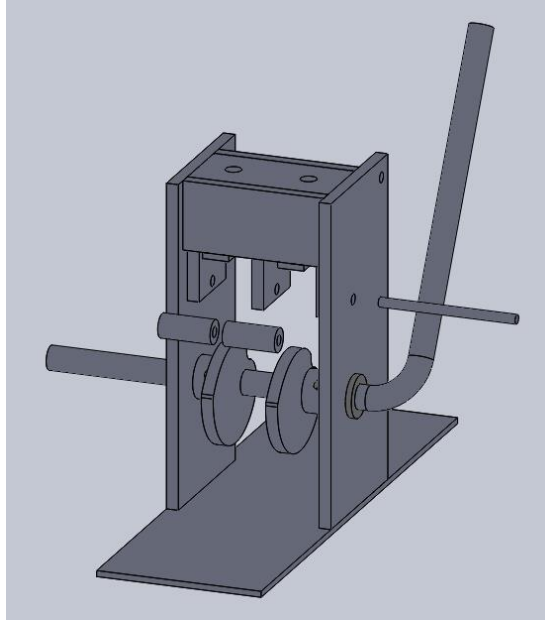


Figure 20. Dimetric Assembly of Baseplate and Body

## 3. Latch Hooks to Body

- a. Align latch hook holes and M5 washers with dowel holes in end walls
- b. Insert M5 x 0.8 x 20mm flat hex bolts from inside end walls to outside with heads in countersunk holes
- f. Add M5 washers and M5 x 0.8mm opposing nuts making sure to leave bolts loose enough to be able to rotate the latch hooks
- g. It is crucial that this step is done third

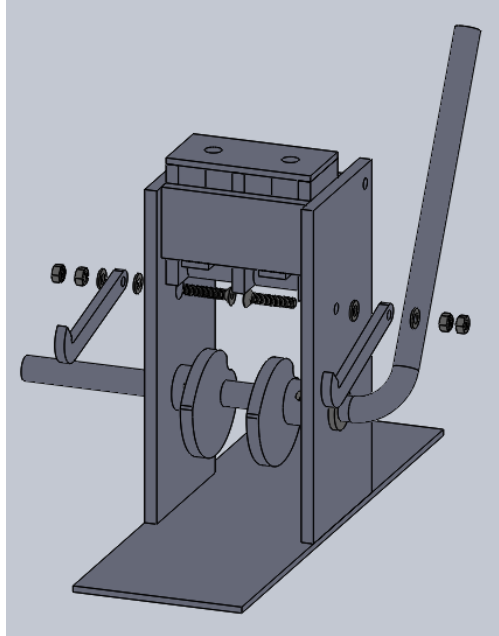


Figure 21. Dimetric Assembly of Latch Hooks and Body

#### 4. Baseplate Guides to Body

- a. Slide baseplate guides onto M5 x 0.80 x 50mm hex bolt and insert bolts through holes in baseplate guide connection pieces
- b. Slide M5 washers onto the end of the bolts and tighten on M5 x 0.8mm opposing nuts
- c. Nuts should not be tightened all the way to allow baseplate guides to have a bit of play

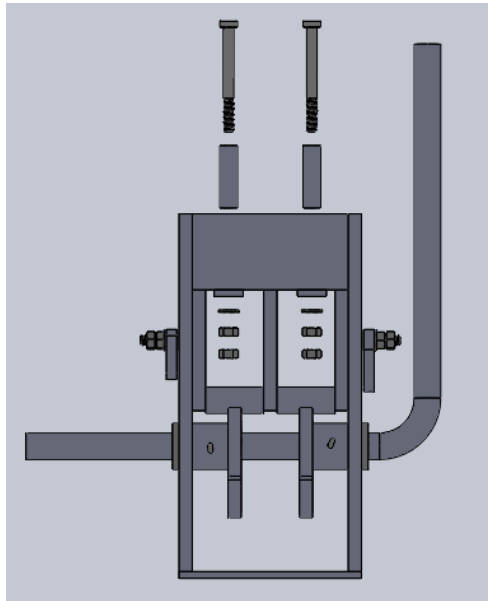


Figure 22. Front View Assembly of Baseplate Guides and Body

#### 5. Lid Hinge to Body

- a. Place lid subassembly flat on top of the body covering the block carriage so that the hinge connected to the lid aligns with the hinge holes on the end walls
- b. Insert M5 x 0.80 x 95mm hex bolt making sure there is a M5 washer on both end walls
- c. Tighten on M5 x 0.8mm opposing nuts

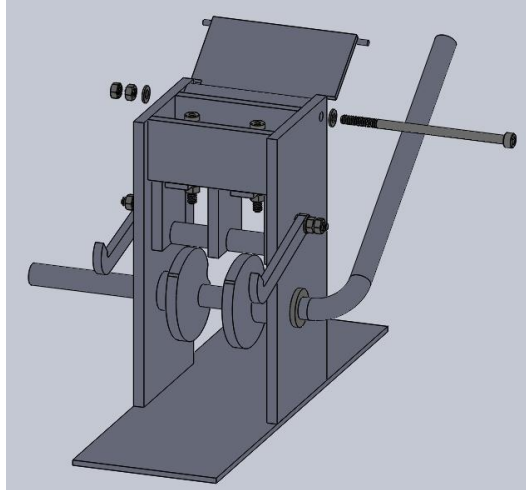


Figure 23. Dimetric Assembly of Lid and Body

#### 6. Baseplate Extrusion Guides to Body

- a. Because of accumulated tolerance error the baseplate may have a slide issue with binding in the block carriage. The baseplate subassembly should not wiggle from front to back in the carriage. For this reason, baseplate extrusion guides are added.
- b. Clamp on guides using vise grips and slide baseplate up and down to ensure that the guides (in their current locations) have fixed the binding issue (baseplate assembly should not wiggle from front to back when pressing and pulling on baseplate extrusion from the front of the press). Adjust guide positions until the issue is fixed.
- c. MIG weld guides to body in current positions
- d. If press still does not press or extract correctly, make sure that this is not due to rough cam edges or incorrect cam profiles. If this is the problem, file or grind cams until the press functions correctly.

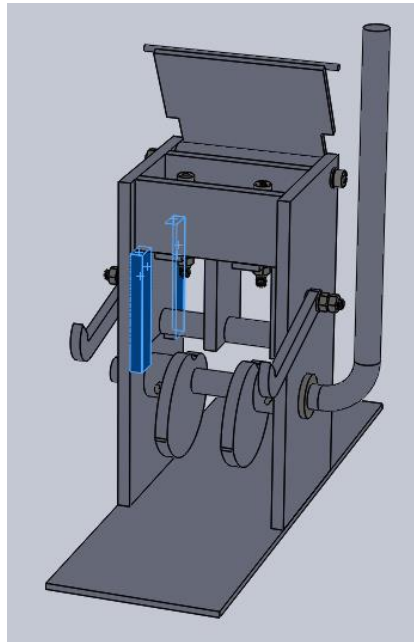


Figure 24. Dimetric Full Assembly with Baseplate Extrusion Guides (Highlighted)

## 6.4 Safety

The block press has inherent safety hazards such as pinch points and unsafe use. Corrective actions have been taken to eliminate or mitigate the chance for injury. Refer to Appendix 5 for a list of potential hazards and the precautions taken to limit them.

## 6.5 Maintenance

The block press has three moving components: the baseplate, the camshaft, and the lid hinge. As a result, these three components have the highest chance of failure. To reduce the likelihood of failure occurring due to friction, lubrication will be applied to the inside walls of the block carriage and the lid hinge every 10 cycles. For the camshaft, because it rotates within the bushings located on both end walls, the bushings will be regularly greased with bearing grease. This will reduce possible damage done to either the bushings or the camshaft. Washers have been placed on all bolts to prevent damage to the bolt heads and press's body. The washers will eventually wear out due to friction, but the washers can easily be replaced as the subassemblies in which the washers are located can be disassembled.

## 6.6 Repair

The entire assembly can be easily disassembled, and each subassembly can be independently repaired or replaced. This can be performed as follows:

1. Lid
  - Remove nuts and bolt
  - Repair or replace fasteners or lid subassembly
2. Baseplate
  - Remove baseplate guides
  - Remove latch hooks
  - Lift baseplate until wheel axle aligns with the latch hook holes
  - Extract dowel by tapping a drift punch through latch hook hole thus pushing wheel dowel out the opposite side
  - Lift baseplate out of carriage
  - Replace or repair baseplate, wheels, or dowel as needed
3. Crankshaft/ Cams
  - Remove both cotter pins
  - Slide cam subassemblies off crankshaft while pulling crankshaft from bushings
  - Replace or repair crankshaft, cam subassemblies, or cotter pins

## 7.0 Design Verification

\*See Test Plan in Appendix 9 for descriptions of component testing.

### 7.1 Test Results

To assess the functionality and durability of the block press, four tests were done:

The first test was designed to find the optimal soil mixture for pressing a brick. Different soil mixtures were made by varying the amounts of sand, clay powder, and water. About 2 or 3 bricks were pressed for every soil mixture. After each brick was pressed, they were dropped from about 4 feet off the ground and their remains were inspected. It was concluded that the most durable and easy to press soil mixture would break into about 6 to 8 chunks when dropped. This mixture consisted of 63% sand, 10.5% water, and 26.5% clay. The second test found any weak components in the block press by subjecting the press to the largest potential force that it will ever experience in normal use. This was done by overloading the carriage with soil (firmly pressing soil into carriage to the top) and forcing the crank arm all the way to the work surface. When this was done, one of the cotter pins sheared out of the cam collar. The cotter pins are by far the

weakest components in the block press, so it was decided that the cotter pins and cotter pin holes diameters should be slightly increased. A positive of the weak cotter pins is that they will always break before any of the other components do. This will save time and money as the cotter pins are very cheap and easy to replace.

The third test evaluated the durability of the components and welds of the press. For this test, the block press was dropped from four feet above the work surface, then inspected for damages. This test was repeated three times. The only damages were on the corners of the press, which were slightly dented. No welds or other components were damaged during the drops, so it was determined that the press's integrity would not be at risk if it was dropped.

The last test determined the number of cycles that could be done before the press needed to be re-lubed. To perform this test, the carriage walls were lubricated with WD40 and the press was used to press and extract multiple bricks until either the compression or extraction process became too difficult to perform. This process was repeated three times, and the average number of cycles before re-lubrication was 10 cycles.

## 7.2 Design Changes

Based on the results of the Test Plan, the following changes have been proposed to improve the functionality and reliability of the block press:

1. The diameters of the cotter pin and cotter pin holes in the collars and crankshaft should be increased from 3/32" to 1/8". This is to decrease the chance of the cotter pins shearing off in the event of overloading the carriage.
2. Rubber end caps should be placed on both ends of the lid-latch connection rod. This is because when extracting the block, the user's hand can scrape against the end of the rod, which can cause injury.

## 8.0 Project Management

Listed below is a chronological map of how the Blockheads will go about designing and producing their product. As can be seen, the process involves repetitive testing and continuous iteration of design.

- Define Problem
- Background Research
  - Interview users
  - Use BP6 and BP10 on Cal Poly campus
  - Research preexisting designs
- Present Probable Solutions
  - Brainstorm
  - Pugh Diagram
  - Project Direction Selection
  - Concept Model
  - Structural Prototype
- Test Structural Prototype
  - If design fails to solve the problem:
    - Background research and present more solutions
  - If design succeeds:
    - Test again to see if new problems arise
      - If design causes more problems:
        - More research and solutions
      - If design succeeds:

- Implement solutions
- Go into Production
  - Test final product
    - Research and provide solutions to issues that arise
- Final Tests
- Present Final Product

## 8.1 Timeline

Table 4. Important Checkpoints and Dates

Key Deliverables	
Deliverable	Due Date
Preliminary Design Review	March 8
Interim Design Review	April 11
Critical Design Review	May 3
All Parts Ordered*	May 16
Manufacturing and Test Review Poster	May 31
Confirmation Prototype	October 22
Final Design Review (Expo)	November 22

## 9.0 Conclusion

The CVBT BP9 compressed earth block press is due for a redesign; there is too much friction when used, it has several weak points due to users unintentionally applying excessive force, and it is too expensive to manufacture. The Blockheads were able to successfully complete said redesign converting the old lever-piston design into a cam-crank design. This design has less moving parts resulting in less friction and more intuitive operation. In addition, the use of thicker materials ensures that critical components are not weak points. Finally, because the design changes resulted in using simpler components, the desired press cost of \$62 was nearly met. However, with a cheaper materials provider and purchasing in bulk, the Blockhead's final press cost of \$63 can be further reduced. It should be noted that this final cost does not include labor costs. The Blockhead's were unfortunately unable to achieve all of the customer specifications due to a completely new design direction. The new press design does not yet have the capability of creating half or channel bricks. In addition, the one obvious weak point is the cotter pins. These can shear off if the user applies too much force due to excess material in the block carriage. However, it is preferable that these components should break as they are much cheaper and easier to replace than other critical components.

