Final Project Report:

Machine Shop Learning Kits

CALIFORNIA POLYTECHNIC STATE UNIVERSITY

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Chapter 1 - Introduction

Currently in the Cal Poly Machine shops, students are struggling to find ways to fulfill the 10 hours of shop experience required to gain their Yellow Tag certification. Red Tag is the first level of certification students generally achieve their freshman year. It allows them to use basic machine tools such as drills, shears, benders, etc. Then after completing 10 hours of shop experience they can take the Yellow Tag test, which gains them access to use a welder, mill, and lathe. The heads of the machine shop, the shop technicians, and the mechanical engineering students will all have different but mutually beneficial advantages from these kits.

Currently, the students ask shop technicians for ideas, and the employees of the shop then give them a stack of project folders on file. These folders contain photos of various wood and metal projects with limited instructions, and can be confusing for a student with no previous shop experience.

Students currently have problems because these folders contain limited instructions, and so they are unable to immediately know the correct process to start making the project. Another problem associated with this current solution, is that many students are unable to acquire the proper materials due to lack of transportation or lack of knowledge about which materials they would need.

Many students start college without shop or machinery experience, and so entering the machine shops can be intimidating. The managers of the Hangar and Mustang 60 would like to decrease any confusion with a set of kits containing basic and detailed instructions. These projects would ideally be creative and interesting projects students would enjoy making, and in the process learn how to use the various machinery available in both shops. Originally we assumed these students had never used a tool before. We then surveyed around 300 mechanical engineering students to gauge a more accurate depiction of average skill level. We will be designing these kits around the data found in our survey as discussed later in this report. These kits would be available and useful to all students attending Cal Poly who wish to increase their tool and manufacturing knowledge.

Our goal, by the end of three quarters, is to create kits for mechanical engineering students to earn hours working in the shop and to become familiarized with the tools and resources there. We will have four kits designed for students with their Red Tag certification, which allows them to use wood tools and general sheet metal work. In addition we will have one kit for students who have their yellow tag, and wish to learn how to use the welders, mills, and lathes. This will give us a final count of 5 projects.

Our overall objective is to create projects that contribute to furthering a student's machining education, and give them first-hand experience with the tools in Mustang 60 and the Hangar. By the end we will deliver a total of five kits containing detailed instructions for kit

assembly and product assembly. The different kits will require a variety of experience and certification, more specifically four red tag kits and 1 advanced yellow tag kit. Machine Shop Learning Kits Formal Engineering Specifications are shown in Table 1 below:

Table 1: Engineering Specifications

Spec #	Parameter Description	Requirement or Target (units)	Tolerance	Level of Risk	Compliance
1	Cost of Kit Assembly	$20	Max	L	A, T
2	Cost of End Product	$20	Max	M	A,T,I
3	Kit Assembly time by Student	2-10 hours	Min	L	T,I
4	Variety of Certification necessary for kits	4 Red Tag & 1 Yellow Tag	Min	L	S
5	Project must use different tools	3 tools/machines minimum	Min	M	A,T
6	Materials	Only standard materials	N/A	M	S
7	Units	Standard	N/A	L	A,I
8	Safety Instructions per tool	1 per kit per tool	Min	L	A,T,S,I

Table 2: Legend for Table 1

Legend	
L	Low associated risk
M	Medium associated risk
H	High associated risk
A	Analyze product to check for compliance
T	Test product to check for compliance
I	Inspect product to check for compliance
S	Same as an existing product

These specifications were derived from our sponsor's expressed deliverables in our original meeting with him, and his feedback from our project proposal. Mr. Pulse confirmed these engineering specifications shown above meet his expectations for our project, and are approved to continue on with the design process.

In addition we used a House of Quality (QFD) shown and explained in Appendix A, which was a great visual tool relating our customer's interests to the current competition. Looking at the QFD we saw a large need for clear instructions for not only the student's assembly process, but also the kit assembly by the technicians. There wasn't a wide variety in the tools used to complete each project, so we want to focus on exposing students to a lot of different types of tools. In addition, the current projects were not tailored to a student's experience level, and there was no differentiation between students with their Red or Yellow Tag certification. Another problem was the lack of creative opportunity with the end product, and as a consequence a limited range of time it would take to create each project. We want each project to be able to take anywhere from two to ten hours to complete. If the student wishes to customize their project, then they can take more time, or if they only needed three more hours the basic product will suffice.

The current solution's in the shop strengths were consistently low cost and use of standard materials. In addition these solutions are strong in practicality and low commitment for the shop technicians. We plan on our designs reducing the time commitment on the shop technicians by including detailed instructions, pictures, and safety information. This way the student will be more independent requiring less of the shop technicians' time.

Another area we wanted to focus on was creating projects students would enjoy. Learning how to use the machinery is the first priority, but we want students to enjoy the experience as well. This can be achieved by designing desirable crafts that students will want to keep or be proud to give away. In addition, we will have kits designed for three different levels of machining experience, so even the beginner should feel comfortable completing their kit. This will include two levels of experience for students with Red Tag certification and then one additional project for those with their Yellow Tag certification. This will help instill a sense of confidence, and from there, a desire to learn and continue practicing their machining skills.

Chapter 2 - Background Research

We have found plenty of very helpful background information already in the shops, online, and in instructional books from the library. All of these resources lend themselves to a variety of project ideas, in addition to expanding our machining knowledge. Our main challenge was narrowing down these project ideas to things that can be reasonably designed as kits for students to assemble. We started by reading through the Red and Yellow Tag Manuals provided by the machine shops. These manuals covered safety material for each machine and tool, in addition to the level of certification needed for them. See Appendix E for a link to these manuals that can be found online.

To expand our knowledge of Mustang 60 and the Hanger we met with Haden Cory, the lead shop technician, on January 28, 2014. On the tour he familiarized us with the procedures and locations of various tools in the shop, but also with common mistakes made by students. This was valuable background research to help us with our instruction manuals, in addition to knowledge of all the machinery available. We have since made several trips on our own as a way to become fully confident with what the machine shops at Cal Poly have to offer. The project ideas they already had were very technical and not very detailed. Some of the options were a tool rack and a work bench. Overall these projects would not appeal to the average student, rather they appeal to a student with vast shop experience.

We then researched how other Universities solved this problem, and what projects their students found interesting. One of these was the University of California, Santa Barbara. It seems they do not have the same priority of Cal Poly for familiarizing all their students with the machine shop as they have very strict rules about who can be in their shops and with specific reasons. Another University we found with a machine shop similar to that we have here at Cal Poly was the University of Delaware. They seem to address the issue of inexperienced students through giving repeated tours and demonstrations until a student can achieve 100% on the shop regulations test. Still, even though these schools do have machine shops for their students, we could not find any projects they offered to their students to help familiarize them with their shops and tools. Cal Poly is a glowing example of the “Learn by Doing” slogan and continues to be a leader in labs and shop resources available to students. Observing other colleges was not exceptionally helpful.

From these research materials, we were able to come up with a plethora of ideas for projects. We found a wide variety of websites with project ideas and plans, in addition to books for beginning woodworkers. These resources we found very helpful, however, many of the existing project ideas that can be found online or in books from the library are too large. We considered these with the thought to scale them down to reduce material cost and ease of manufacturing. The books we referenced from the library are shown in Appendix E along with other websites we visited. Appendix E also shows examples of some of these projects.

Chapter 3 - Design Development

After deciding on our project parameters and confirming them with our sponsor, we began brainstorming a multitude of project ideas. This ideation period was unrestrained and we used a number of different techniques to come up with as many ideas as we could think of, no matter how impossible. From our pages and pages of ideas, we began to narrow them down using our parameters and interest in the projects as seen in the House of Quality mentioned in the Objectives section.

We finally narrowed our list down to thirty options of which we further analyzed the validity using a Pugh matrix, seen in Appendix B. We completed four different matrices for some of the different products that were already used by the shops. We then listed our design requirements against all the ideas we had come up with to solve the problem. This made for four very large Pugh Matrices because we had so many concepts already.

The first existing product we compared our new ideas to was the book end. According to the Pugh Matrix using the Book End datum the top five projects shown were the small bookshelf, picture frame, wall mounted bottle opener, personalized coasters, and the floating wine holder. These five projects were scored much higher than the other options. Through this matrix we noticed the book end was weak in the areas of clear instructions, using a variety of machinery for construction, and the end result being a desirable craft. The good news is these qualities can be changed in any project we choose, and the five projects mentioned above are strong in these areas. However the book end was strong on low cost and using standard materials, which are qualities we wish to model in any project chosen.

The Pugh Matrix using the Push Stick datum proved the personalized wooden coasters, picture frame, cutting board, puzzle box, and engraving cell case as the top rated projects. The push stick was strong on being low cost, use of standard materials, and ease of assembly for shop technicians which are very important characteristics. However the push stick fell short in the areas of a variety of student experience, being fun to assemble, clear instructions, and in the end producing a desirable craft.

We also compared our new designs to a marble rolling toy design the shops had been using. From comparing the old design to our new design using the given specifications, we concluded that the picture frame, personalized wooden coasters, and wooden blocks follow the design criteria much more to beat out the marble roller. These three best the original design through a variety of tools and ease of completion for students. The project proposals that fared the worst were the pencil holder, the kitchen spoon rest, the cutting board, and the clothes drying rack. Most of these did poorly because they are too simple. They would not take up enough time to complete and the project would not use a large variety of tools. The clothes drying rack suffered because it is too complex. By considering possible reversals of the lacking projects, the

projects can be revamped to be more complex. The first three designs could occupy more time and utilize a larger variety of tools by suggesting the student add a creative design using different tools. Overall we found that our designs were much superior to the marble roller.

Lastly, we looked at a metal tool rack. The designs that looked to most completely fulfill our design requirements when weighed against the metal tool rack were the birdhouse, personalized coasters, lunch box, picture frame, and wooden blocks. These scored well when compared to the metal tool rack because they would all use a larger variety of tools, take up more time, and were more desirable to have. A metal tool rack would only be a desirable project for a select group of individuals. The project ideas that scored the worst were the pencil holder, kitchen spoon holder, cutting board, and the clothes drying rack. The issues in these lacking projects are very similar to the problems listed in the previous paragraph.

Through analyzing these matrices we noticed that there were some projects which kept scoring low, and therefore will be dropped as possible choices. The electric plug safety holder, wall shelves, bedside table, key holder bowl, and clothes drying rack continuously produced low scores preventing their continuation as future projects. In addition we noticed each datum were all weak in several areas, which we will focus on when designing the future products. Each project can be customized to fulfill several of these requirements. We need to be sure they are easy to assemble for students, increase the variety of student's experience, and in the end produce a desirable craft. This where all the existing products fell short, and we need to make sure the future product is strong in these areas.

Our next step in narrowing down our projects further was creating a Decision Matrix for our top choices. This method is special in that not all parameters are weighted equally. We decided that the most important qualification for our designs is how interested the student would be in the product. This led us to creating a survey that would better represent what Cal Poly mechanical engineering students would be interested in purchasing and making.

As a part of our survey we asked students to mark the top ten projects they would be interested in building from the list below:

Engraving cell phone case or safety goggles
Puzzle box (it's a puzzle to open it)
Bedside Table
Floating wine bottle holder
Cell phone charging station
Wall mounted bottle opener
Personalized wooden coasters
Small Bookshelf
picture frame
Birdhouse
Wall shelves
Wooden Block Letters (initials/name)
Foot stool
Basket mounted to bicycle
Cutting board
key rack
Crate for storage
Lunch box
Jewelry box
Key holder (box or bowl)
Silverware organizer
Files holder
wall hook
Vegetable Planters
Clothes Drying Rack
pencil case
Pencil holder
Electric plug safety cover
Kitchen spoon holder
Wooden candle holder

The data we acquired from this part of the survey was most heavily weighted in our Decision Matrix, shown in Appendix C. The survey was the most helpful tool we used in deciding which choices to keep and eliminate. The survey was also used to gather data on student's current ability to use tools in the shop before any instruction.

The results of our survey are shown below:

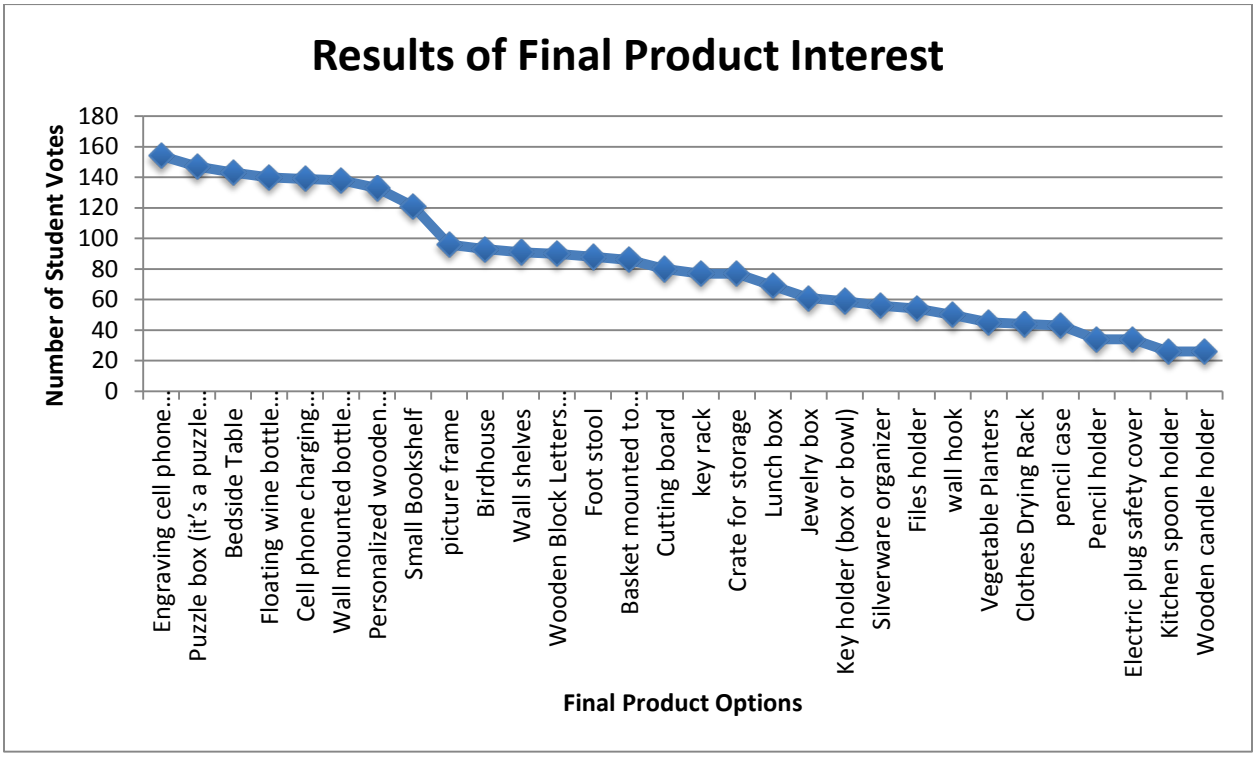


Figure 1: The figure above shows the number of student votes for each final product option

In the chart above you will notice there is a group of projects that are clear front-runners. These projects include: engraving cell phone case or safety glasses, puzzle Box, bedside table, floating wine bottle holder, cell Phone charging station, wall mounted bottle opener, personalized wooden coasters, and at the end was a small bookshelf. All of these projects received over 100 votes from a survey given to 277 students ranging in age from freshmen to seniors.

When creating our decision matrix, and gave each project a score proportional to the amount of votes they received. This had a big impact on the results of our Decision Matrix. The other specifications we weighted heavily were clear instructions for the students and safety. These we decided should be weighted very heavily as well because a project cannot be completed if it is not safe and if the student cannot understand what they need to do. These two categories were so important, that we scored all the projects equally. We were able to do this because those two criteria are greatly dependent on the style with which we write the directions. From our Decision Matrix, we found our top choices with which we would move forward. We divided the projects that most satisfied our requirements and wrote a brief description of how we plan to complete these projects:

Wall Mounted Bottle Opener

Figure 2: Wall Mounted Bottle Opener

The back plate could be either wooden and the bottle opener made of sheet metal could be nailed on. Or if the backing could be metal, in which case the bottle opener could be welded on and used as a Yellow Tag project. The bottle opener mechanism would be a net shape punched from sheet metal, and bent into its desired final shape.

Birdhouse

This would require 7 blocks of wood, nails, planar, sanding paper, and some kind of finish to make it look nice. This is your standard birdhouse made in a lot of beginning woodworking classes, great for people with little to no experience.

Figure 3: Birdhouse

Personalized wooden coasters

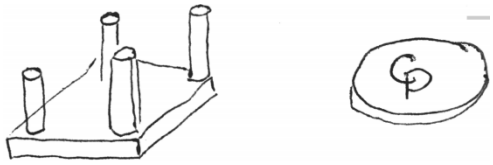


Figure 4: Personalized Wooden Coasters

This is a two-part project. One part is the base, which would be a block of wood with four pegs glued into the four corners to act as a guide/holder for the coasters. Part two would be numerous wooden circles or squares that would require sanding, rounding of edges, and other finishing techniques to personalize each coaster. This could include routering, using a jigsaw, burning designs into the coaster, etc.

Puzzle Box

Basic wooden box with a indent on the very bottom of the sides of the box. Located within the top plate there are three circular disks with a rod attached, and another circular disk glued to the opposite end of the rod. On the bottom circular disk there is a flat edge taken off, so when the three circles are aligned just right the top lid will come off, and the puzzle box can be opened.

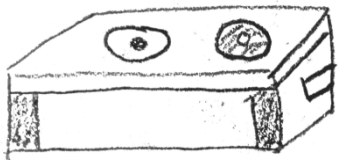


Figure 5: Puzzle Box

Block Letters

Figure 6: Wooden Block Letters

Basic wooden blocks that the student will sketch a letters outline on one surface. They will then use a router or jigsaw depending on the blocks thickness, and cut along the traced outline. Then they will smooth the edges with the belt sander, and finish sanding by hand. This was supposed to be a very simple project for beginners.

Cellphone Charging Station

This would be a simple wooden box with the back edge extending above the rest of the box. The construction would consist of using a router to cut four holes in the back panel for cords to pass through. Once the back panel is finished the student will attach the other three finishing the box. All the panels would be smoothed with the belt sander and attached with either wood glue or nails.

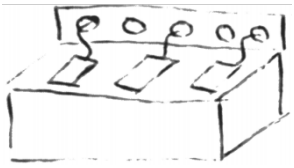


Figure 7: Cellphone Charging Station

Picture Frame

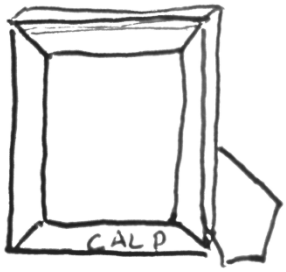


Figure 8: Picture Frame

Supplied with two pieces of wood to make into 4 properly sized pieces using compound miter saw, the student would then decorate them using saw decoration and make angles using the chop saw. Make an indent in the back of the wood so there is room for glass using a hand router. All pieces would be sanded. Glue the four pieces together with wood glue and clamps. Insert provided glass. Drill holes in back of wood for dowels. Press fit metal pins to attach frame. Use a small block of wood to make a stand. Drill hole with drill press. Use screws, taps, screw driver.

Floating Wine Bottle Holder

Supplied with a thick piece of wood, roughly cut, the students could then cut the piece into the desired shape with special attention to the bottom angle of the piece of wood. This angle could be cut using the vertical band saw. A caliper would be used to carefully measure the distance between the edge of the wood and the hole located for holding the bottle. This hole would be marked, then cut using a drill press and miter saw with a possible chamfer put in with a file. The piece would have to be well sanded. After these main steps were

Figure 9: Floating Wine Bottle Holder

completed, the student could then use the same technique used to make the center circle to then make additional glass holders

Key Rack

Supplied with a thick piece of wood, roughly cut, the students would then cut the piece into the desired shape. The student would also be supplied with a small scrap of sheet metal. This sheet metal would be bent, punched with holes, cut with tin ships, and filed to create hooks and hangers for the key rack. The wood would need tapped holes using taps and the drill press. The student would also be supplied with some screws that they would install with a screwdriver.

Figure 10: Key Rack

Bedside Table

The student would be supplied with a thin sheet of wood and rectangular wood stock, and some screws. The student would cut the thin pieces into two squares of equal size using the table saw. They would cut the rectangles into four equal pieces. The second piece will act as a lower shelf and will need four square notches cut out of each of the corners. All these pieces would need to be properly sanded. Construct using the drill press, taps, screws, and a screwdriver.


Figure 11: Bedside Table

Small Bookshelf

Supplied with a thin piece of wood, the table saw to cut this into three identically sized notch would need to be cut into each of the would then be sanded, with special attention to the of rectangular stock, cut into four equally sized each of these posts, drill a pattern of equally drill press. Students are supplied with a thick cut with metal chop saw to obtain 12 equally sized, 1-inch dowels. Assemble.

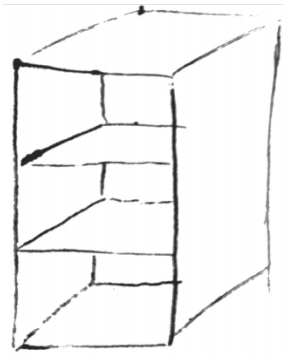


Figure 12: Small Bookshelf

student would use a pieces. A square corners. The boards notches. Then, out posts. In one side of spaced holes using a round metal stock,

Wall Hooks


Figure 13: Wall Hooks

Supplied with a small block of wood, student would then fashion that block into a design of his or her choosing. The student would use chisels, hammers, handsaws, etc. The student would then drill two holes into the back of the piece and tap one, and enlarge one for hanging. The student would also be supplied with a piece

of metal sheet metal that they could bend into a hook and punch a hole in to be attached to the back of the wood with a screw.

Additional Data

Thus far, the brunt of our efforts for this design project has been in choosing suitable and desirable projects for the students to complete. However, when distributing the surveys, we also polled students on their various shop experience. Through analyzing this data, we plan to deliver to the students instructions that will most fully suit the exhibited need. Below are the additional questions from our surveys and analysis to help us deliver a set of instructions that will be most helpful to the user:

1. *What length of time would you want to work in the shop at a time?*
2. *Would you prefer one large project or a collection of smaller projects?*
3. *On a scale of 1-10, how confident are you walking into a shop on campus?*
4. *Approximately how many hours have you spent in the Cal Poly shops?*
5. *On a scale of 1-10, how confident are you with wood working?*
6. *On a scale of 1-10, how confident are you with metal working?*
7. *Do you have any previous shop experience?*
8. *Do you have your red/yellow tag?*

The results are shown below in the following histograms.

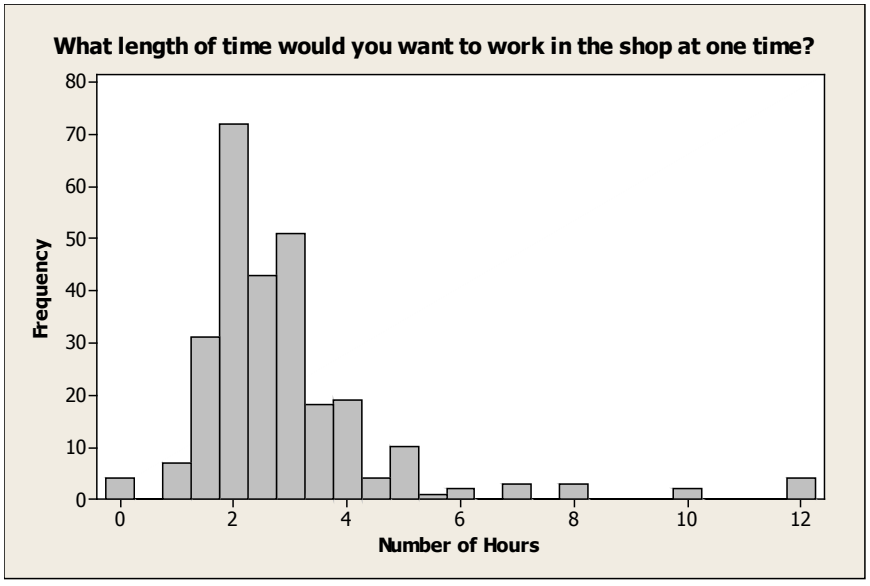


Figure 14: The figure above is a histogram with results of the 1st question on our student survey

We see from the chart above that most students don't prefer to spend long hours in the shop at one time. Most would prefer to work on their project for 2-3 hours and then return to it at a later date. This is very helpful information when we begin writing instructions. We can design them in two hour blocks to meet the needs of the students who don't have large chunks of time, and need to be able to pick up and continue working on their project at a later date.