### 9.1 Next Steps

Because this design is unique, it provides CVBT Thailand with a new design direction to explore. One important improvement that should be made is that the cotter pin and cotter pin hole diameters should be increased as to improve its resistance to shearing. However, the diameter will remain small enough that these components will still act as fail-safes. Also, all threaded fasteners can be replaced with cotter pin bolts. Finally, the press was not designed to create half and channel bricks; these brick options can be easily implemented. Once these improvements are added, the design can be scaled up and tested to determine the viability of the design at full scale.

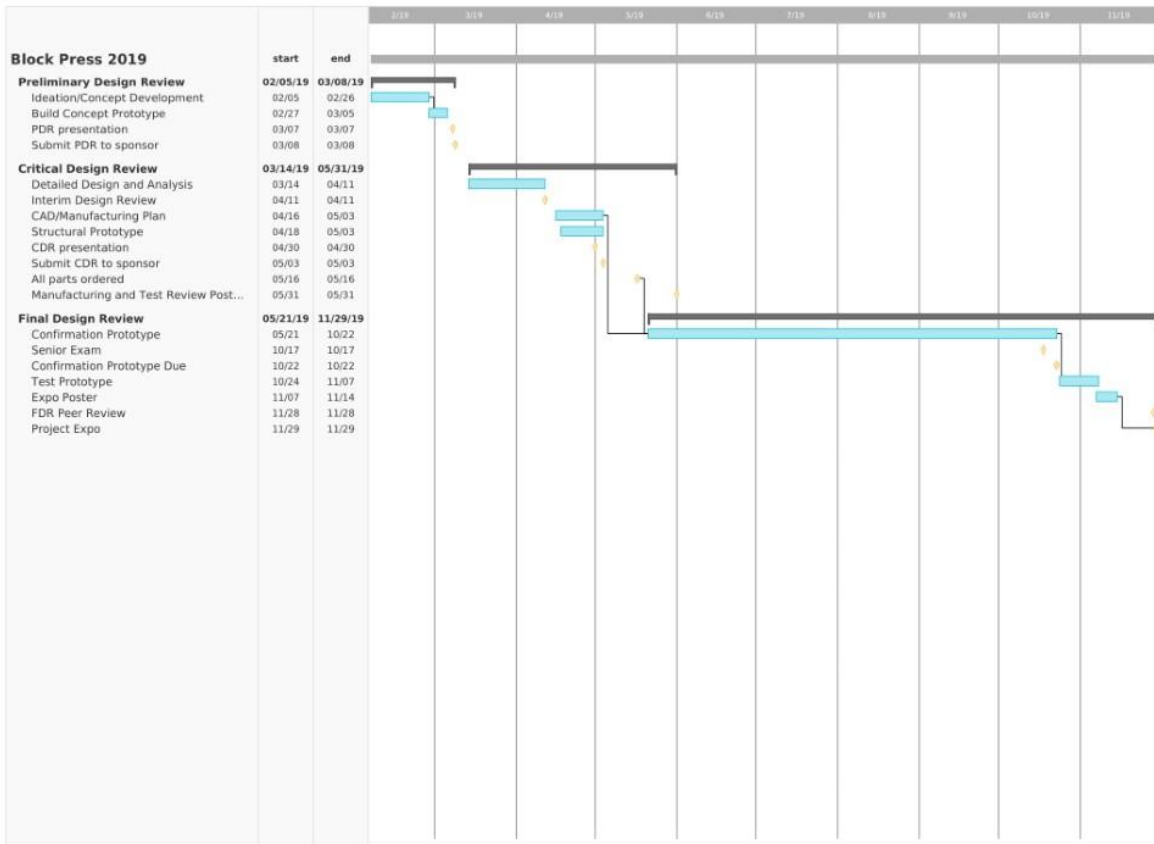
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## Appendix 2. Project Gantt Chart



## Appendix 3. Preliminary Force Calculations

① Compressing lever can be modeled as ②

③ The crankshaft-eccentric assembly can be modeled as ④

From the side, ③ looks like:

⑤ Simplifying the calculation by postulating ⑤ to be completely horizontal, it becomes →

⑤

⑥

$F_e$  ↓  $R_y$  ↑  $F_{user}$  ↓

20mm 180mm

$\sum M = 0 \quad (20\text{mm})(F_e) - (180\text{mm})F_{user} = 0$

$F_{user} = \frac{20\text{mm}}{180\text{mm}}(F_e) = \frac{283.5\text{N}}{9}$

$F_{user} = 31.5\text{N}$   
= 7.1 lbf

①  $L_1 = 28.25\text{mm}$   $L_2 = 180\text{mm}$   $F_{user}$   $R_x$   $R_y$   $F_e$

$\sum M_b = 0 \quad -L_1 F_e + L_2 F_{user} = 0$

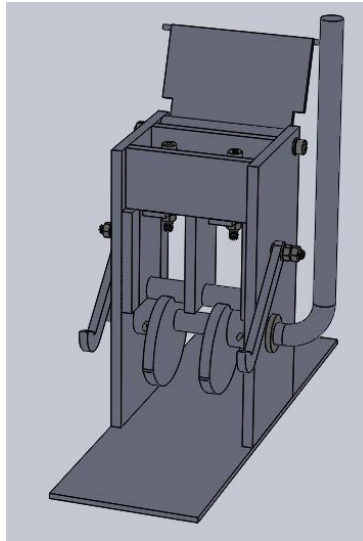
$F_e = \frac{L_2}{L_1} F_{user} = \left(\frac{180\text{mm}}{28.25\text{mm}}\right)(44.5\text{N})$

$F_e = 283.5\text{N}$

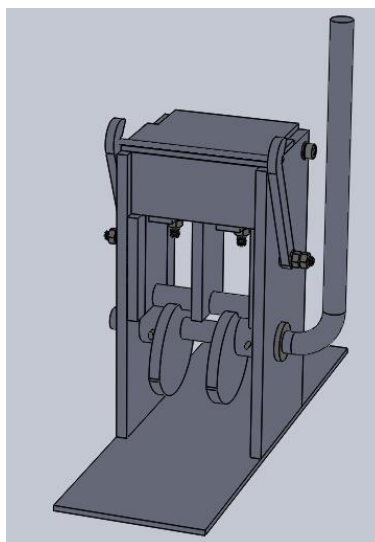
$F_e$  represents the resistive force the lid exerts on the eccentric during compression of the BPIO, and can be used as the same resistive force exerted on the eccentric of the FACP when the crank is rotated.

## Appendix 4. Operation Manual

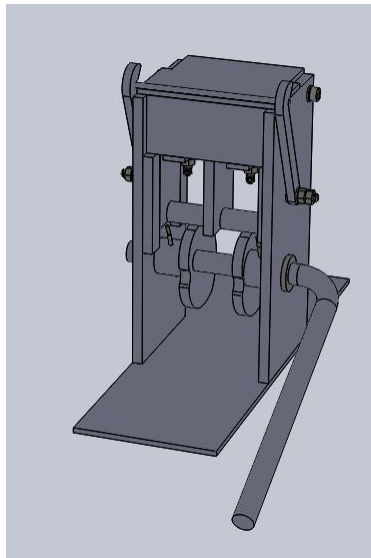
- 1) Unlatch and open the lid.
  - a. Rotate latch hooks off the latch rod so that they hang below their pivot points.
- 2) Ensure the lever is in the vertical starting position.
  - a. The wheels should sit in the notch in the cam profile.
  - b. This is important for maintaining a consistent compression distance to yield consistent blocks.



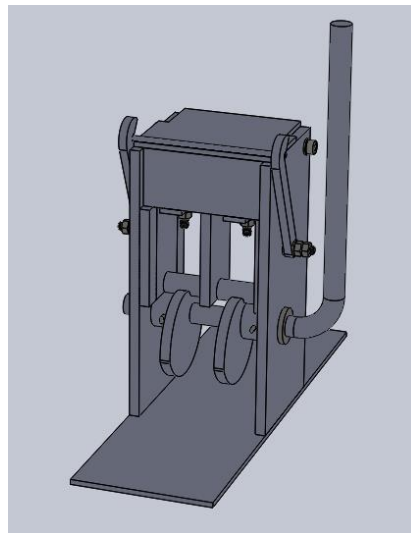
- 3) Load the correct soil mixture into the block carriage.
  - a. Make sure that the top faces of the baseplate guides and the tops of the block carriage walls are not covered in dirt.
- 4) Close and latch the lid.
  - a. Rotate the latch hooks above their pivot points to hook the latch rod.



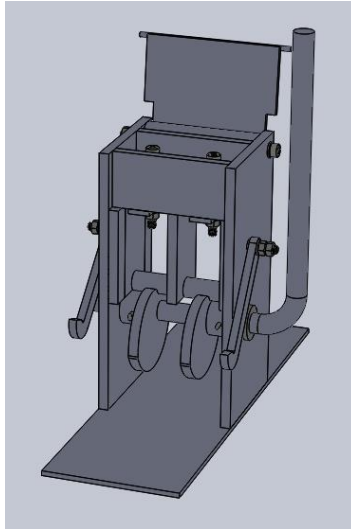
- 5) Press a brick.
- a. Rotate the lever counter clockwise until the tip of the lever reaches the working surface (~110deg).
    - i. The wheels function as the cam-followers as they run along the profile of the cam. As the lever rotates counter-clockwise, the wheels are forced upward thus lifting the baseplate and pressing the soil mixture.



- 6) Return the lever to the vertical starting position.
- a. The wheels will, again, sit in the notches on the cam profiles.
  - b. This relieves pressure on the lid so that the lid can be unlatched.

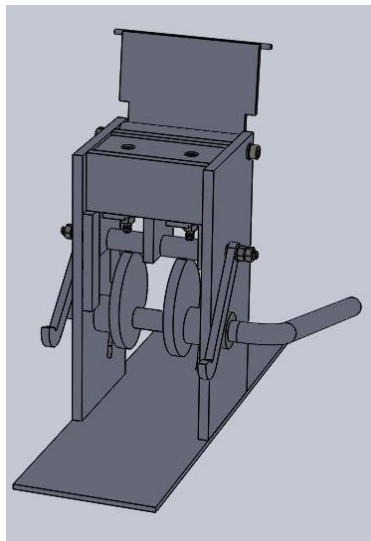


7) Unlatch and open the lid.

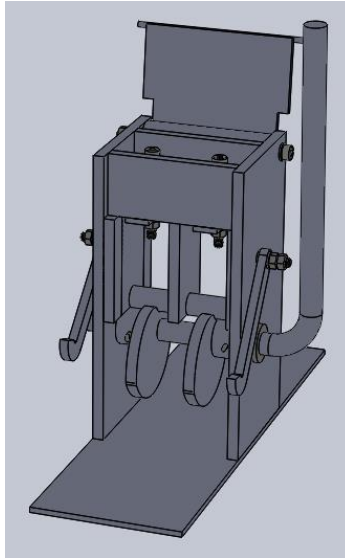


8) Extract the block.

- a. Rotate the lever clockwise until the tip of the lever reaches the working surface (~110deg)
  - i. The base plate will again be lifted. This time the base plate will rise until its surface is flush with the tops of the block carriage walls thus exposing the compressed block to the air on all sides.
- b. The block can be lifted and removed by hand from this position.



- 9) Reset the block press to the starting position.
  - a. Rotate the lever back to the vertical starting position.
  - b. Manually press the base plate down until the wheels firmly contact the cam.