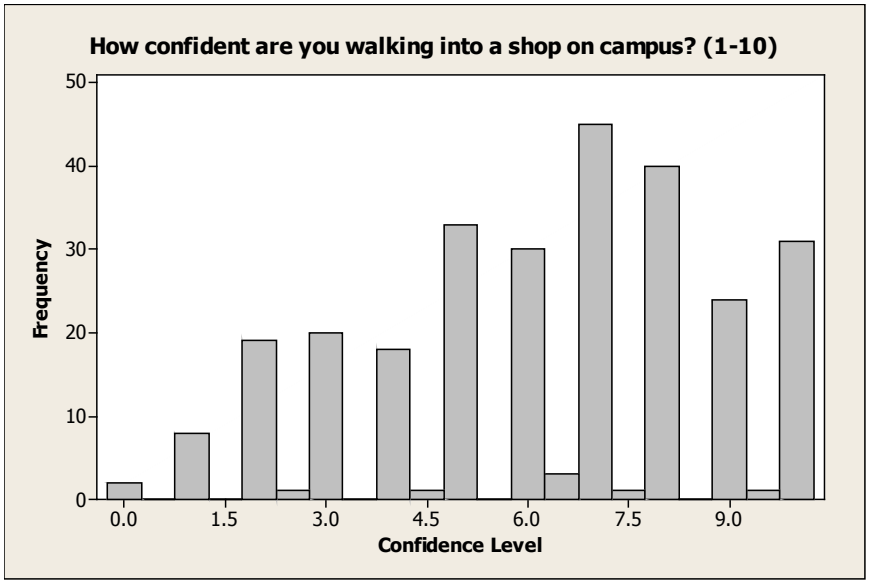


Figure 15: The figure above is a histogram with results of the 3rd question on our student survey

This question provided an interesting set of results. We expected a lower confidence level among students to walk into the machine shops. We thought students would be intimidated to enter the shops simply because they were unsure of how they worked, or how to use the tools. Clearly this wasn't the case as most students rated themselves a 7 out of 10 for confidence to enter the shops. This is great news; it means we don't need to worry about that mental barrier when designing the kits.

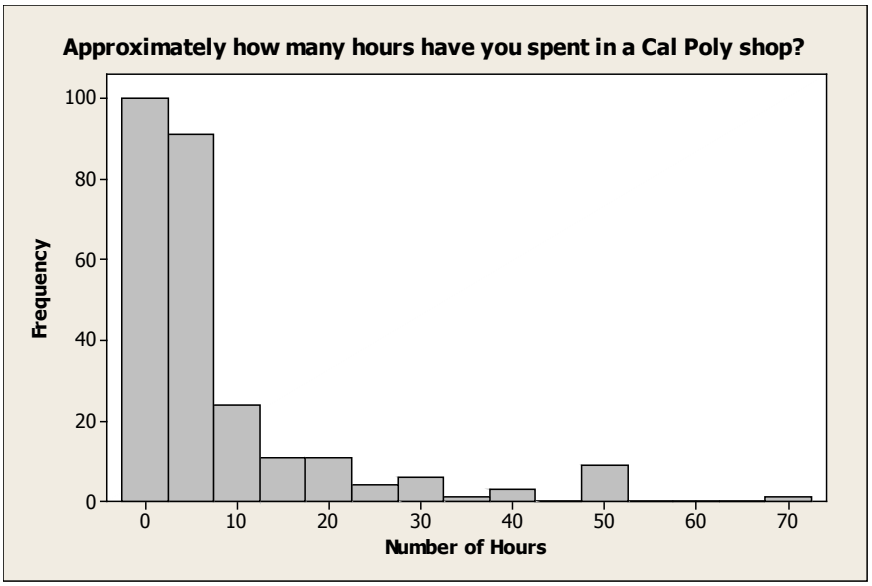


Figure 16: The figure above is a histogram with results of the 4th question on our student survey

This was helpful because seen above the vast majority of students has spent little to no time in either Mustang 60 or the Hangar. This means we will need to be very thorough in our assembly direction where tools are located, and how to operate the appropriate machinery. When analyzing this data, we decided to ignore those students who were clearly associated with the shops either through clubs or working as an employee of the shops. These individuals sometimes had hundreds of hours and would not be interested in purchasing our kits.

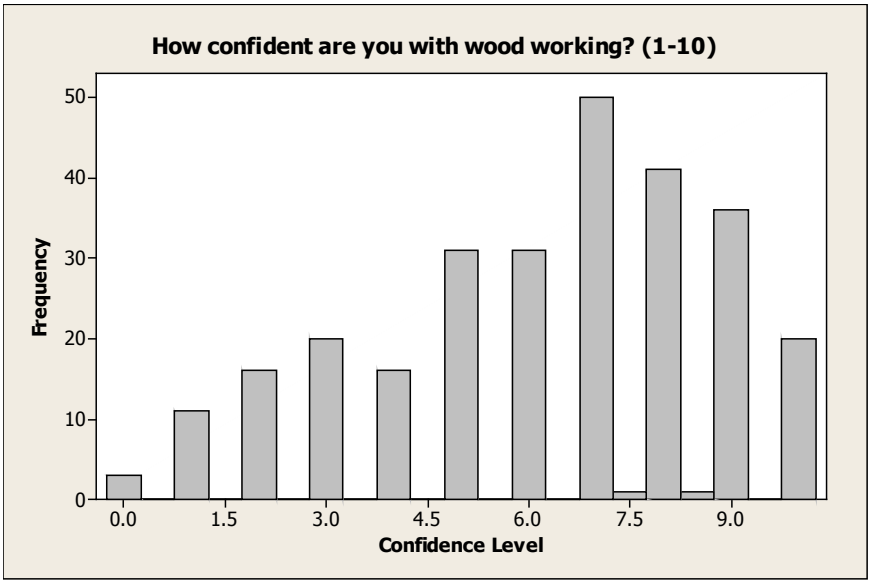


Figure 17: In the figure above is a histogram with results of the 5th question on our student survey

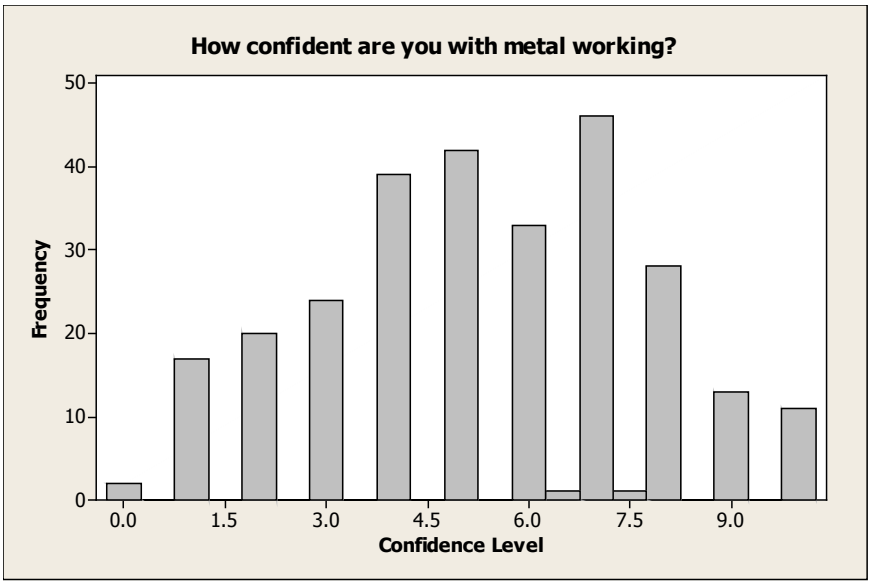


Figure 18: In the figure above is a histogram with results of the 6th question on our student survey

In Question 5 and 6 we were gauging the students' familiarity with woodworking and metalworking. We noticed that students were more comfortable working with wood as opposed to metal. Due to some responses on the surveys themselves, we think many students haven taken woodshop class at their high school and have a greater confidence with wood. This is really good to know because most students have a basic knowledge of woodworking, and so our instructions don't need to be as basic as we originally thought.

Some additional data we collected from the surveys not displayed in the histograms are shown below. In Table 2 you can see our largest population was freshman students in Dr. Davol's Introduction to Mechanical Engineering class, and the second largest is students currently starting the Mechanical Senior Project Sequence. In addition we were able to survey Dr. Mello's Intermediate design accounting for the few juniors. We choose to mostly survey freshman and seniors because we thought these two groups would be benefitting most from the instructional machine kits. The freshman need hours to utilize their new red tag, and seniors need ten hours in order to obtain yellow tag certification for senior project. Therefore we decided we wanted their opinions most, and decided to survey the classes mentioned above.

Table 3: The class level of students surveyed

Class Level of the Students Surveyed				
Freshman	Sophomore	Junior	Senior	Super Senior
100	0	8	74	0

In response to the size of project students preferred there was no clear distinction between large and small projects. We wanted to see if students would prefer a collection of smaller items since as students we don't have a lot of real estate to accumulate stuff, but the data was

inconclusive. Therefore we will use the popularity of projects to determine which will be our final products, rather than including a factor for size in our final decision matrix.

Table 4: The size of project preferred by students

Question 2 What type of project would prefer whether one large or a collection of smaller projects?		
# of Small	# of large	# of both
73	97	7

We asked students both whether or not they had any shop experience, and if so how many hours. Shockingly, the data was split exactly in half. We had expected more of the students to have been in a machine shop at least once. However this is really good to know when writing the instructions for each kit. We can now safely assume the students have very little experience and we need to provide even more detail.

Table 5: Students' previous shop experience

Question 7 Do you have any previous shop experience?			
Yes	138	No	138

These results from Table 2 simply confirm our assumption that most students don't have their yellow tag until they are required too in order to pass the first senior project class. This is great information so we know that our main audience will be able to use the tools available to those with Red Tag certification.

Table 6: How many students have their Yellow or Red Tag

Question 8 Do you have your yellow or red tag?			
Yellow Tag	41	Red Tag	228
neither	8		

This concludes the research we gathered from the surveys. Our next step is to begin writing the instructions in accordance with the information given to us by the students. Once completed, we plan to contact Senior Project classes and Introduction to Mechanical Engineering classes to gather a few interested students to complete our projects. This testing phase is indicated in the Gantt chart and should take place over a few weekend sessions at the Hangar. Using feedback from these trials, we will then make the appropriate changes to our projects and manuals.

Chapter 4 – Description of the Final Design

Below is the list of our final choices; these will be the five products for the Machine Shop Learning Kits. As discussed above these five were chosen by analyzing the needs of our sponsor and the requirements from the students. We made sure our sponsor was pleased with the learning capability from each kit, and yet the products are desirable so students will actually purchase them. Included in the descriptions below are brief summaries of the assembly processes of each kit. Material specifications and pricing for each part and kit are located at the end in Appendix C. All kits fall far under our initial price maximum range of $20.

1. Personalized Wooden Coasters

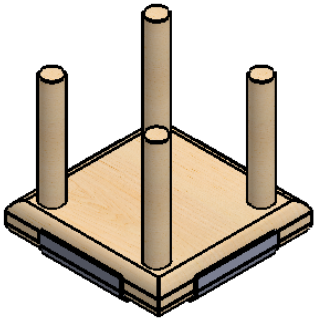


Figure19: Personalized wooden coaster stand

This project was a clear favorite in both the student poll and our decision matrix. The flexibility with the coaster design and coaster holder allows the student to spend anywhere from 2-10 hours on this project. If they only needed a couple of hours, then plain coasters will only take 2-5 hrs. However, if they want to decorate and personalize each coaster, as is recommended, this project could take up to 10 hours or more, depending on the level of creativity. Some examples of coaster designs are shown in the surrounding Figures. There are drawings with complete dimensions in Appendix B; Figure 20 and 24 is an example of these detailed drawings. The shapes that the students choose are not important, but we hope that they will utilize a couple different materials for the coasters that we will include in the kit. The circle coaster in Figure 21 could be made of pine wood. The rounded shape would be made by first cutting the wood down with a table saw, and then rounding the edges with a router. The decoration in the middle could be cut out with the laser they have in the shop. We are going to write the code for a CP design, but any other design, they would have to write some code themselves. The star example shown in Figure 22 we modeled as a plastic acrylic part. The angles are very specific and could be difficult to execute for a beginner, but that is why these shapes are only an example. The student would cut the piece into a square, and then

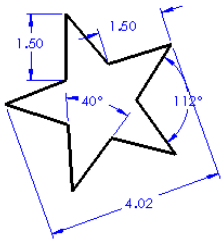


Figure 20: Dimensioned star coaster

Figure 22: Acrylic star coaster

Figure 21: Wooden circle coaster

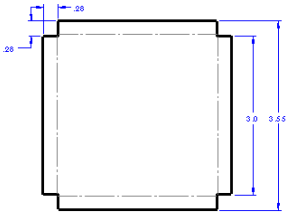


Figure 24: Dimensioned flat pattern for square coaster

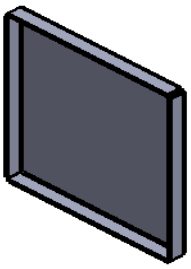


Figure 23: Metal square coaster

cut all the angles using a table saw for wood. If this process ends up being too challenging, then the star design can also be completed using the same laser with a different code design. Lastly there is a design included for a square coaster made of sheet metal. The flat pattern is shown in Figure 24. Supplied with a rough cut of sheet metal, the student would make the flat pattern by shearing the sides to size and using the corner notch punch. After creating the flat pattern, the sides would be folded up in the bender. These materials are low cost and easily accessible, making this a great choice for a beginner's kit.