## Appendix 5. Design Hazard Checklist

Y N

- 1. Will the system include hazardous revolving, running, rolling, or mixing actions?
- 2. Will the system include hazardous reciprocating, shearing, punching, pressing, squeezing, drawing, or cutting actions?
- 3. Will any part of the design undergo high accelerations/decelerations?
- 4. Will the system have any large (>5 kg) moving masses or large (>250 N) forces?
- 5. Could the system produce a projectile?
- 6. Could the system fall (due to gravity), creating injury?
- 7. Will a user be exposed to overhanging weights as part of the design?
- 8. Will the system have any burrs, sharp edges, shear points, or pinch points?
- 9. Will any part of the electrical systems not be grounded?
- 10. Will there be any large batteries (over 30 V)?
- 11. Will there be any exposed electrical connections in the system (over 40 V)?
- 12. Will there be any stored energy in the system such as flywheels, hanging weights or pressurized fluids/gases?
- 13. Will there be any explosive or flammable liquids, gases, or small particle fuel as part of the system?
- 14. Will the user be required to exert any abnormal effort or experience any abnormal physical posture during the use of the design?
- 15. Will there be any materials known to be hazardous to humans involved in either the design or its manufacturing?
- 16. Could the system generate high levels (>90 dBA) of noise?
- 17. Will the device/system be exposed to extreme environmental conditions such as fog, humidity, or cold/high temperatures, during normal use?
- 18. Is it possible for the system to be used in an unsafe manner?
- 19. For powered systems, is there an emergency stop button?
- 20. Will there be any other potential hazards not listed above? If yes, please explain on reverse.

Description of Hazard	Planned Corrective Action	Planned Date	Actual Date
Revolving Crank	Safety guard so that no one can put their fingers under the cam during rotation	May 31	
Falling off table	Attach wide feet to reduce risk of toppling. Fasten to table.	May 31	
Pinched by the lid	Tight tolerance on the hinge so the lid is not affected much by gravity.	May 31	
Press and extraction physical exertion	Locate press on edge of table at waist height for most ergonomic positioning.	May 31	
Unsafe use	Create a clear list of directions to use the press.	May 31	



## Appendix 6. Indented Bill of Materials with Cost Analysis

Assembly Level	Part Number	Description				Method of Attainment	Qty	Vendor	Stock Material	Cost/Part	Ttl Cost	Status
		Lvl0	Lvl1	Lvl2	Lvl3							
0	100000	Final Assy										
1	101000	Top Assy										
2	101001	Lid Subassem.										
3	102000			Hinge	in-house	1	Online Metals	22mm dia x 914.4mm lg		3.345	Completed	
3	102001			Lid	in-house	1	Online Metals	80mm x 160mm x 3.175mm		7.56	Completed	
3	102002			Lid-Latch Connection	in-house	1	Online Metals	3.175mm dia x 1m lg	3.19	0.27	Completed	
2	101002	Body Subassem.				in-house	1				Completed	
3	102003			Side walls	in-house	2	Online Metals	305mm x 203mm x 6.35 mm		35.68	Completed	
3	102004			End wall left	in-house	1	Online Metals	305mm x 203mm x 6.35 mm			Completed	
3	102005			End wall right	in-house	1	Online Metals	305mm x 203mm x 6.35 mm			Completed	
3	102006			Foot	in-house	1	Online Metals	80mm x 160mm x 3.175mm			Completed	
3	102007			Baseplate Guide Connect	in-house	2	Online Metals	80mm x 160mm x 3.175mm			Completed	
2	101003	Baseplate Subassem.				in-house	1				Completed	
3	102008			base plate	in-house	1	Online Metals	80mm x 160mm x 3.175mm			Completed	
3	102009			base plate extrusion	in-house	3	Online Metals	305mm x 102mm x 6.35 mm			Completed	
3	102010			Baseplate extrusion guide	in-house	2	Online Metals	80mm x 160mm x 3.175mm			Completed	
2	101004	Cam Subassem.				in-house	2				Completed	
3	102011			cams	in-house	2	Online Metals	305mm x 203mm x 6.35 mm			Completed	
3	102012			collars	in-house	2	Online Metals	22.2mm dia x 914.4mm lg			Completed	
1	101005	M5 x 0.80 x 100mm Hex Bolt				off-shelf	1	McMaster Carr		0.814	0.814	Bought
1	101006	M5 x 0.80 x 50mm Hex Bolt				off-shelf	2	Ace's Hardware		0.95	1.9	Bought
1	101007	M5 x 0.80 x 30mm Flat Hex Bolt				off-shelf	2	Ace's Hardware		1.19	2.38	Bought
1	101008	Oil-Embedded Bushing 1/2"				off-shelf	2	McMaster Carr		2.96	5.92	Bought
1	101009	M5 Washer				off-shelf	8	Ace's Hardware		0.11	0.88	Bought
1	101010	M5 x 0.8mm Hex Nut				off-shelf	10	McMaster Carr		0.0295	2.95	Bought
1	101011	3/32" Hammerlock Cotter Pin				off-shelf	2	Ace's Hardware		0.65	1.3	Bought
1	101012	rebam rod/guides				in-house	2	Online Metals	8mm dia x 280mm lg		1.49	Completed
1	101013	Latch Hooks				in-house	2	Online Metals	80mm x 160mm x 3.175mm			Completed
1	101014	cam shaft				in-house	1	Online Metals	12.7mm dia x 305mm lg		2.87	Completed
1	101015	dowel				in-house	1	McMaster Carr	5mm dia x 305mm lg		1.73	Bought
1	101016	wheels				in-house	2	Online Metals	12.7mm dia x 305mm lg		2.57	Completed
					<b>Ttl Parts</b>	<b>51</b>				<b>Ttl Cost</b>	<b>63.00</b>	



## Appendix 8. DVP&amp;R

Senior Project DVP&R													
Date: 10/25/2019		Team: Blockheads		Sponsor: CVBT Thailand			Description of System: Model Block Press				DVP&R Engineer:		
TEST PLAN										TEST REPORT			
Item No	Specification #	Test Description	Acceptance Criteria	Test Responsibility	Test Stage	SAMPLES		TIMING		TEST RESULTS			NOTES
						Quantity	Type	Start date	Finish date	Test Result	Quantity Pass	Quantity Fail	
1	Crank/ lift base plate	Press and extract at least 20 bricks	completes tasks with smoothly with constant resistance	Chester Wong	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	Press is difficult to operate after 10 cycles
2	Crank/ Ergonomic to use	Press and extract at least 20 bricks	user does not feel discomfort in any part of the body (besides tiredness)	Ben van Hamersveld	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	
3	Crank/ Provide mechanical advantage	Press and extract brick by simply pressing up on baseplate with fingers, then using the crank	using the crank requires much less effort	Alex Giannousis	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	
4	Carriage/ Hold soil without leaking	Press and extract at least 20 bricks	soil must stay in carriage and not leak	Chester Wong	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	
5	Carriage/ Slide smoothly	Press and extract at least 20 bricks	completes tasks with smoothly with constant resistance (minimal binding)	Ben van Hamersveld	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	
6	Lid/ rotates smoothly	Press and extract at least 20 bricks	lid must open and close smoothly everytime without being hindered by soil	Alex Giannousis	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	
7	Lid/ latches tightly	Press and extract at least 20 bricks	lid remains tightly shut every repetition	Chester Wong	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	
8	Support legs/ support press during process	Press and extract at least 20 bricks	legs should never visually bend	Ben van Hamersveld	FP	30	Sub	11/7/2019	11/7/2019	Success	30	0	

## Appendix 9. Test Plan

### Test #1: Block Test

#### Description of Test:

This test is extensive as it entails many soil mixture iterations by way of trial and error in order to determine the strongest soil mixture.

- A. Drop soil/block test: Evaluates the soil mixture's strength and water/clay content
- B. Bend and break block by hand: Another mode of comparing the strengths of different soil mixtures

#### Required Materials:

- Block Press
- Soil Mixture
  - Sand
  - Clay powder
  - Water

#### Testing Protocol:

- A. Drop soil/block test
  - 1. Create unique mixture
  - 2. Drop soil from chest height making sure it breaks into about 5 pieces
  - 3. Load soil mixture into block press and follow press and extraction procedures
  - 4. Let brick dry
  - 5. Drop from chest height and evaluate the break
  - 6. Repeat steps many times comparing results
- B. Bend and break test
  - 1. Use mixture from part (A)
  - 2. Press another block using the block press
  - 3. Let brick dry
  - 4. Break brick in half by hand
  - 5. Observe interior of brick and force necessary to break
  - 6. Repeat steps many times comparing results

Data:

MIXTURE	SAND CONTENT	WATER CONTENT	CLAY CONTENT	DROP OBSERVATIONS	BREAK OBSERVATIONS
1	82%	9%	9%	Shatters completely	Crushes completely
2	79%	9%	12%	mostly broken, some chunks	mostly crusted with some chunks
3	78%	8.5%	13.5%	a few chunks	broke into a few chunks
4	76.5%	8.5%	15%	a few chunks	broke into a few chunks
5	72%	12%	16%	barely broken	broke cleanly
6	67%	11%	22%	breaks easily	breaks too easily
7	65%	11%	24%	breaks into larger chunks	breaks less easily
8	63%	10.5%	26.5%	breaks into larger chunks	broke cleanly
9					
10					

note: these mixtures were made without a sieve, so the proportion of dirt is likely inaccurate.

## Test #2: Excess Force Test

### Description of Test:

These two tests represent the largest potential force that the press can experience in normal use. Critical components include the crank shaft, lid latch, lid hinge, cams, and foot. These components have the highest potential for damage and will be closely monitored.

- A. Excess soil test: The user loads more soil into the press than it is designed for.
- B. Attempt to extract with closed lid: The user turns the crank shaft clockwise while the lid is closed and attempts to muscle the crank to the table's surface.

### Required Materials:

- Block Press
- Soil Mixture

### Testing Protocol:

- A. Excess Soil Test
  1. Load as much soil as can fit in carriage (compressing soil with fingers and adding more soil to fill empty space)
  2. Close and latch the lid
  3. Attempt to compress block by trying to rotate the crank shaft to the table's surface
  4. Inspect components for damage
- B. Attempt to extract with closed lid
  1. Load specified amount of soil in the press
  2. Close and latch lid
  3. Rotate crank shaft clockwise (WRONG WAY) in an attempt to compress the block, bringing the crank shaft as close to the table's surface as physically possible
  4. Inspect components for damage

### Data:

COMPONENT	EXCESS SOIL TEST (PASS/FAIL)	EXTRACTION WITH CLOSED LID (PASS/FAIL)
CRANKSHAFT	Pass	Pass
LID LATCH	Pass	Pass
LID HINGE	Pass	Pass
CAMS	Fail (Cotter Pins)	Fail (Cotter Pins)
FOOT	Pass	Pass

**Test #3: Drop test****Description of Test:**

This test represents the potential of the press to fall off the table it is being used on. The press will be dropped from table height onto a concrete surface. Afterwards it will be inspected for damage, especially weld breaks and parallelism of the walls.

**Required materials:**

- Block press
- Measuring tape or other length measurement
- Concrete surface

**Testing Protocol:**

1. Measure a four-foot height above the concrete surface and hold the block press at that height.
2. Drop the press onto the concrete surface.
3. Inspect the press for weld breaks.
4. Measure parallelism by sliding base plate within block carriage.

**Data:**

WELDS (PASS/FAIL)	PARALLELISM (PASS/FAIL)
Pass	Pass

**Test #4: Lubricant Test****Description of Test:**

This test serves to determine how many cycles the press can complete until more lubricant is needed. Critical components include bushing on crank shaft, block carriage, and lid hinge.