The basic construction of the coaster holder will be a square wooden base with four round wooden pegs pressed into pre-cut slots. The base would be made from the same block of wood that the coaster was made from. The students would cut this piece to size and possibly decorate the edges with a router as desired. The pegs would be cut from a long, supplied dowel with a miter saw. The holes in the base would be drilled with a large drill bit. To account for tapering of the drill bit, the holes would extend about 0.1" further than necessary. The pegs would be secured into place using wood glue. In order to integrate metal into this product, we included a decorative metal base as shown in Figure 25. The decorative base would be manufactured the same way as was described for the square metal coaster. The details for the suggested designs are shown in Appendix B.

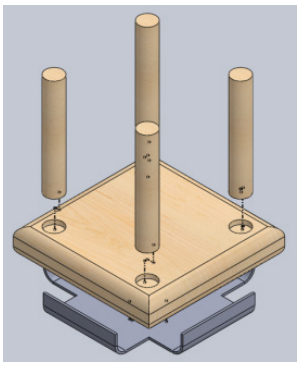


Figure 25: Exploded view of coaster stand

2. Wall Mounted Bottle Opener

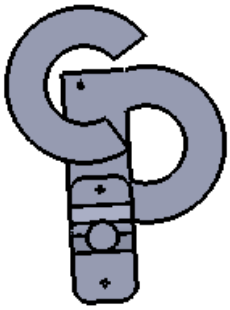


Figure 26: Wall mounted bottle opener

This project idea scored second in the decision matrix and sixth in the student survey vote. We decided this would make an excellent project for a Yellow Tag Kit. The CP will be made of 1018 low carbon steel sheet metal, cut using the optical plasma torch located in the Hangar. Then the student would be able to weld the two letters together to practice the welding skills learned in IME 142. One of the additional benefits of using the plasma torch with the optical scope is that the student could use any design for the backing plate to their bottle opener as long as they could draw it without fine detail. We will include specifications on the limitations of the scanning plasma cutter. Once the design of the backing plate is cut, the student will punch holes in the design in order to mount it on a wall. The holes will be made with the standard hole punch machine also located in the Hanger. The bottle cap opener will be supplied form a vendor and attached with rivets as shown in Figure 27.

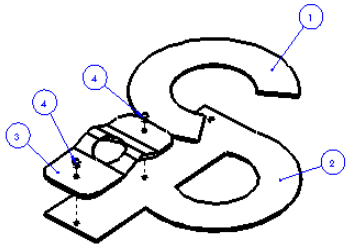


Figure 27: Exploded view of wall mounted bottle opener

The kit will come with an additional supply of the same type of sheet metal to make a bottle cap catcher, shown in Figure 28. This part the student will cut to size using a metal shearer and then weld together. The large backing plate is an excellent area of metal where beginner welders can weld lines for practice. The easiest welding for beginners on corners such as these will probably be TIG welding. In addition they would punch holes in this backing plate, again with the metal hole puncher, in order to attach the cap catcher to a wall. The whole part would need to be ground and polished to remove any burrs or slag from the welding process. Detailed drawings can be found in Appendix B.

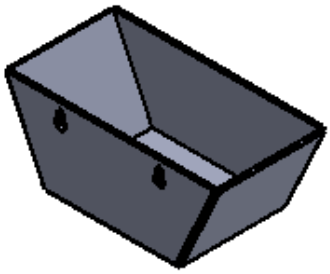


Figure 28: Bottle cap catcher

3. Floating Wine Holder

Figure 29: Floating wine bottle holder example

The kit to make this wine bottle holder is a good project for a beginner red tag student. For the average student this project would require 1-1.5 hours, but could take longer is multiple mistakes are made. The strict geometry, shown in Figure 29, could take some effort, but would allow the student to become very familiar with the calipers and other measuring tools available for check out. Supplied with a rough cut of wood, the student would have to sand and size the rectangular stand appropriately. The main difficulty is in cutting the correct angle at the bottom of the stand and hole position for the bottle. However, there is a machine in the shop equipped especially for tackling this specific angle. The angle will be reasonably easy to cut using the table saw. The hole will be cut using the circle saw, which is an attachment to a hand drill. After the initial hole is cut using the circle saw, it will need to be leveled out so that the bottle can sit at the right angle to counteract the moment caused by the weight of the bottle. The hole alteration for this part, however, does not need to be too specific. This alteration can be roughly done with a wood chisel and hammer, and then smoothed down with sanding. One benefit of this project is that if the student gets it wrong the first time, he or she can have a second attempt at making a slightly shorter stand. We chose this design because it ranked fourth in our Decision matrix,

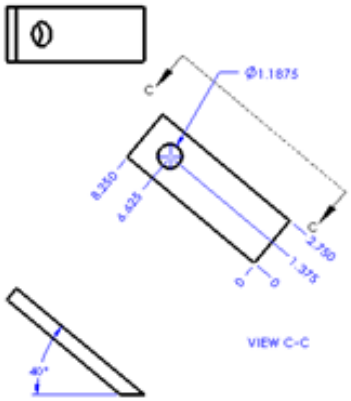


Figure 30: Detailed drawing preview

Figure 31: Floating wine bottle holder

which was very high and second in the survey given to students. Detailed drawings for this part can be found in Appendix B and technical analysis in Appendix E.

4. Puzzle Box

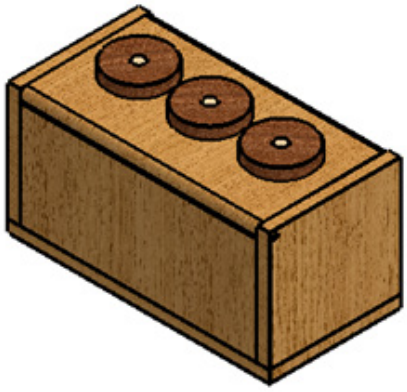


Figure 32: Puzzle box

This kit will be for a more advanced Red Kit user. We estimate this project will take the average student 5-8 hours. The basic geometry is a square box with a hinged top and partway down the front side will be an added ledge. The lid will contain three circular disks with a dowel inserted into the center and another disk attached to the other end. The rounded discs will be supplied. The students will need to cut holes into the middles of the discs for the dowels using the drill press. The inside disks will have a flat edge cut to allow for the "puzzle" part of the box as shown in Figure 33. These flats the students would cut using a hand saw. The dowels attaching the upper and lower discs will be supplied as a long rod that the student will have to cut to the correct length using a miter saw. These three components with be secured with a slight press fit, hammered together and wood glued. When these three disks are oriented in the correct position the lid will open because the three flat edges are lined up with the ledge. Also included would be some smaller stock to be cut for the hinge; these can be seen in Figure 34. These boxes will be made from thin pieces of wood to be sanded and cut to size by the student. The sides will be attached together to form a box with finishing nails. The ledge will also be connected with these finishing nails. This is a little more advanced of a project since the straight edges need to be accurate so the lid will still open in the correct orientation. However other than that this is a generally simple box with a hinged lid. There is also some room for error when placing the ledge, because the student can always sand down the ledge to achieve a better fit. Detailed drawings for each of the pieces are included in Appendix B.

Figure 33: Puzzle box example

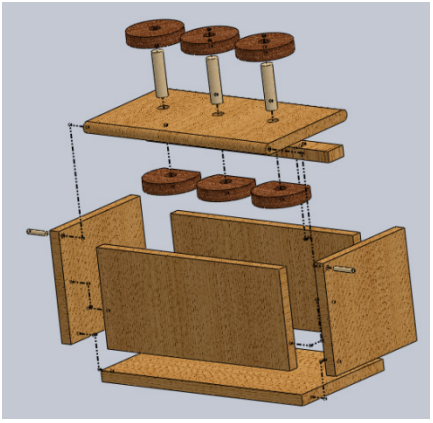


Figure 34: Exploded view of puzzle box

5. Key Rack

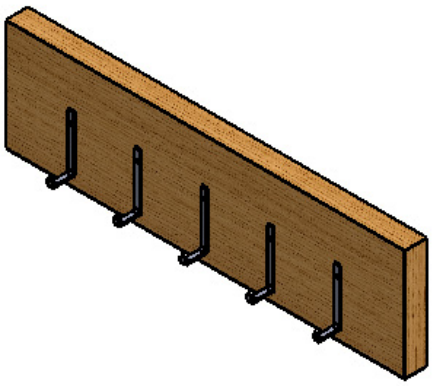


Figure 35: Key rack

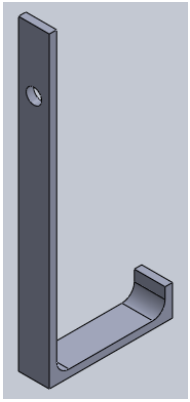


Figure 36: Metal hook

The key rack was selected for the experience it will provide the student with in both metal work and woodwork. Although it only scored sixteenth when ranking student survey data, it did score eighth in the Decision Matrix, which considered some additional very important criteria which students may not have considered when making their choices. The student would be supplied with a rough plank of wood, which they will reshape and decorate as desired. For a basic, minimum time required kit, the student can merely sand and smooth the wood to make the back panel shown in Figure 35.

Figure 37: Additional back plate option

However, it will be recommended that the student experiment with the wood to achieve a more personal design. This could be completed with a series of tools to complete this task, such as hand saws, band saws, hammers, chisels, taps, and drill presses. An example of an alternate back design is shown in Figure 37. The strips can be made by running the wood through the table saw and then reattaching the wood using wood glue and clamps. This look can also be achieved by making notches out of the wood using a band saw or a scroll saw. The student would also get plenty of experience shearing, bending, punching, and filing metal for the hooks. These would be made of a large rectangular bar of sheet metal. Detailed drawings for the components are found in Appendix B and technical analysis in Appendix E.

Manufacturing and Safety Plan

The manufacturing plan for the Machine Shop Kits will be the shop technicians assembling the necessary material for each kit. Our sponsor Eric Pulse plans on utilizing the shop cleaning hours mandatory for all students who use Mustang 60 and the Hangar. This assembly will include cutting the large bulk sheets of wood and steel into smaller pieces for the student to continue to work upon. We will include drawings for the shop technicians to follow in order to cut the large sheets down to size. In addition the technicians will assemble the necessary number of bolts, screws, and additional components necessary for each kit to be successfully completed. The final kits will include detailed instruction, necessary materials, and any additional

components. They will be kept in Mustang 60 for students to purchase and begin using by winter 2014.

The main safety we are concerned with is the students using tools they are unfamiliar with. We will prevent any injury by including written safety material and warnings for the machinery used in individual kits. In addition the shop technicians are very aware of students looking confused, and jump in with advice the moment they see confusion on a student's face. Between the expertise and guidance from shop technicians and our safety information the students will be fully equipped to prevent accidents and harm to themselves and others. We feel these two precautions are more than adequate to face this safety concern.

Chapter 5 – Product Realization

Our next step in this project was to build the projects ourselves. We began the rough draft of instructions for student assembly coinciding with construction of each project. This way, we can be sure to acknowledge any confusion the student may encounter along the way because we will have first-hand knowledge. We collaborated with two shop technicians, Jessica Cain and Hayden Cory, to gain more knowledge about the various shop machinery available. This was very helpful in deciding the best process to construct each of the individual kits.

The five projects were split between the two of us for initial building. Samantha Kelley was responsible for the Wooden Coasters, Floating Wine Bottle Holder and the Key Rack. Ellen Chambers was responsible for the Wall Mounted Bottle Opener and Puzzle box construction.

The Puzzle Box kit was a challenge due to the small thickness of the wood. However the table saw was the best choice in breaking up the sheet of walnut into the individual kit squares. The first iteration of the kit provided a puzzle box that was too small, and so we scaled up all the dimensions by 30%. In order not to waste base materials we constructed make-shift kits used for the initial prototype and testing event, but kept the original design for the kit material for future use. We then used the vertical band saw in order to cut the dowels down to size, and put all the small wooden pieces in a recycled McMaster bag. During this process it was found a hand saw worked much better for cutting the dowels, since the vertical band saw usually sent the small pieces flying. This manufacturing change made a little more physical effort in the cutting process, however resulted in a safer and higher quality product.

The Wall Mounted Bottle Opener Kit is a very simple kit to manufacture. The large aluminum sheet was cut down to size by using the manual shear in Mustang60. We ran into trouble since one half of the blade is duller than the other, and resulted in some small damage to the material. However, once the correct half was identified we noted this change in the student assembly instructions. The bottle opening attachment and rivets were pre-ordered, and so the appropriate number for each was put in a recycled McMaster bag for the final kit. For future manufacturing we are looking at purchasing a larger sheet of aluminum, and so the large shear in the Hangar may be necessary for kit construction.

The Floating Wine Bottle Holder is our simplest kit. Although this kit has only a few cuts to make, it is still fairly time consuming because it is a largely iterative project. The geometry for this stand is such that every wine bottle shape requires slightly different dimensions. This is something we learned while making the project. We recommend using the drill press with a spindle bit or a hole saw to make the hole for the neck. The angle at the bottom of the wood can be easily cut with the miter saw. The iterative part comes next. We are recommending that there be a bottle on site or that students bring their own to ensure proper geometry. Our dimensions work with the typical bottle, but for some other shapes and sizes, additional sanding with the vertical belt sander may be required.

The Personalized Coasters is a very fun kit with lots of different materials to work with and a lot of opportunity for creativity. Students are able to practice working with wood, metal, and acrylic here to make a base for their coasters and at least three other coasters. The base of the coasters has a unique edging added to it with the router. Because this tool requires a piece that is twelve inches long, a jig was made for this specific purpose. Then the drill press is used to add holes for wooden dowels that are supplied. These are press fit into the drilled holes and secured with wood glue if desired. The coasters are made with a large variety of tools in both the wood and metal shops. The metal coaster is made with the brake press to shear and bend, or the tin snips. The wooden and acrylic coasters can be made with mostly wood tools, with acrylic having some restrictions. Overall, tools and machines in the shop are suggested, but ultimately the design and process will come from the student.

The Key Rack is a simple kit that incorporates both metal and wood. The wood backing is made using the table saw, band saw, or miter saw to shorten the material. Then the holes are added with the drill press. The wood is sanded down using the vertical band saw, or by hand. The metal for the hooks is then cut using the brake press and/or tin snips with the hole made using a hole punch for metal. The pieces are assembled with screws provided in the kit and a screwdriver.

For further instructions on how to assemble kits and projects, please see the instructions guides for students and Shop Technicians. These packets are designed to be fully comprehensive and should answer any and all questions about types of materials, machines, and processes that are to be used in these projects.

Chapter 6 – Design Verification

After the initial kit prototypes were completed, we began testing the effectiveness of our instruction manuals. In addition we tested the quality of the final kit products. On Saturday November 1st, our big testing event was held in Mustang 60 from 9am-2pm. We found volunteers by presenting to Professor Schuester's Senior Project I class, and convinced them to give us their Saturday morning in exchange for shop hours and donuts. We had enough kits for ten students, and even had to turn away some students who showed up simply because we didn't have the materials. Two shop technicians, Haden Cory and Jessica Cain, opened the shops and remained to help the students throughout the entire morning. This testing event was a great success; all the students enjoyed making their individual kits.

Each kit had at least two students testing the prototypes, and a few had three testers. The students arrived at 9am and were greeted with coffee and donuts while they read through our shop safety information. We then met with each group of students constructing the different kits, and distributed the assembly instructions and materials. Once the students started work on their projects we spend the rest of the time answering questions. The students had little trouble in constructing their kit, but through this process we did find better ways of making the kits. Each student had suggestions about how to either make the kit itself or the manufacturing process better. We received a large amount of feedback and suggestions that really improved our original instructions.

Below are some photos from this event:

Figure 19. Shop Technician Jess Cain helping some of our volunteers with their key racks.

Figure 20. Toby and Austin with the wooden coasters base.

Figure 21. One of our volunteers testing his successful floating wine bottle holder.

Figure 22. Two of our volunteers working out dimensions for the puzzle box.

Figure 23. Group Shot of everyone who attended the Machine Shop Kit Testing Event.

Using our initial prototypes and the student's final products from testing day, we will select a few for functionality testing. It is important to test both our products and the ones completed by the students who were brand new to our kits and their construction. This is important because if one of the prototypes fails a test we can see if it was a design error or an assembly error made by the student.

Primarily we will need to test the key rack for buckling based on our predetermined test weight of five pounds. To test the key rack hook we hung a five pound weight from each of the hooks and see their response. If there is no visual deflection the hook the key rack passed our test. We also tested a hook to failure by adding additional weight until the hook either tears from the wooden backboard or strains creating permanent deflection. The maximum weight before permanent deflection occurred was seven pounds on the hook that was ¾" wide. This way we found the actual maximum allowable load on the hooks to ensure they corresponded with our theoretical values. This information is included as a warning on the kits with a large factor of safety to discourage home testing of the failure modes.

In addition we conducted a fatigue test on the wall mounted bottle opener prototype. This test occurred during the weekend of November 7-9th in the home of Toby Goldsteinholm. This way throughout the weekend our bottle opener will withstand heavy usage. This will be a good indication of its strength and durability to be opened in rapid succession. The bottle opening attachment will be bought from an online supplier provided by our sponsor Eric Pulse. We conducted this test to verify the supplier's component specifications and the reliability of the rivets attaching the bottle opening attachment to the backing plate.

Another factor we observed from this test is how easy it is for the caps to fall in the cap catcher. This test was a design verification to ensure the bottle cap catcher's top surface is large enough to catch the falling bottle caps, and the original design passed. We were unable to find data supporting normal trajectories of bottle caps, so we were unable to create a theoretical model. This test was important to confirm the dimensions are adequate on the current design. This test does not impact the safety of the product, so consequences will be minimal if failure occurs, but luckily failure did not occur so it was a non-issue.

Additional information concerning these testing processes can be found in the Gannt chart, FMEA charts (Failure mode and Effect Analysis), and the DVP&R (Design Verification Plan and Report) found in Appendix F.

Chapter 7 – Conclusions and Recommendations

Throughout this report we have proven that the designs appropriately fulfill the predetermined design specifications. Of the five projects we followed to completion, four are for red tag designated users, and one is for those who already have their yellow tag. We are going to recommend the key rack and floating wine bottle holder for beginner red tag students, who are new to shops and their equipment. The personalized wooden coasters is a project that will be recommended for a student of intermediate skill level. The puzzle box is then an advanced red tag project. Although these kits were designed at slightly different skill levels, the included instructions made each project easily accomplished by all levels of experience in a shop.

After extensive testing, we found that our project fulfilled and exceeded all of the testing requirements that had been set. Feedback from our sponsor and the student testers reinforced that these designs will fully satisfy the need for teaching kits in the Cal Poly Machine Shops.

Chapter 8 – Operators Manual

Each kit will need:

- Printed Student Assembly Instructions
- Base Materials

Located in the lower lockers provided to us by Mustang 60 are the left over materials from the testing event. There is enough material to make a couple of each kit, so it is sufficient to get the two shops started. Within the Shop Technician instructions is a list of raw materials needed for each it, and so when you need to purchase more materials this is where you can find what to buy.

All of our files are located within the dropbox file shared with George, Haden, and Eric. The files are separated by projects and are pretty self-explanatory. Each kit has its own file, and located within each file is a folder that contains the Shop Technician Instructions, Student Instructions, and Solidworks Drawings. All these files are unprotected and subject to change if any need to be made.

Appendix A:

House of Quality

The house of quality is a tool used to facilitate decision making in a way that ensures you remain true to the required deliverables. It does this by visually displaying the relative importance of the user demands into a more measurable quantity representing design quality. It also indicates the best methods to implement as a way to achieve this design quality.

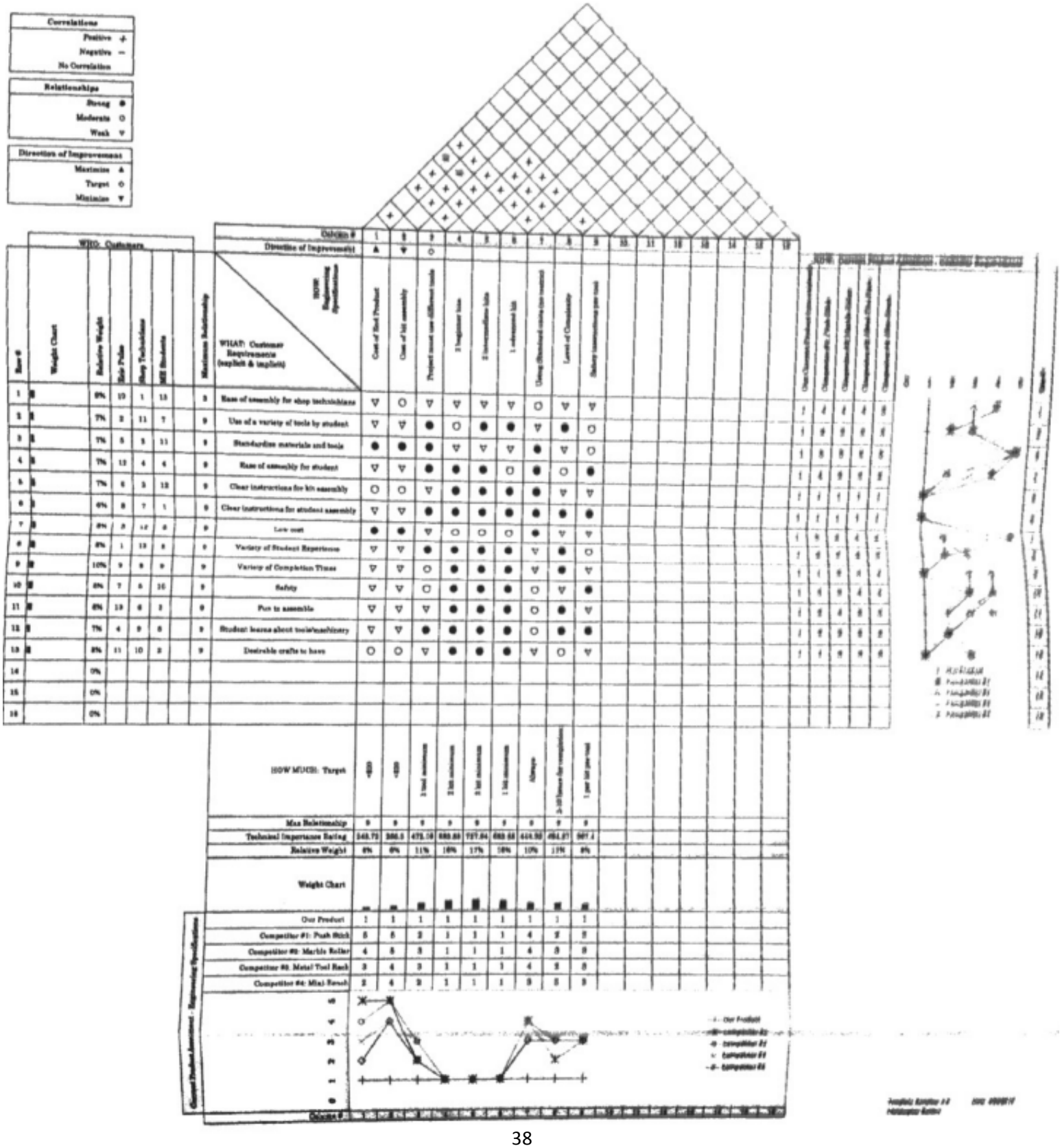
In our house of quality, shown on the following page, we have our three customers shown in the column farthest to the left. Our three customers we are hoping to satisfy with our kit design are Eric Pulse, the shop technicians, and the students. The next column over has a list of the customer requirements. In the columns for each customer, we rated how important each criterion was according to our three unique markets. Interestingly enough, this meant that the QFD rated our requirements as almost equally important since our customers all had different interests in the kit.