**Required Materials:**

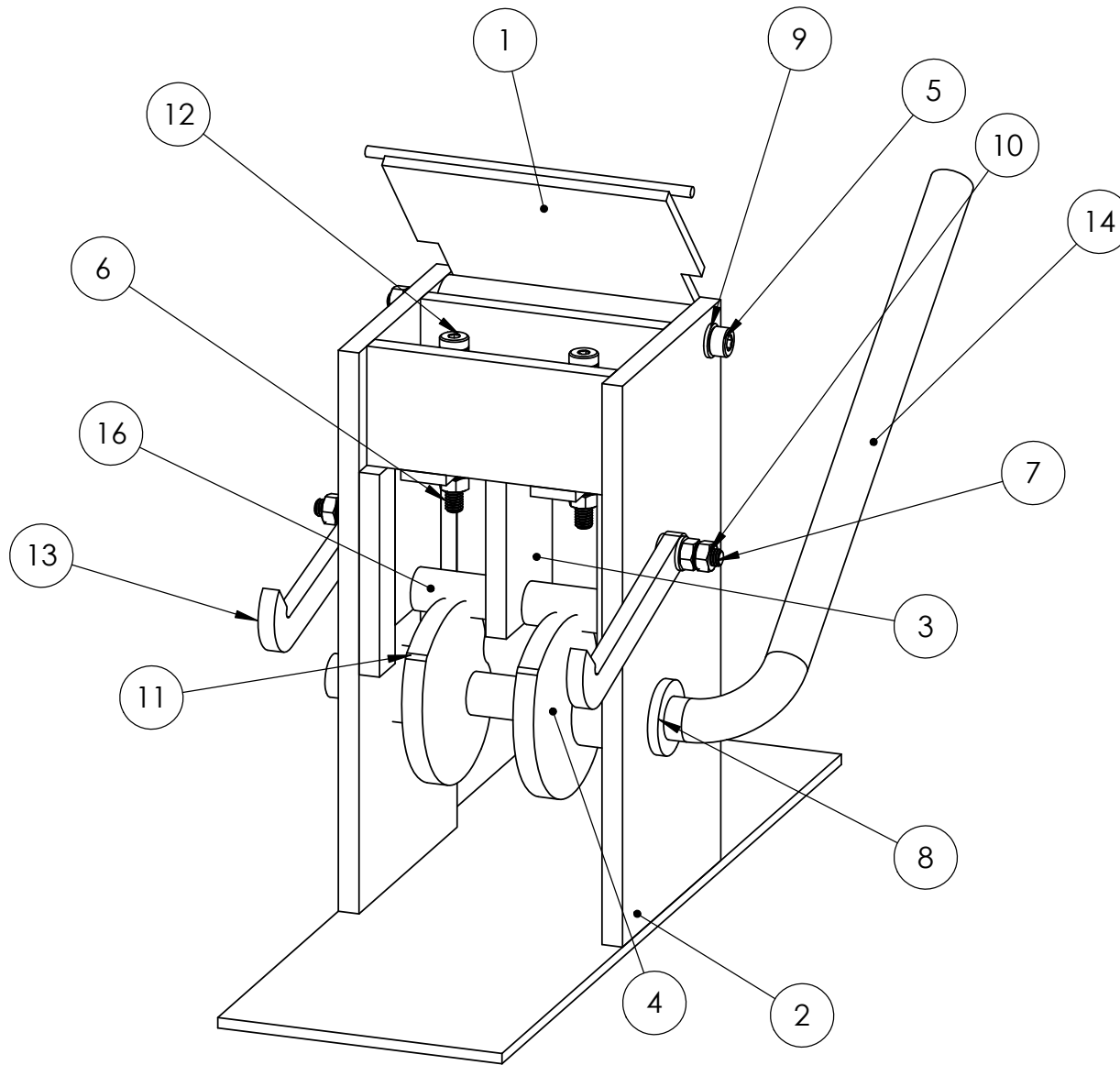
- Block Press
- Soil Mixture
- WD40

**Testing Protocol:**

1. Press as many blocks as possible until the crank shaft becomes very difficult to rotate or the base plate jams itself in the block carriage
2. Apply WD40 and repeat process making sure number of cycles is consistent

**Data:**

TEST NUMBER	NUMBER OF CYCLES
1	11
2	9
3	10



TOLERANCES  
IN MM:  
X     ± 3.0  
X.X   ± 1.0  
X.XX  ± 0.5

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: CRS		Part: BODY SUBASSEM.		Drwn. By: The Blockheads
	Dwg. #: 100000	Date: 11/14/2019	Scale: 1:4		Chkd. By: ME STAFF



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	101001	LID SUBASSEMBLY	1
2	101002	BODY SUBASSEMBLY	1
3	101003	BASEPLATE SUBASSEMBLY	1
4	101004	CAM SUBASSEMBLY	2
5	101005	M5x 0.80x100mm HEX BOLT	1
6	101006	M5x 0.80x50mm HEX BOLT	2
7	101007	M5x 0.80x30mm FLAT HEX BOLT	2
8	101008	Oil-Embedded Bushing 1/2"	2
9	101009	M5 Washer	8
10	101010	M5x 0.80 Nut	10
11	101011	3/32" HAMMERLOCK COTTER PIN	2
12	101012	REBAM ROD/GUIDE	2
13	101013	LATCH HOOKS	2
14	101014	CAM SHAFT	1
15	101016	WHEELS	2

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: CRS

Dwg. #: 100000

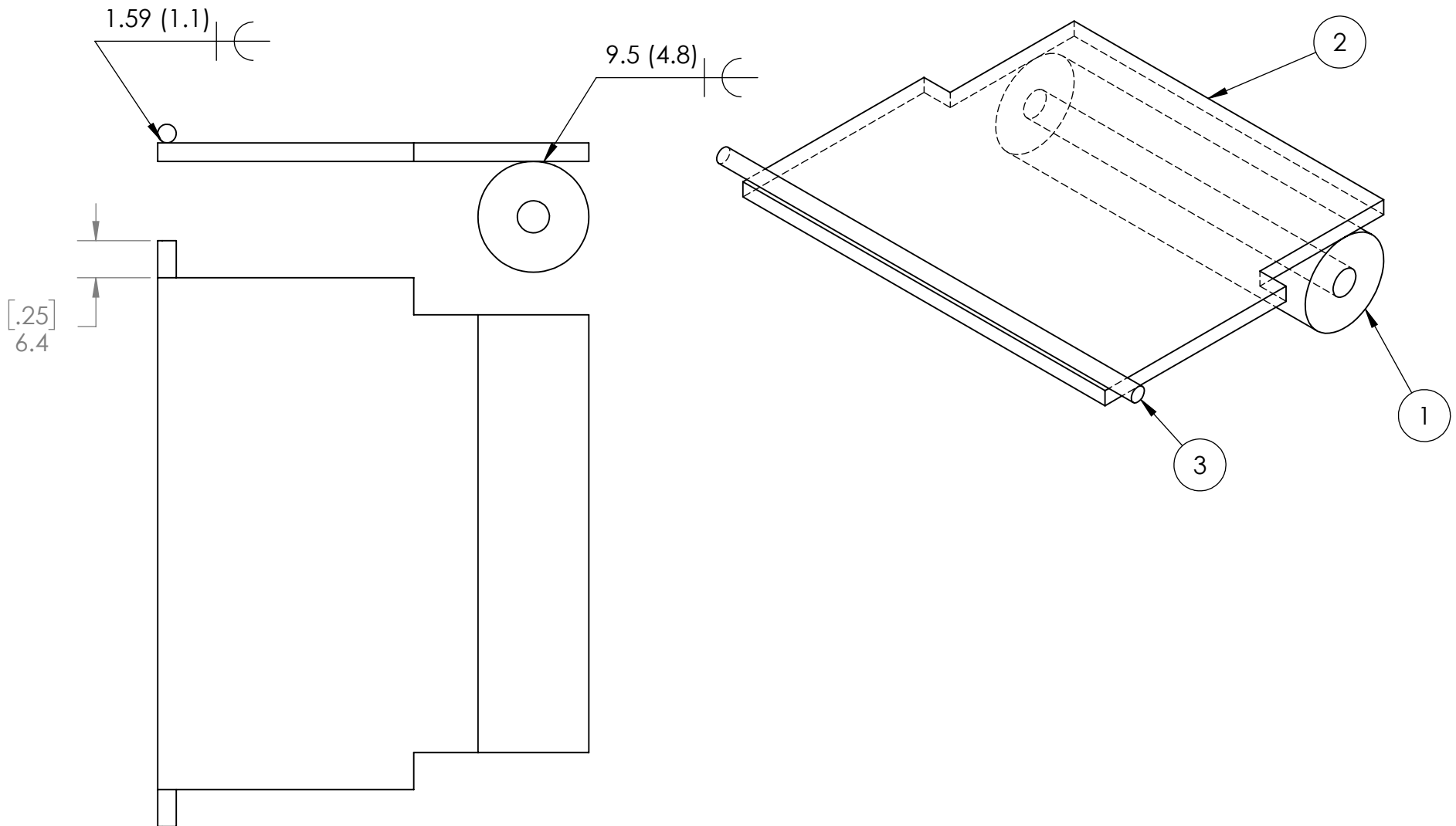
Date: 11/14/2019

Part: BODY SUBASSEM.

Scale:1:4

Drwn. By: The Blockheads

Chkd. By: ME STAFF



TOLERANCES  
IN MM:  
X ± 3.0  
X.X ± 1.0  
X.XX ± 0.5

[Inches]  
Millimeters

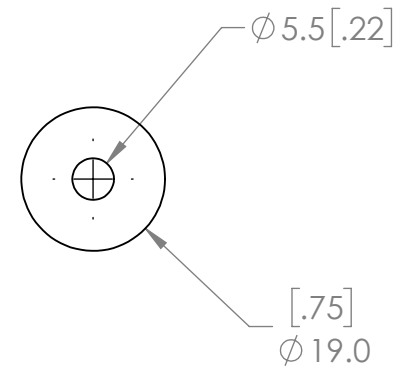
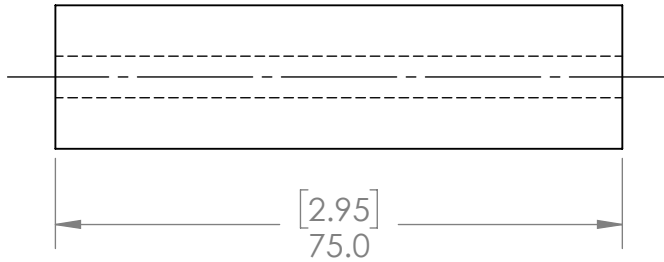
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	102000	LID HINGE	1
2	102001	LID	1
3	102002	LID-LATCH CONNECTION	1

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: CRS  
Dwg. #: 101001 Date: 11/14/19

Part: LID SUBASSEMBLY  
Scale: 1:1

Drwn. By: The Blockheads  
Chkd. By: ME STAFF



TOLERANCES

IN MM:

X ± 3.0

X.X ± 1.0

X.XX ± 0.5

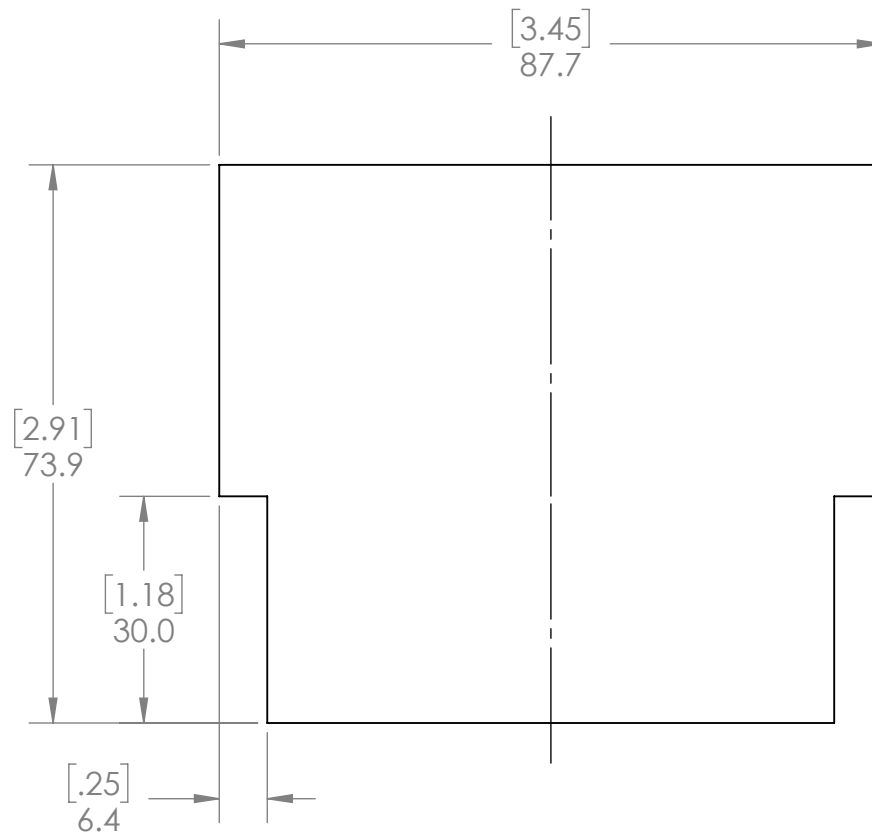
[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: 19.05mm (0.75") DIA. CRS  
Dwg. #: 102000 Date: 11/14/2019