The QFD also compares these criteria against the current products being used and what we hope to create. These existing products are shown in the columns on the right with ratings of how well each project fulfills each of the specific design requirements located on the left. The lines to the left of these columns is a more visual display of how well each project is satisfying the given project parameter. In the QFD shown, our project is rated only with ones because at this point in the decision making process, we had not decided on any of our designs. The other projects the shops currently use excelled in using standardized materials, and ease of assembly for shop technicians. The projects did poorly when it came to the ease of assembly for the student and clear instructions.

The middle section of the house of quality has symbols that represent to what degree the customer requirements are related to each other. The legend for these symbols is located in the upper left hand corner of the diagram. This helps the QFD to calculate which project parameters are the most important. The upper section of the QFD, or the roof of the house, serves a similar purpose. The only difference is that this section relates the engineering requirements to each other, rather than the customer requirements to the engineering requirements. The engineering requirements, located along the top, differ from the customer requirements by being more specific and more measurable. This also helps to calculate which requirements are the most important.

The bottom portion, or the basement of the house, totals up the importance of all the requirements with the importance of each requirement to illustrate the overall quality of each design. Completing a house of quality analysis indicated the strengths and weaknesses of the existing products. This was very helpful in demonstrating which parameters we had to focus on and in which parameters their projects already excelled.

QFD: House of Quality
Project:
Revision:
Date:



Pugh Matrices

	Datum- Book End	Bedside Table	Small Bookshelf	Clothes drying rack	Picture frame	Wall hooks	Key rack	Cell phone charging station	Cutting board	Kitchen spoon holder	Personalized wooden coasters	Pencil holder	Silverware organizer	Wall mounted bottle opener	Puzzle box (it's a puzzle to open it)	Engraving cell phone case or safety goggles	Wooden candle holder	Electric plug safety cover	Basket mounted to bicycle	Files holder	Foot stool	Crate for storage	Vegetable Planters	Wall shelves	Lunch box	Birdhouse	pencil case	Key holder (box or bowl)	Jewelry box	Floating wine bottle holder	Wooden Block Letters (initials/name)
Ease of assembly for shop technichians		-	+	-	+	+	-	+	+	-	+	-	-	+	-	+	-	+	-	-	-	-	+	+	-	+	-	-	+	+
Use of a variety of tools by student		+	+	-	+	-	-	+	-	+	+	+	+	+	+	-	+	-	+	+	+	+	-	-	+	-	-	+	+	+	-
Standardize materials and tools		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ease of assembly for student		-	+	+	-	-	+	-	+	-	+	-	-	-	-	-	+	-	-	-	-	+	-	-	+	+	-	-	-	+
Clear instructions for kit assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Clear instructions for student assembly		-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	-	+	+	+	+	+	-	+	+	+
Low cost		-	-	+	+	+	-	+	+	+	-	+	-	-	+	-	+	-	-	-	-	-	+	-	-	+	+	-	-	+	+
Variety of Student Experience		-	+	+	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	+	-	-	-	+	-	-	+	+	-	-
Variety of Completion Times		+	+	+	+	+	+	-	-	+	-	+	+	+	+	-	+	-	+	+	+	+	+	-	-	+	-	-	+	+	+
Safety		-	-	+	+	+	+	-	+	-	+	-	+	+	-	+	-	+	-	+	+	-	+	+	-	-	-	-	+	+	+
Fun to assemble		+	+	+	+	+	-	+	-	+	+	+	-	+	+	+	+	-	+	-	-	+	-	-	-	-	-	-	-	+	+
Student learns about tools/machinery		-	+	-	+	-	-	+	-	+	+	+	+	+	+	-	+	-	+	+	+	-	-	-	+	+	-	-	-	-	-
Desirable crafts to have		+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	+	-	+	-	-	-	-	-	+	+	+	+	-
Score		-1	9	5	9	5	1	5	3	5	7	5	1	9	5	-3	3	-1	3	1	3	1	3	-3	-1	3	1	-3	3	7	5

Figure 1. Pugh Matrix using the Book End datum.

	Datum- Marble Roller	Bedside Table	Small Bookshelf	Clothes drying rack	Picture frame	Wall hooks	Key rack	Cell phone charging station	Cutting board	Kitchen spoon holder	Personalized wooden coasters	Pencil holder	Silverware organizer	Wall mounted bottle opener	Puzzle box (it's a puzzle to open it)	Engraving cell phone case or safety goggles	Wooden candle holder	Electric plug safety cover	Basket mounted to bicycle	Files holder	Foot stool	Crate for storage	Vegetable Planters	Wall shelves	Lunch box	Birdhouse	pencil case	Key holder (box or bowl)	Jewelry box	Floating wine bottle holder	Wooden Block Letters (initials/name)
Ease of assembly for shop technichians		+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	-	+	-	-	+	+	+	+	-	+	+
Use of a variety of tools by student		-	+	+	+	-	-	-	-	-	+	-	+	+	+	-	-	+	+	+	-	+	+	-	+	+	-	-	+	-	+
Standardize materials and tools		s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
Ease of assembly for student		+	+	-	+	+	+	-	+	+	+	+	+	-	-	+	+	+	-	-	+	-	+	+	s	s	+	+	s	+	+
Clear instructions for kit assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Clear instructions for student assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Low cost		-	-	-	s	s	s	s	s	+	+	s	s	+	s	+	+	+	-	s	-	-	-	s	-	-	s	+	-	+	+
Variety of Student Experience		-	+	+	+	-	-	+	-	-	+	-	+	+	+	-	-	-	+	+	-	+	+	-	+	+	-	-	+	-	+
Variety of Completion Times		+	+	+	+	+	-	-	-	-	+	-	-	+	+	-	+	+	+	+	-	+	+	-	+	+	-	-	+	+	+
Safety		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Fun to assemble		+	+	-	+	+	+	-	-	-	+	-	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Student learns about tools/machinery		-	+	-	+	-	-	+	-	-	+	-	+	+	+	+	+	-	+	+	+	+	+	-	+	+	-	+	+	+	+
Desirable crafts to have		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Score		5	11	3	13	7	5	5	3	3	13	3	11	9	11	7	9	7	7	9	5	7	9	5	11	11	5	7	9	9	13

Figure 2. Pugh Matrix using the Marble Roller datum.

	Datum- Marble Roller	Bedside Table	Small Bookshelf	Clothes drying rack	Picture frame	Wall hooks	Key rack	Cell phone charging station	Cutting board	Kitchen spoon holder	Personalized wooden coasters	Pencil holder	Silverware organizer	Wall mounted bottle opener	Puzzle box (it's a puzzle to open it)	Engraving cell phone case or safety goggles	Wooden candle holder	Electric plug safety cover	Basket mounted to bicycle	Files holder	Foot stool	Crate for storage	Vegetable Planters	Wall shelves	Lunch box	Birdhouse	pencil case	Key holder (box or bowl)	Jewelry box	Floating wine bottle holder	Wooden Block Letters (initials/name)
Ease of assembly for shop technichians		+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	-	+	-	-	+	+	+	+	-	+	+
Use of a variety of tools by student		-	+	+	+	-	-	-	-	-	+	-	+	+	+	-	-	+	+	+	-	+	+	-	+	+	-	-	+	-	+
Standardize materials and tools		s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
Ease of assembly for student		+	+	-	+	+	+	-	+	+	+	+	+	-	-	+	+	+	-	-	+	-	+	+	+	+	+	s	+	+	+
Clear instructions for kit assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Clear instructions for student assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Low cost		-	-	-	s	s	s	s	s	+	+	s	s	+	s	+	+	+	-	s	-	-	-	s	-	-	s	+	-	+	+
Variety of Student Experience		-	+	+	+	-	-	+	-	-	+	-	+	+	+	-	-	-	+	+	-	+	+	-	+	+	-	-	+	-	+
Variety of Completion Times		+	+	+	+	+	-	-	-	-	+	-	-	+	+	-	+	+	+	+	-	+	+	-	+	+	-	-	+	+	+
Safety		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Fun to assemble		+	+	-	+	+	+	-	-	-	+	-	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Student learns about tools/machinery		-	+	-	+	-	-	+	-	-	+	-	+	+	+	+	+	-	+	+	+	+	+	-	+	+	-	+	+	+	+
Desirable crafts to have		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Score		5	11	3	13	7	5	5	3	3	13	3	11	9	11	7	9	7	7	9	5	7	9	5	11	11	5	7	9	9	13

Figure 3. Pugh Matrix using the Marble Roller datum.

	Datum- Push Stick	Bedside Table	Small Bookshelf	Clothes drying rack	Picture frame	Wall hooks	Key rack	Cell phone charging station	Cutting board	Kitchen spoon holder	Personalized wooden coasters	Pencil holder	Silverware organizer	Wall mounted bottle opener	Puzzle box (it's a puzzle to open it)	Engraving cell phone case or safety goggles	Wooden candle holder	Electric plug safety cover	Basket mounted to bicycle	Files holder	Foot stool	Crate for storage	Vegetable Planters	Wall shelves	Lunch box	Birdhouse	pencil case	Key holder (box or bowl)	Jewelry box	Floating wine bottle holder	Wooden Block Letters (initials/name)
Ease of assembly for shop technichians		-	-	-	+	-	-	-	+	-	+	-	-	-	-	+	-	+	-	-	-	+	-	-	-	-	-	-	+	+
Use of a variety of tools by student		+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	+	-	+	+	+	-	-	+	-	+	+	+
Standardize materials and tools		+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+	+	-	-	+	+	-	-	+
Ease of assembly for student		-	-	-	+	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-
Clear instructions for kit assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Clear instructions for student assembly		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Low cost		-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Variety of Student Experience		+	+	+	+	-	-	+	-	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Variety of Completion Times		-	+	-	-	+	-	-	+	-	+	+	-	+	+	-	-	-	+	-	+	-	-	+	-	+	-	-	+	+
Safety		-	-	-	+	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	+	+	-	-	+	-	-	-	-
Fun to assemble		-	-	+	+	-	-	-	+	-	+	-	-	+	+	-	+	-	+	-	-	-	-	-	-	-	-	-	+	-	-
Student learns about tools/machinery		+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+	-	-	+	+	+	+	+	+	+	+
Desirable crafts to have		+	+	-	+	+	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Score		1	3	-1	7	-1	-3	1	5	-3	11	5	-1	5	5	5	3	-3	3	-1	3	5	3	-1	-3	5	-1	-1	3	5	5

Figure 4. Pugh Matrix using the Push Stick datum.

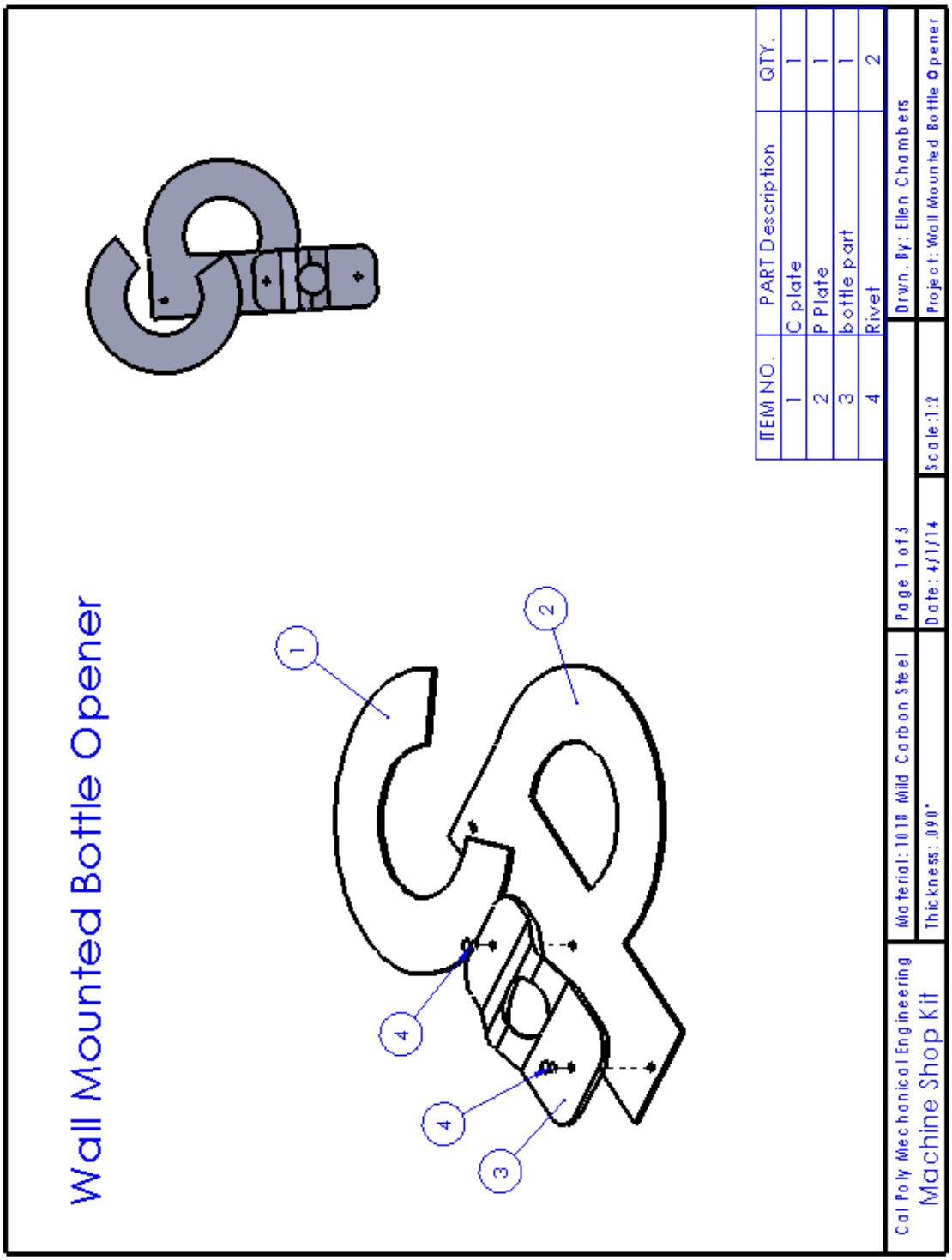
Decision Matrix

Weigting Factor	2	3	5	3	3	5	3	4	12	4	4	5	3	56
	4%	5%	9%	5%	5%	9%	5%	7%	21%	7%	7%	9%	5%	100%
Option	Ease of Shop Tech Assembly	Tool Variety	Std. Materials	Ease of Student Assembly	Assembly Instructions for Techs	Clear Student Instructions	Variety of Experience	Time Variety	Student Survey	Fun	Student Learning	Safety	Low Cost	Score
Personalized wooden coasters	100	75	50	75	90	100	100	100	100	75	75	50	50	82
Wall mounted bottle opener	50	75	50	50	90	100	50	50	100	75	75	50	75	74
Wooden Block Letters	100	50	50	75	90	100	100	100	75	75	50	50	50	73
Floating wine bottle holder	100	25	50	25	90	100	100	75	100	75	25	50	75	72
Picture Frame	100	75	50	25	90	100	100	100	75	75	75	50	25	72
Puzzle box (it's a puzzle to open it)	75	50	50	10	90	100	25	75	100	75	50	50	75	70
Cell phone charging station	100	50	50	50	90	100	25	50	100	75	50	50	50	70
Key rack	100	50	50	75	90	100	75	50	75	75	50	50	75	70
Bedside Table	75	25	50	75	90	100	25	50	100	75	25	50	75	68
Small Bookshelf	75	25	50	50	90	100	25	50	100	75	25	50	50	66
Wall hooks	100	50	50	75	90	100	75	50	50	75	50	50	100	66
Birdhouse	75	50	50	50	90	100	10	90	75	75	50	50	50	65
Engraving Personal Items	100	10	50	75	90	100	10	10	100	75	10	50	100	65
Cutting board	100	25	50	75	90	100	10	50	75	75	25	50	75	63
Foot stool	75	25	50	75	90	100	25	50	75	75	25	50	50	62
Basket mounted to bicycle	25	50	50	25	90	100	25	75	75	75	50	50	25	61
Crate for storage	75	25	50	75	90	100	25	50	75	75	25	50	25	60
Wall shelves	75	25	50	50	90	100	25	50	75	75	25	50	50	60
Jewelry box	25	75	50	25	90	100	50	75	50	75	75	50	25	60
Silverware organizer	100	50	50	50	90	100	25	50	50	75	50	50	50	59
Lunch box	50	50	50	25	90	100	10	75	50	75	50	50	25	55
Files holder	50	25	50	75	90	100	25	50	50	75	25	50	50	55
Pencil holder	100	25	50	75	90	100	25	50	25	75	25	50	75	53
pencil case	75	25	50	75	90	100	10	50	25	75	25	50	75	51
Vegetable Planters	75	25	50	75	90	100	25	50	25	75	25	50	25	49

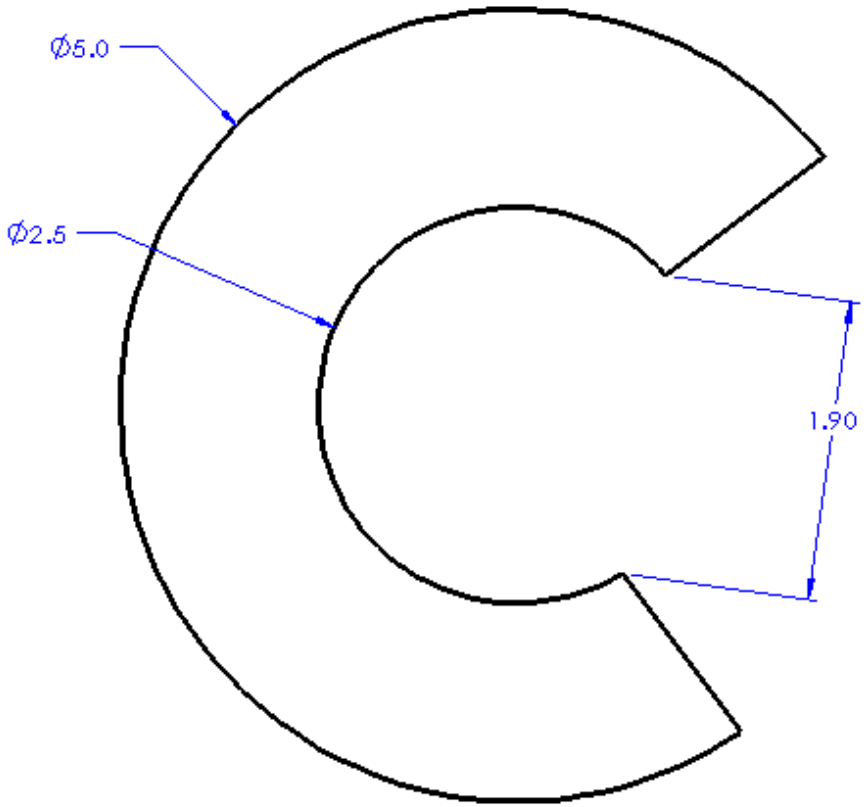
The decision matrix shown above is a different format than commonly seen, however it performs the same function in a more compact version. For each project option we assigned a score from of 0, 25, 50, 75, 90 or 100 based on how well they fulfilled the engineering specification for the column. This score was then multiplied by the weighted percentage we assigned each engineering specification based on how important we considered it compared to the other specifications. We then added up all these numbers to give us a final score which ranked the projects top to bottom based on which fulfilled the specifications best, and in the areas we found most important. The results can be seen above.

Appendix B: Detailed drawings

Includes assemblies with Bill of materials, detailed part drawings, Process and Instrumentation Drawings



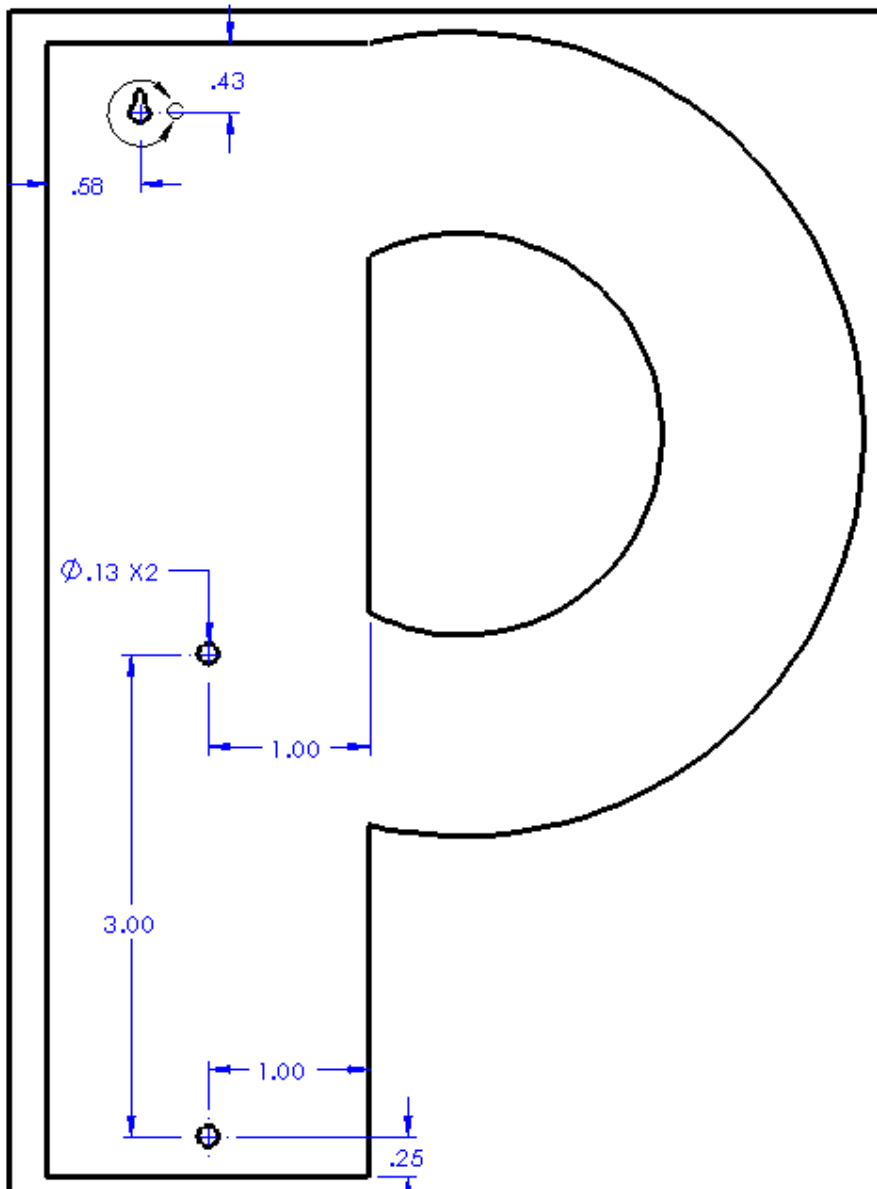
C-Plate

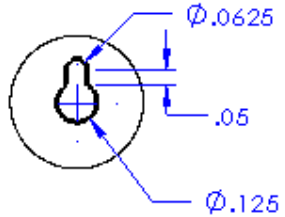


NOTE:
1. Drawing is scaled to actual size so the image may be carefully traced for use in the scanning plasma cutter.
2. Dimensions are suggestions, the backing plate is open for creativity.

Cal Poly Mechanical Engineering Machine Shop Kit	Material: 1018 Mild Carbon Steel Thickness: .090"	Page 2 of 3 Date: 4/1/14	Scale: 1:2	Drwn. By: Ellen Chambers Project: Wall Mounted Bottle Opener

P-Plate



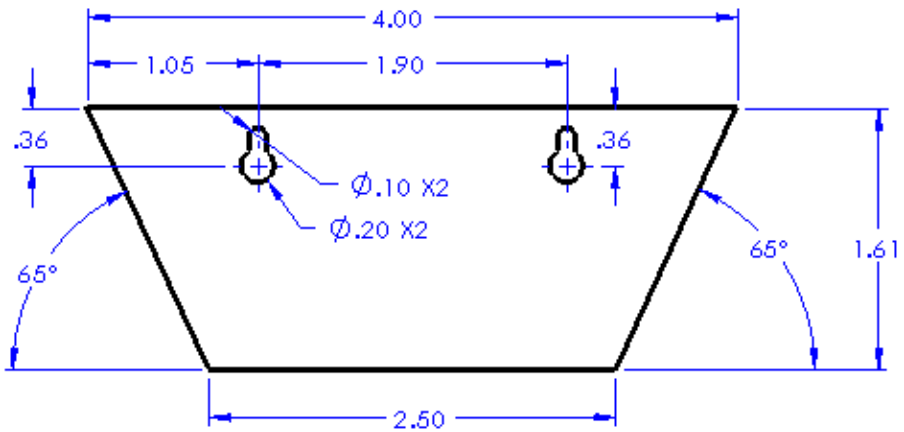


DETAIL C
SCALE 2 : 1

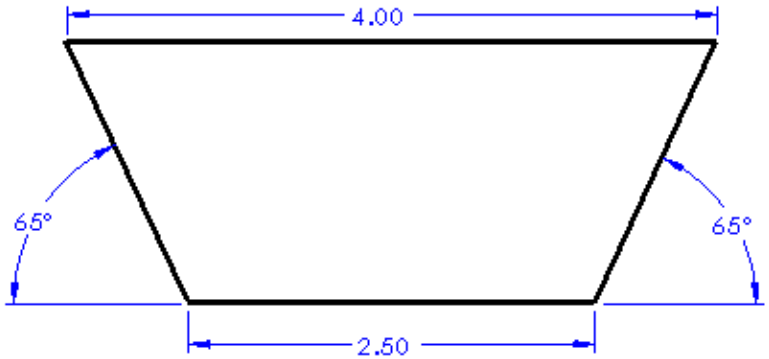
NOTE:
1. Drawing is scaled to actual size so the image may be carefully traced for use in the scanning plasma cutter.
2. Dimensions are suggestions, the backing plate is open for creativity.