Part: LID HINGE  
Scale: 1:1

Drwn. By: The Blockheads  
Chkd. By: ME STAFF



TOLERANCES

IN MM:

X ± 3.0

X.X ± 1.0

X.XX ± 0.5

[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

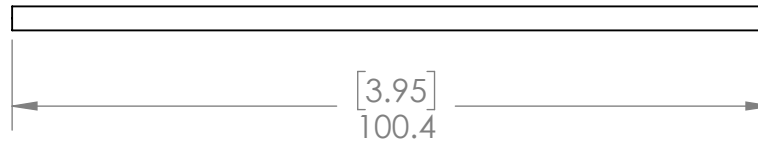
Material: 3.175mm (0.125") THK CRS  
Dwg. #: 102001 | Date: 11/14/2019

Part: LID

Scale: 1:1

Drwn. By: The Blockheads

Chkd. By: ME STAFF



TOLERANCES

IN MM:

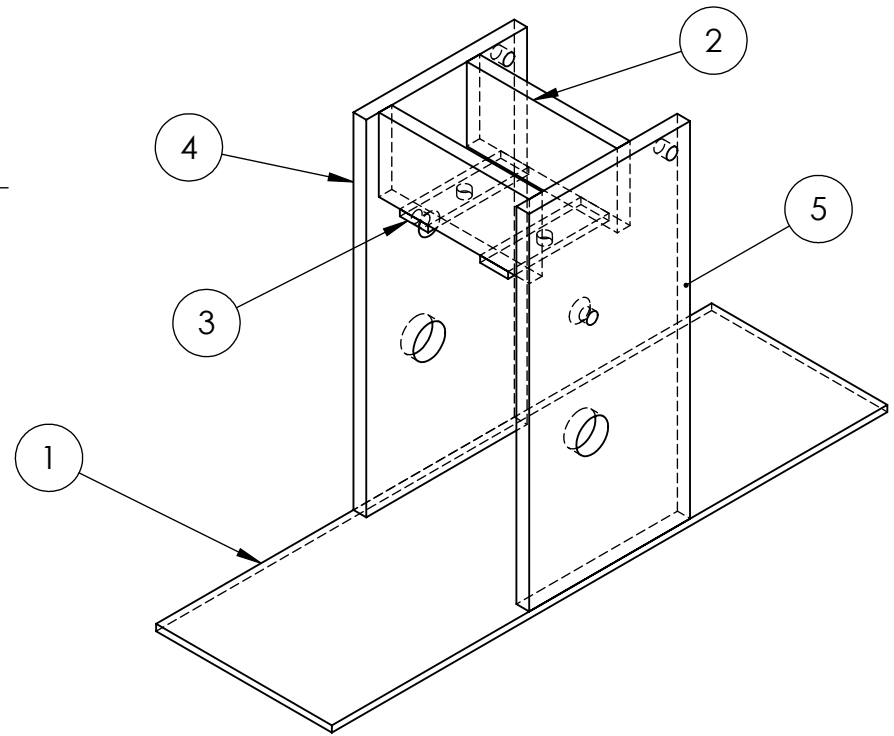
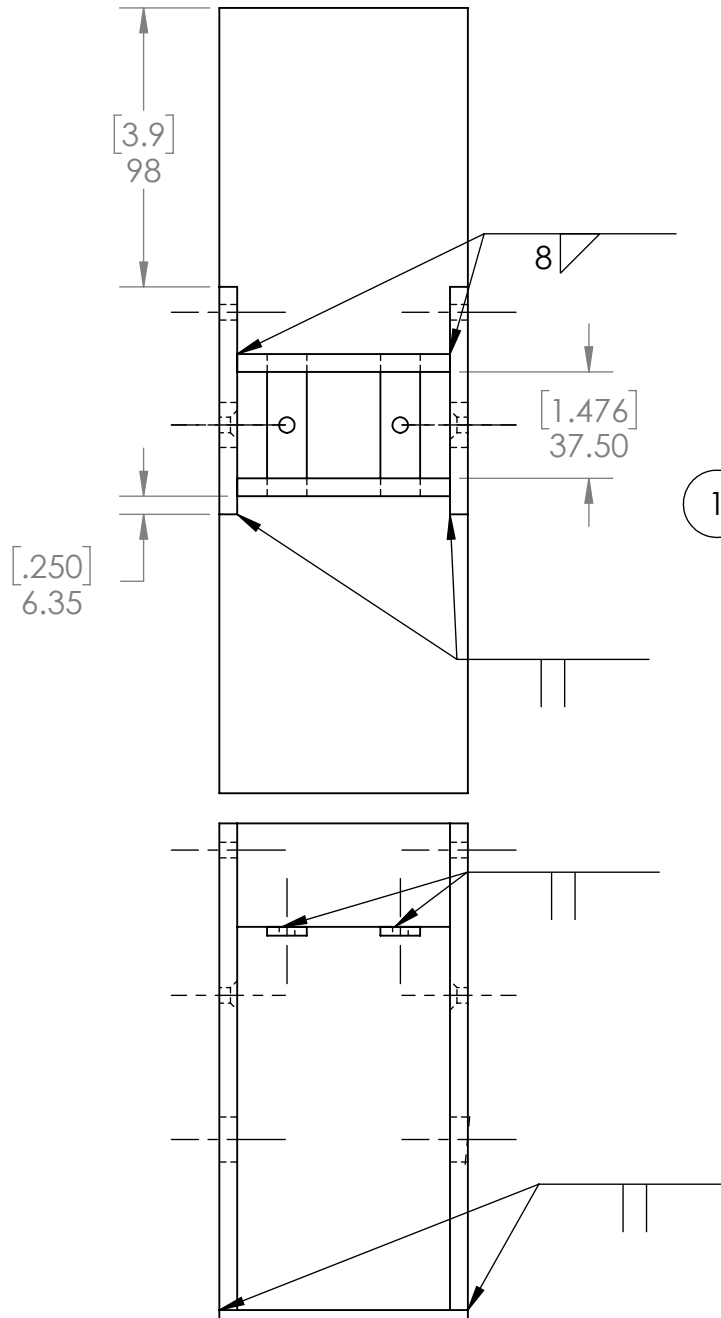
X ± 3.0

X.X ± 1.0

X.XX ± 0.5

[Inches]  
Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: 3.175mm (0.125") DIA. CRS	Part: LID-LATCH CONNECTION	Drwn. By: The Blockheads
	Dwg. #: 102002	Date: 11/14/19	Scale:1:1
			Chkd. By: ME STAFF



[Inches]  
Millimeters

TOLERANCES  
IN MM:  
X ± 3.0  
X.X ± 1.0  
X.XX ± 0.5

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	102006	FOOT	1
2	102003	SIDE WALL	2
3	102007	BASEPLATE GUIDE CONNECT	2
4	102004	END WALL LEFT	1
5	102005	END WALL RIGHT	1

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: CRS

Dwg. #: 101002

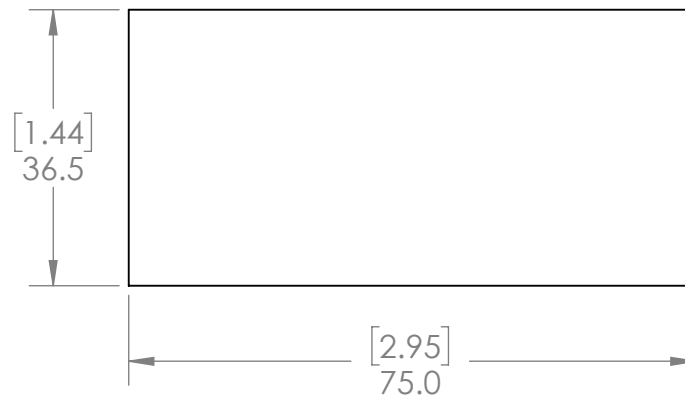
Date: 11/14/2019

Part: BODY SUBASSEM.

Scale: 3:8

Drwn. By: The Blockheads

Chkd. By: ME STAFF



TOLERANCES

IN MM:

X ± 3.0

X.X ± 1.0

X.XX ± 0.5

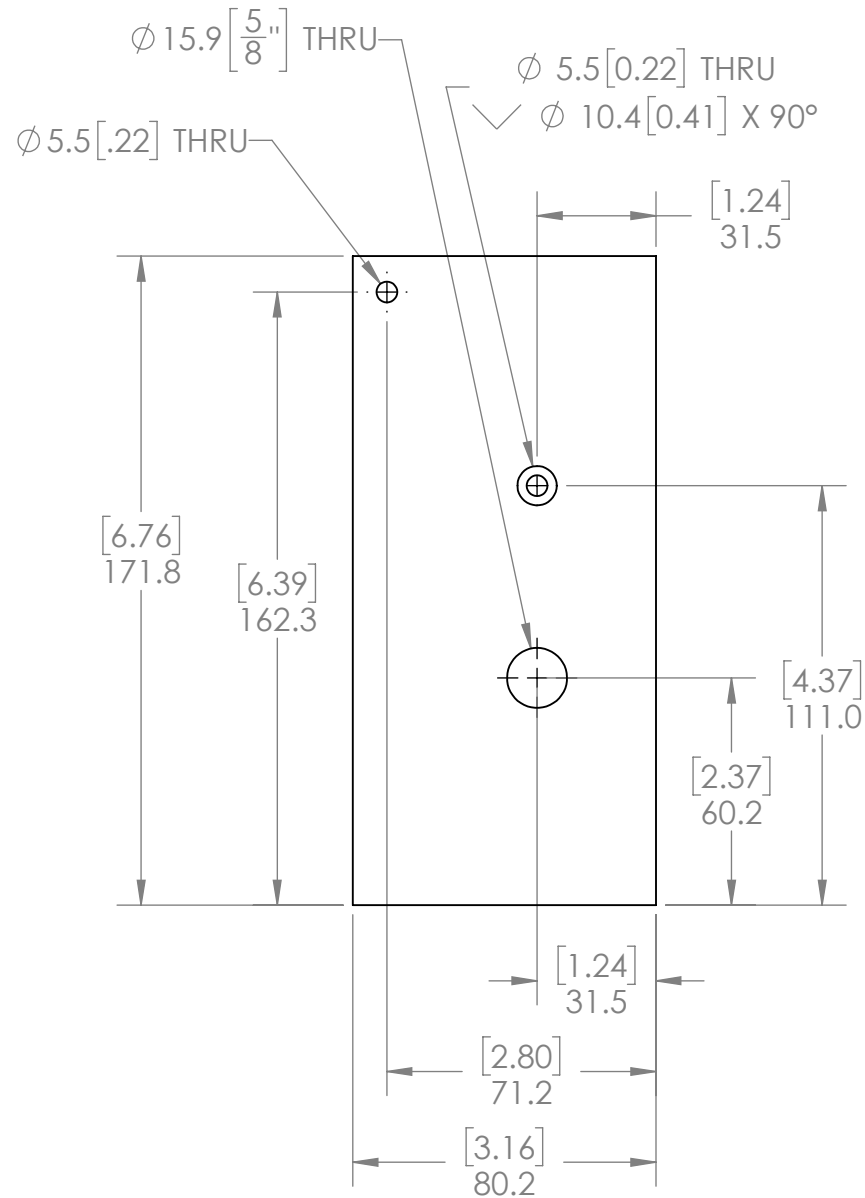
[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: 6.35mm (0.25") THK CRS  
Dwg. #: 102003 Date: 11/14/19

Part: SIDE WALL  
Scale:1:2

Drwn. By: The Blockheads  
Chkd. By: ME STAFF

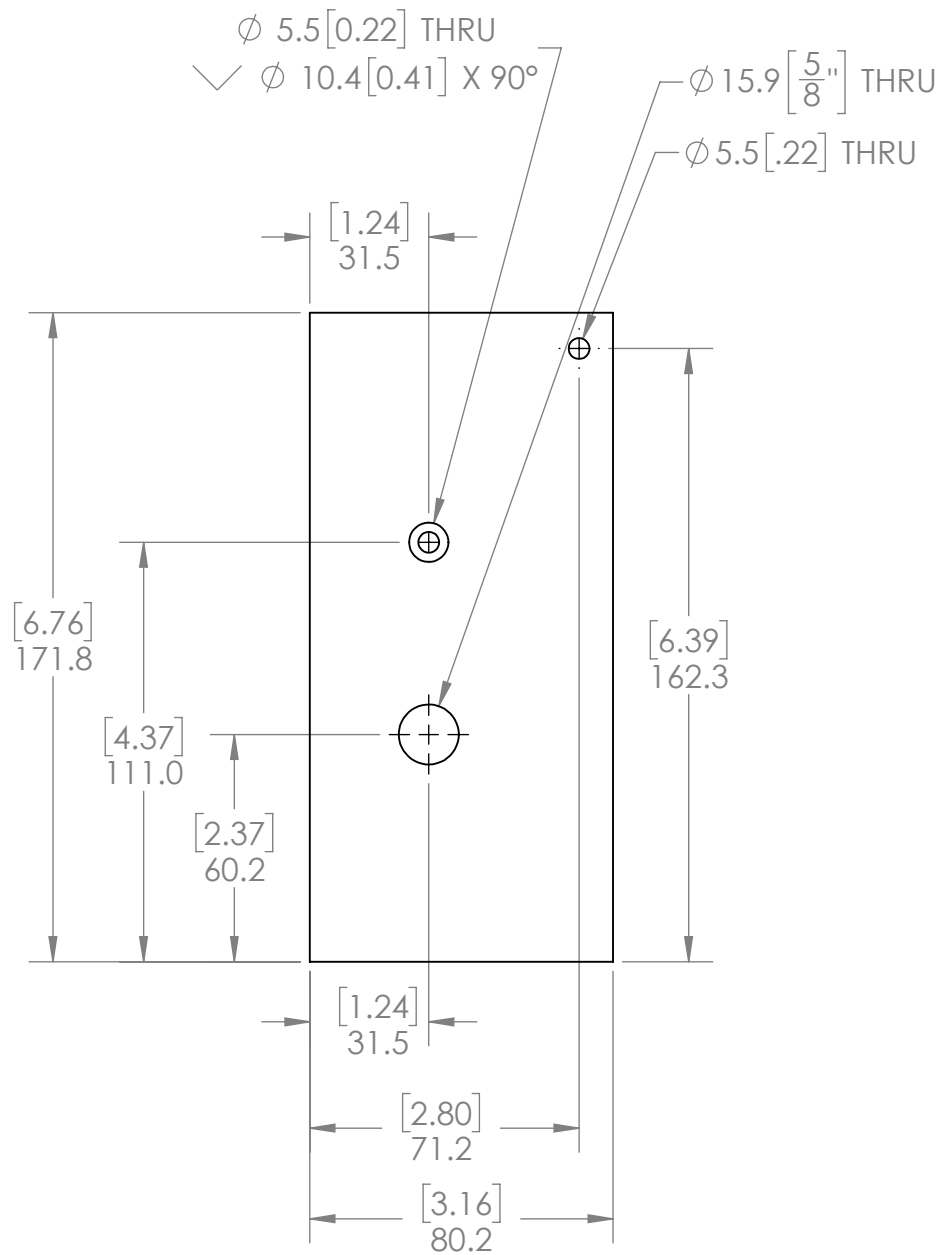


TOLERANCES  
IN MM:  
X  $\pm 3.0$   
X.X  $\pm 1.0$   
X.XX  $\pm 0.5$

[Inches]  
Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: 3.175mm (0.125") THK CRS	Part: END WALL LEFT	Drwn. By: The Blockheads
Dwg. #: 102004	Date: 11/14/2019	Scale: 1:2	Chkd. By: ME STAFF





TOLERANCES  
 IN MM:  
 X  $\pm$  3.0  
 X.X  $\pm$  1.0  
 X.XX  $\pm$  0.5

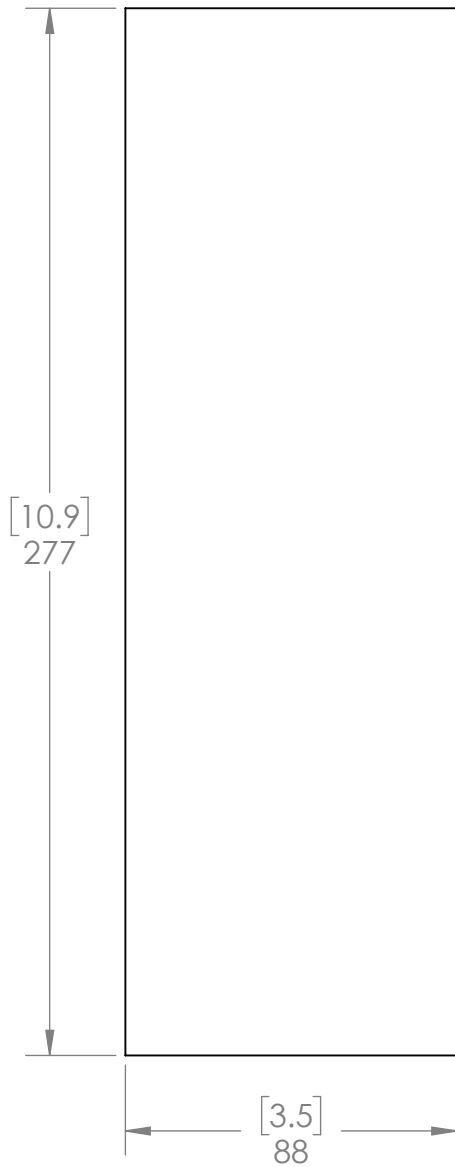
[Inches]  
 Millimeters

Cal Poly Mechanical Engineering  
 ME 430 - Fall 2019

Material: 3.175mm (0.125") THK CRS  
 Dwg. #: 102005 Date: 11/14/2019

Part: END WALL RIGHT  
 Scale: 1:2

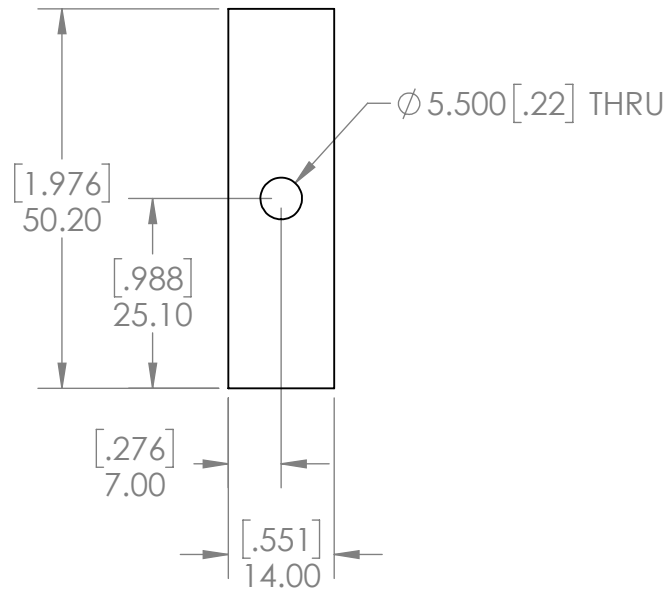
Drwn. By: The Blockheads  
 Chkd. By: ME STAFF



TOLERANCES  
 IN MM:  
 X  $\pm 3.0$   
 X.X  $\pm 1.0$   
 X.XX  $\pm 0.5$

[Inches]  
 Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: 3.175mm (0.125") THK CRS		Part: FOOT		Drwn. By: The Blockheads
	Dwg. #: 102006	Date: 11/14/2019	Scale:1:2		Chkd. By: ME STAFF



TOLERANCES

IN MM:

X  $\pm 3.0$

X.X  $\pm 1.0$

X.XX  $\pm 0.5$

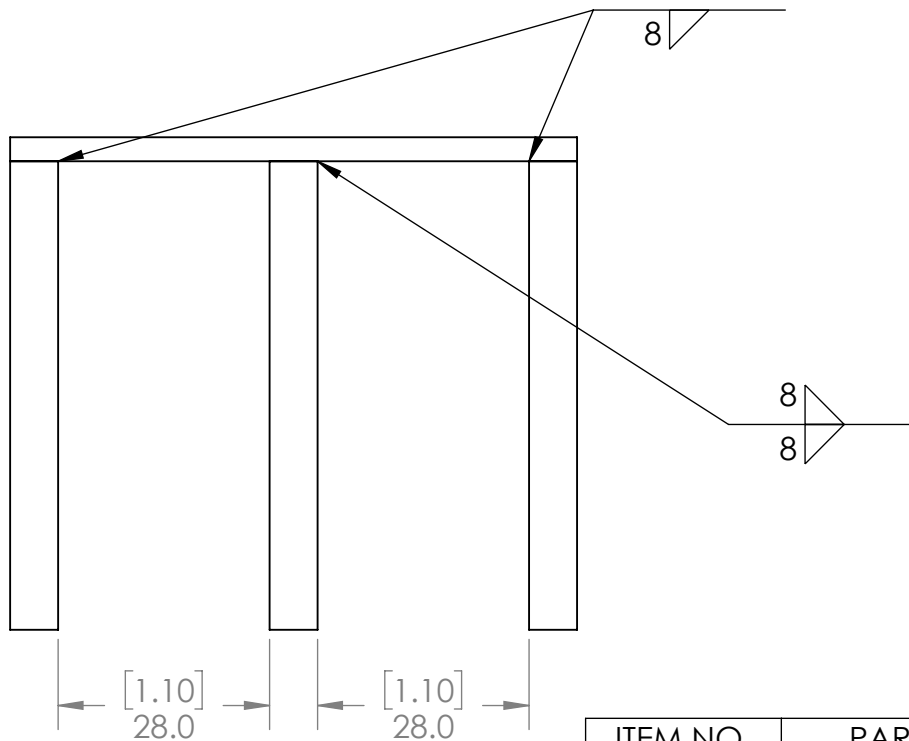
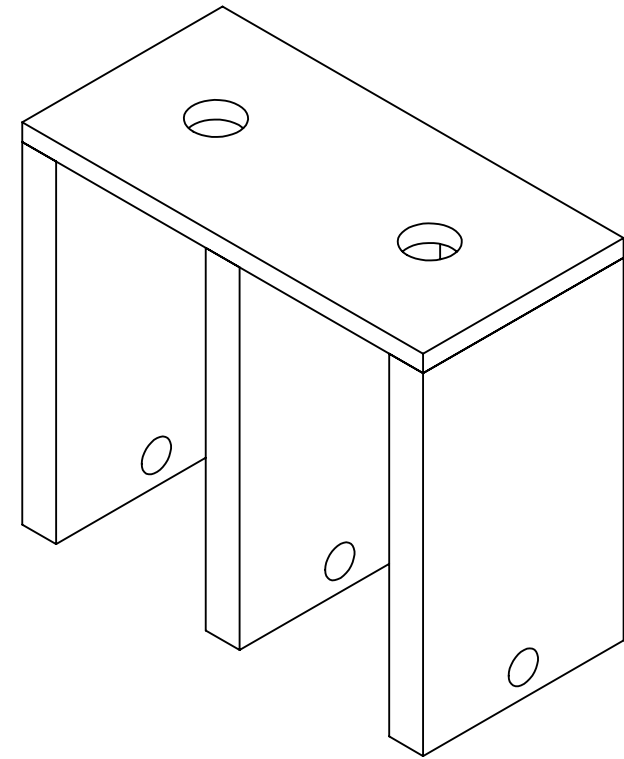
[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: 3.175mm (0.125") THK CRS  
Dwg. #: 102007 Date: 11/14/19

Part: BASEPLATE GUIDE CONNECT  
Scale: 1:1

Drwn. By: The Blockheads  
Chkd. By: ME STAFF



TOLERANCES  
IN MM:

X	± 3.0
X.X	± 1.0
X.XX	± 0.5

[Inches]  
Millimeters

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	102008	BASEPLATE	1
2	102009	BASEPLATE EXTRUSION	3

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: CRS

Dwg. #: 101003

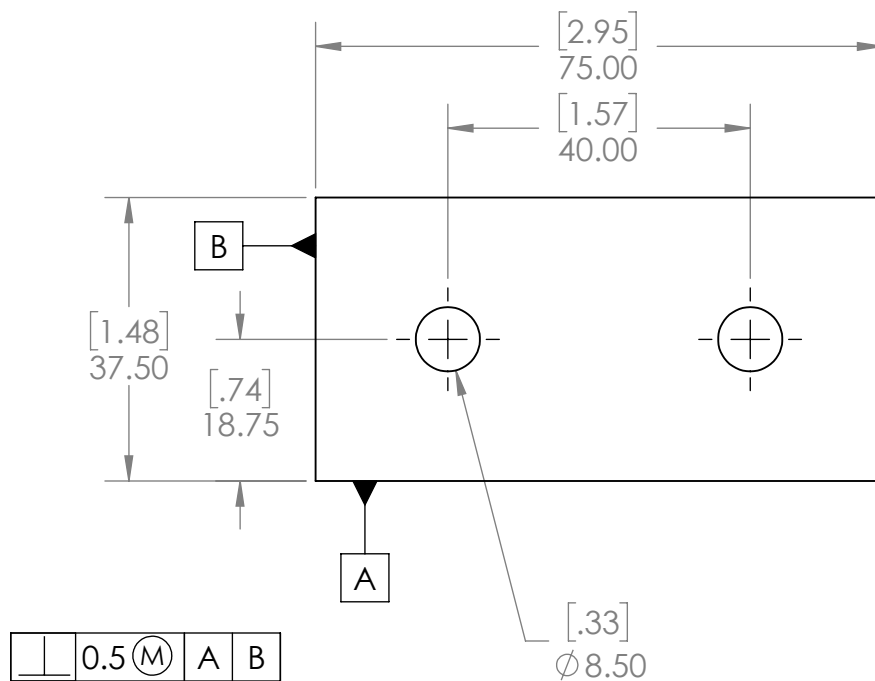
Date: 11/14/2019

Part: BASEPLATE SUBASSEMBLY

Scale: 1:1

Drwn. By: The Blockheads

Chkd. By: ME STAFF



TOLERANCES

IN MM:

X  $\pm 3.0$

X.X  $\pm 1.0$

X.XX  $\pm 0.5$

[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: 3.175mm (0.125") THK CRS

Part: BASEPLATE

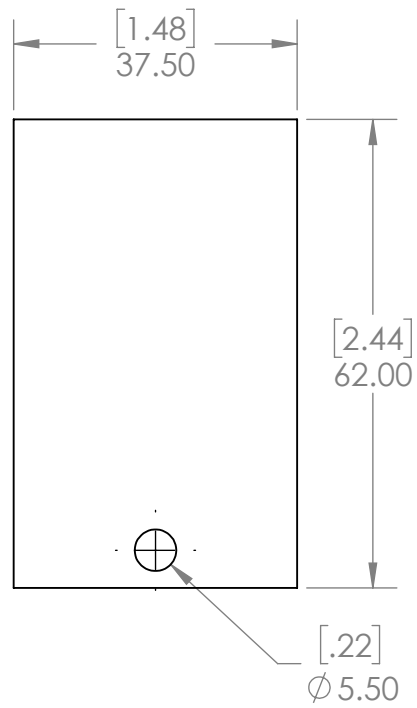
Drwn. By: The Blockheads

Dwg. #: 102008

Date: 11/14/2019

Scale: 1:1

Chkd. By: ME STAFF



TOLERANCES

IN MM:

- X  $\pm 3.0$
- X.X  $\pm 1.0$
- X.XX  $\pm 0.5$

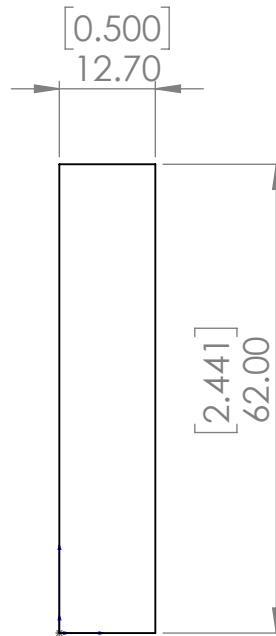
[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: 6.35mm (0.25") THK CRS  
Dwg. #: 102009 Date: 11/14/2019

Part: BASEPLATE EXTRUSION  
Scale: 1:1

Drwn. By: The Blockheads  
Chkd. By: ME STAFF



TOLERANCES

IN MM:

X ± 3.0

X.X ± 1.0

X.XX ± 0.5

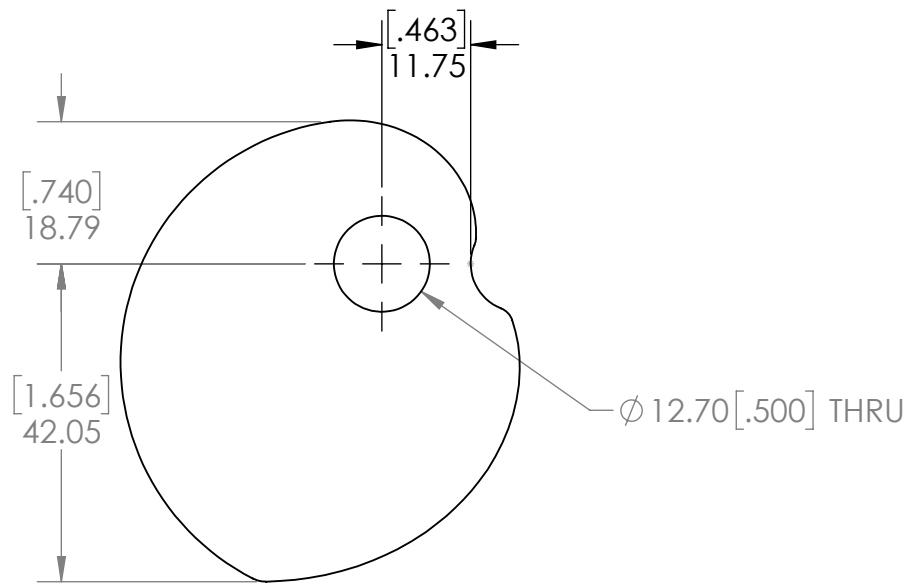
[Inches]  
Millimeters

Cal Poly Mechanical Engineering  
ME 430 - Fall 2019

Material: 3.175 mm (0.125") THK CRS  
Dwg. #: 102010 Date: 11/14/2019

Part: BASEPLATE EXT. GUIDE  
Scale: 1:1

Drwn. By: The Blockheads  
Chkd. By: ME STAFF



TOLERANCES

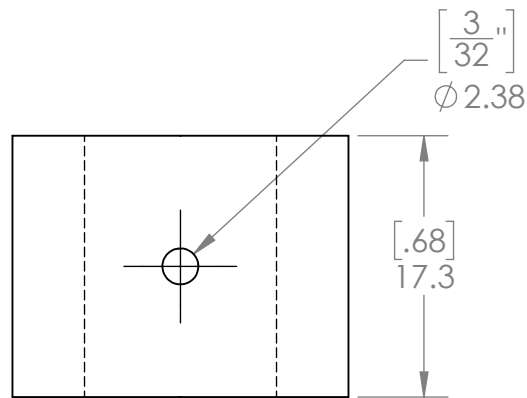
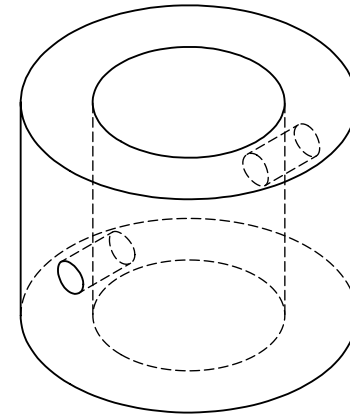
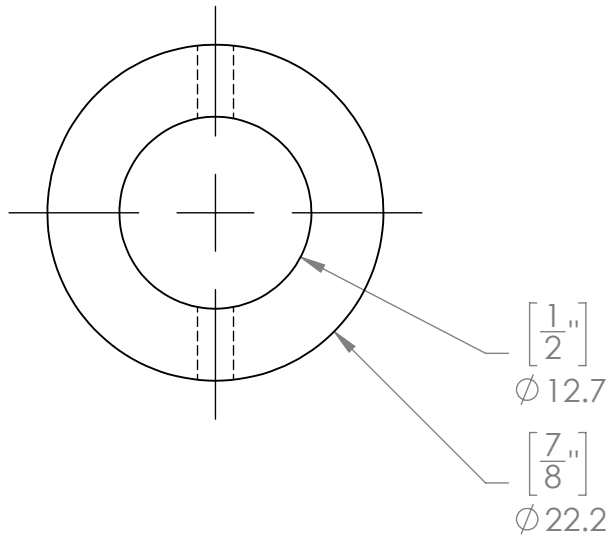
IN MM:

- X  $\pm 3.0$
- X.X  $\pm 1.0$
- X.XX  $\pm 0.5$

[Inches]  
Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: 6.35mm (0.25") THK CRS		Part: CAM		Drwn. By: The Blockheads
	Dwg. #: 102011	Date: 11/14/2019	Scale: 1:1		Chkd. By: ME STAFF





TOLERANCES

IN MM:

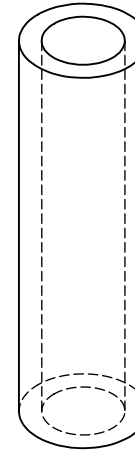
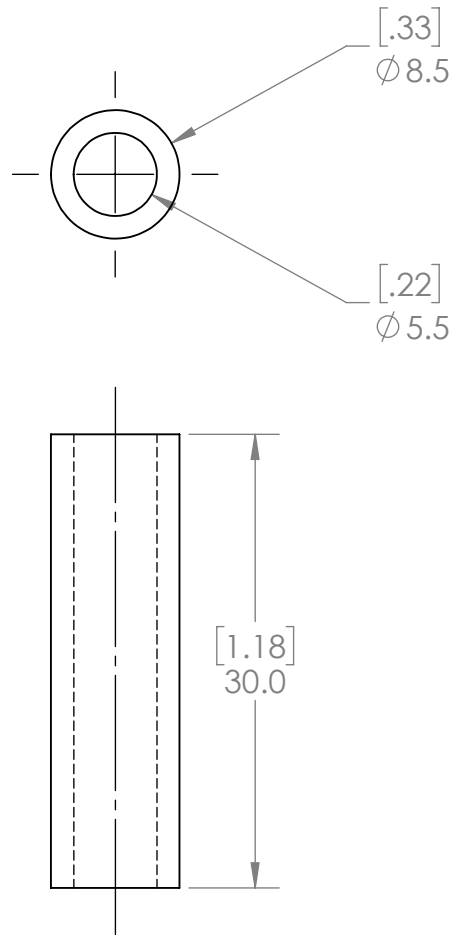
X ± 3.0

X.X ± 1.0

X.XX ± 0.5

[Inches]  
Millimeters

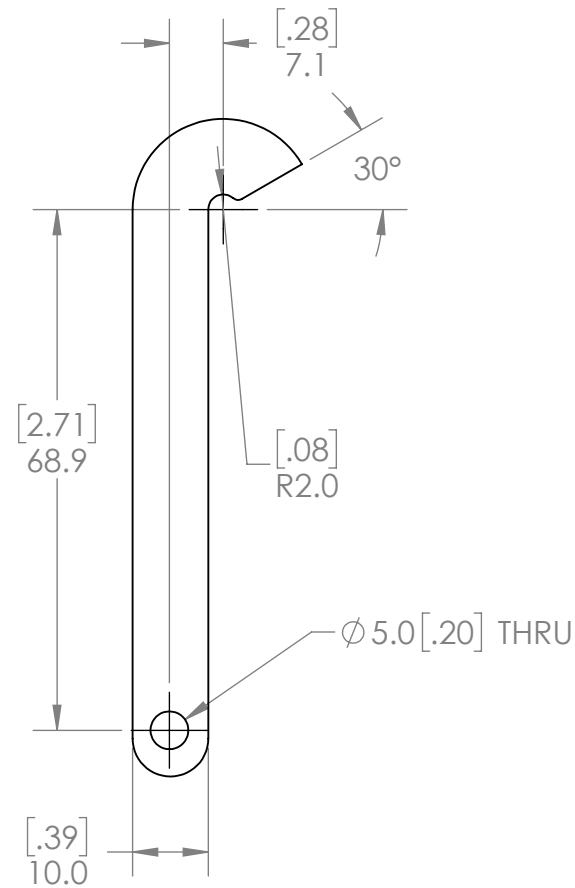
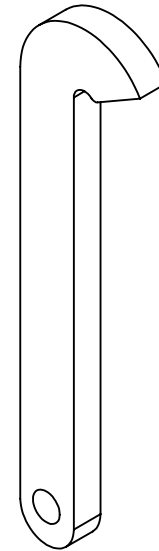
Cal Poly Mechanical Engineering	Material: 22.2 mm (7/8") DIA. CRS	Part: COLLAR	Drwn. By: The Blockheads
ME 430 - Fall 2019	Dwg. #: 102012	Date: 11/14/19	Scale:2:1
			Chkd. By: ME STAFF



TOLERANCES  
 IN MM:  
 X ± 3.0  
 X.X ± 1.0  
 X.XX ± 0.5

[Inches]  
 Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: CRS		Part: BASEPLATE GUIDE		Drwn. By: The Blockheads
	Dwg. #: 101012	Date: 11/14/19	Scale: 2:1		Chkd. By: ME STAFF



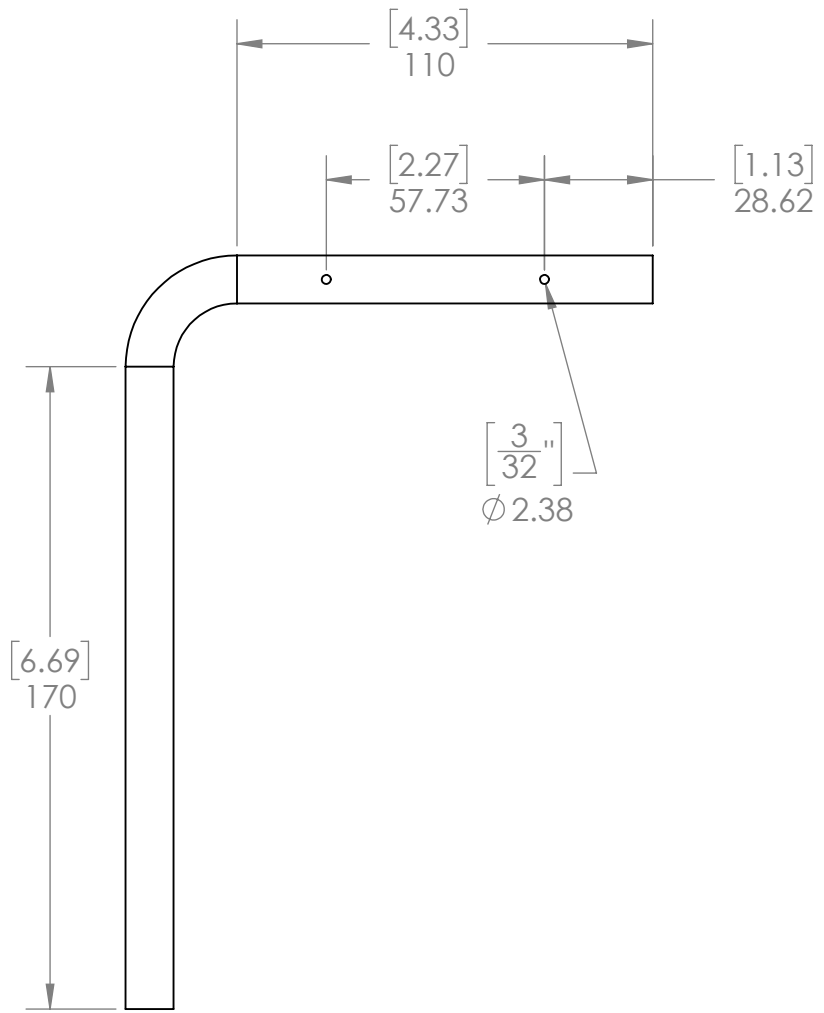
TOLERANCES

IN MM:

- X  $\pm 3.0$
- X.X  $\pm 1.0$
- X.XX  $\pm 0.5$

[Inches]  
Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: 3.175mm (0.125") THK CRS		Part: LATCH HOOK		Drwn. By: The Blockheads	
	Dwg. #: 101013	Date: 11/14/2019	Scale: 1:1		Chkd. By: ME STAFF	



TOLERANCES  
 IN MM:  
 X ± 3.0  
 X.X ± 1.0  
 X.XX ± 0.5

[Inches]  
 Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: 12.7mm (0.5") DIA. CRS		Part: CAMSHAFT	Drwn. By: The Blockheads
	Dwg. #: 101014	Date: 11/14/2019	Scale: 1:2	Chkd. By: ME STAFF



TOLERANCES

IN MM:

X ± 3.0

X.X ± 1.0

X.XX ± 0.5

[Inches]  
Millimeters

Cal Poly Mechanical Engineering

ME 430 - Fall 2019

Material: 5.0mm (0.197") DIA. CRS

Dwg. #: 101015

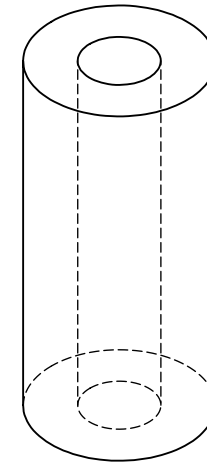
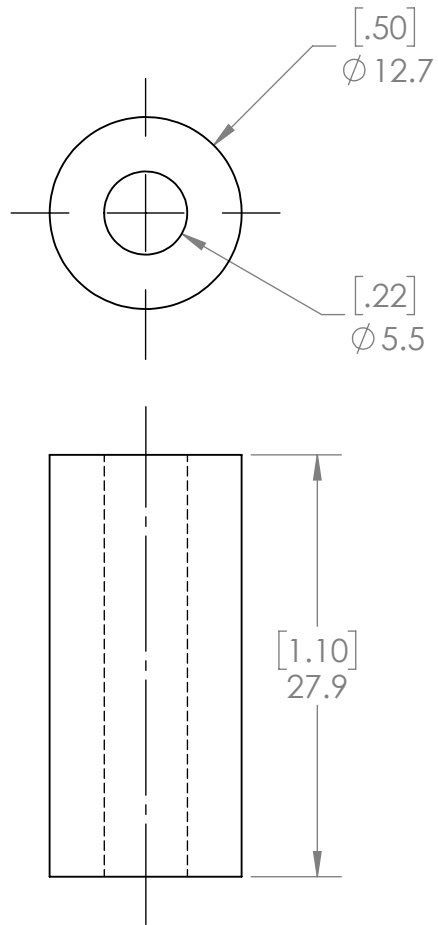
Date: 11/14/19

Part: WHEEL DOWEL

Scale:2:1

Drwn. By: The Blockheads

Chkd. By: ME STAFF



TOLERANCES

IN MM:

X  $\pm 3.0$

X.X  $\pm 1.0$

X.XX  $\pm 0.5$

[Inches]  
Millimeters

Cal Poly Mechanical Engineering

Material: CRS

Part: WHEEL

Drwn. By: The Blockheads

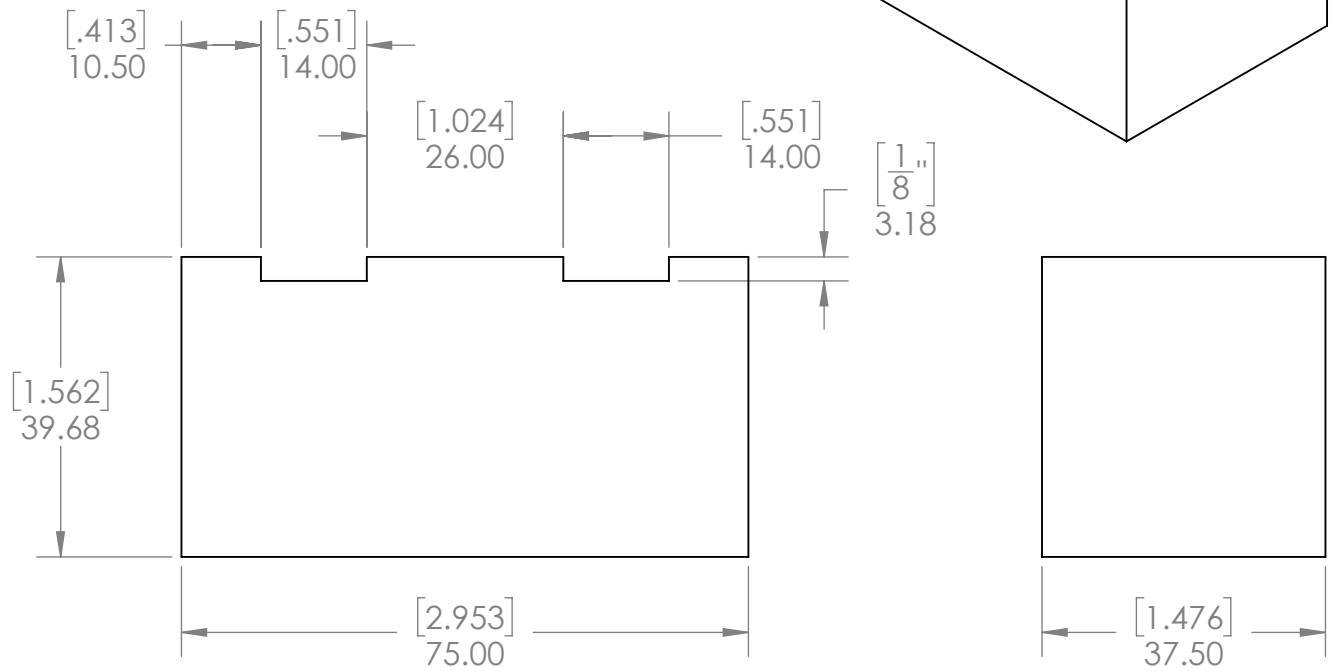
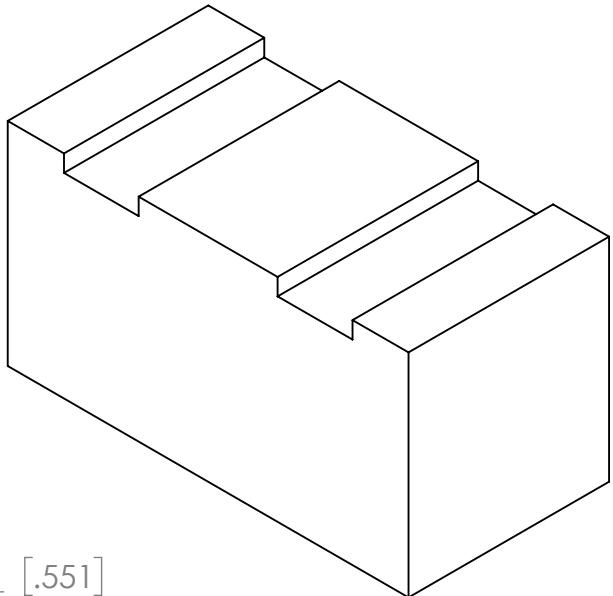
ME 430 - Fall 2019

Dwg. #: 101016

Date: 11/14/19

Scale:2:1

Chkd. By: ME STAFF



TOLERANCES  
 IN MM:  
 X  $\pm 3.0$   
 X.X  $\pm 1.0$   
 X.XX  $\pm 0.5$

[Inches]  
 Millimeters

Cal Poly Mechanical Engineering ME 430 - Fall 2019	Material: MAPLE	Part: WOOD BLOCK FIXTURE	Drwn. By: The Blockheads
	Date: 11/14/19	Scale:1:1	Chkd. By: ME STAFF