Cal Poly Mechanical Engineering Machine Shop Kit	Material: 1018 Mild Carbon Steel	Page 3 of 5		Drwn. By: Ellen Chambers
	Thickness: .090"	Date: 4/1/14	Scale:1:1	Project: Wall Mounted Bottle Opener

Bottle Cap Catcher



Item NO. 1



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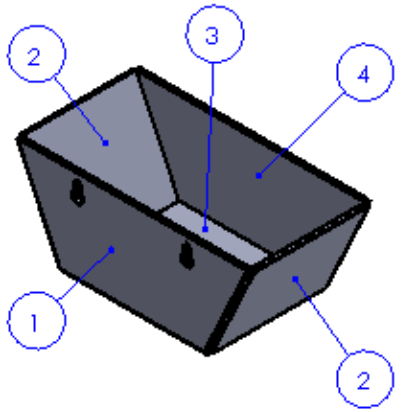
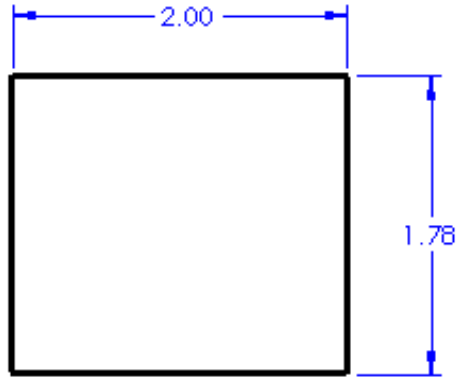


NOTE:
All metal is mild steel 0.06" thick.

ITEM NO.	PART DESCRIPTION	QTY.
1	Bottle Catcher Back Plate	1
2	Bottle Catcher Side	2
3	Bottom Plate	1
4	Bottle Catcher Front	1

Cal Poly Mechanical Engineering Machine Shop Kit	Material: 1018 Mild Carbon Steel	Page 4 of 5		Drwn. By: Ellen Chambers
	Thickness: .090"	Date: 4/1/14	Scale:1:2	Project: Bottle Cap Catcher

Bottle Cap Catcher



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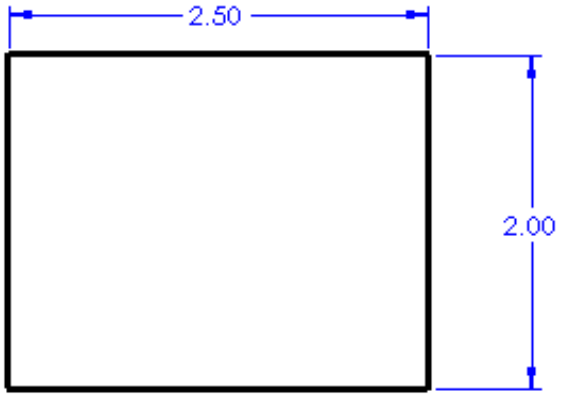
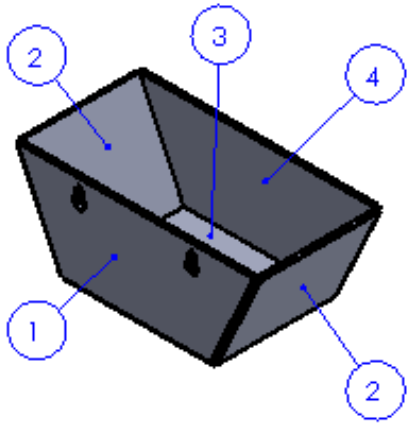


ITEM NO.3

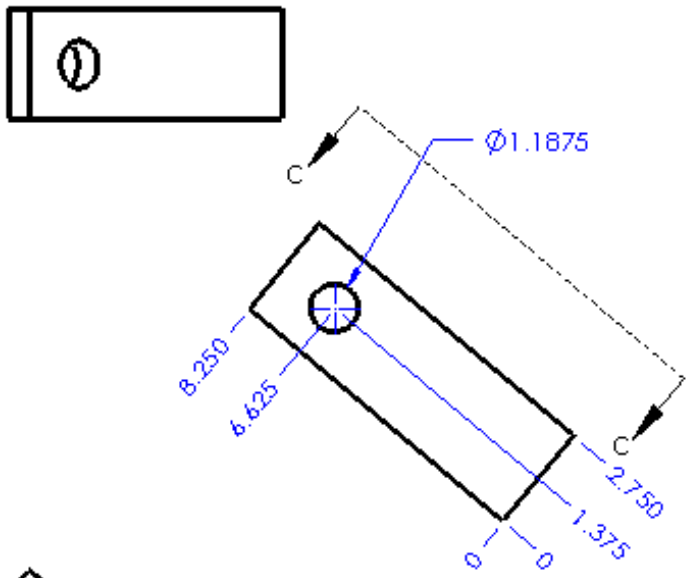


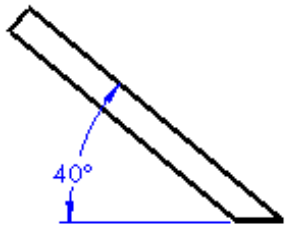
NOTE:
All metal is mild steel 0.06" thick.

ITEM NO.	PART Description	QTY.
1	bottle catcher back plate	1
2	bottle catcher side	2
3	bottom plate	1
4	bottle catcher front	1

Cal Poly Mechanical Engineering Machine Shop Kit	Material: 1018 Mild Carbon Steel	Page 3 of 3		Drwn. By: Ellen Chambers
	Thickness: .090"	Date: 4/1/14	Scale: 1:2	Project: Bottle Cap Catcher

Floating Wine Bottle Holder

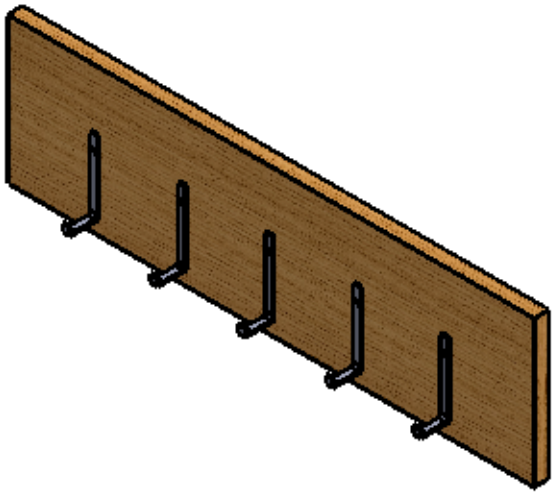


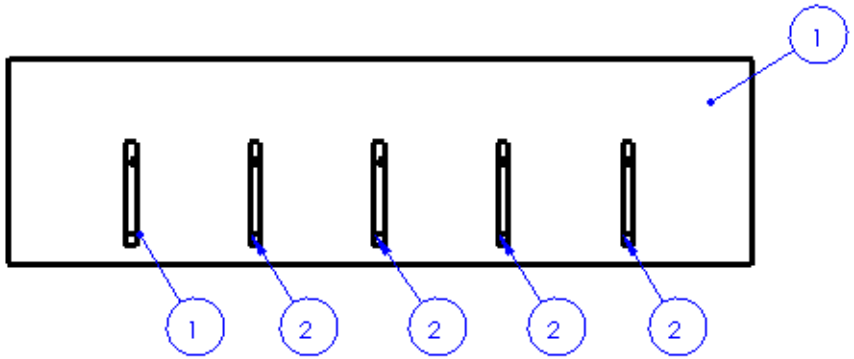


VIEW C-C

Cal Poly Mechanical Engineering Machine Shop Kit	Material: Pine Wood	PAGE 1 of 1		Drwn. By: Samantha Kelley
	Thickness: .75"	Date: 4/1/14	Scale: 1:1	Project: Floating Wine Bottle Holder

Simple Key Rack

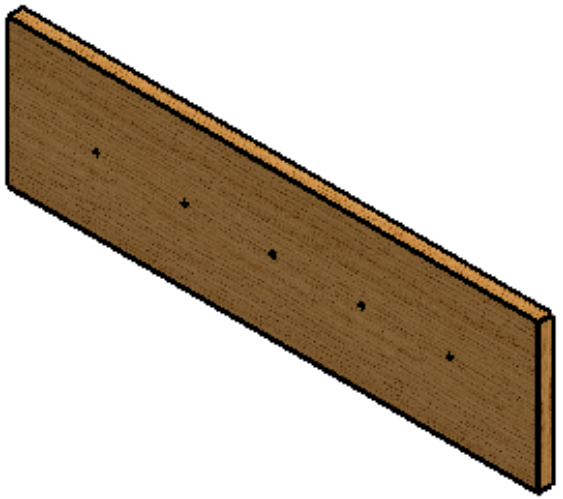


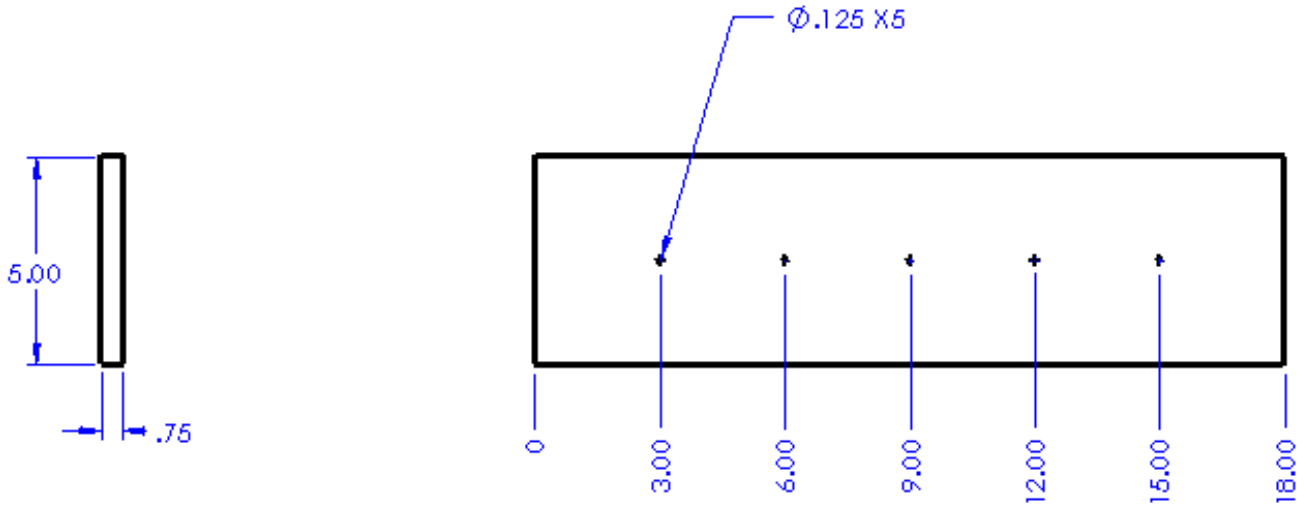


ITEM NO.	PART DESCRIPTION	QTY.
1	Basic Back	1
2	Small Hook	5

Cal Poly Mechanical Engineering Machine Shop Kit	Material:	Page 1 of 3		Drwn. By: Samantha Kelley
	Thickness:	Date: 4/1/14	Scale:1:1	Project: Simple Key Rack

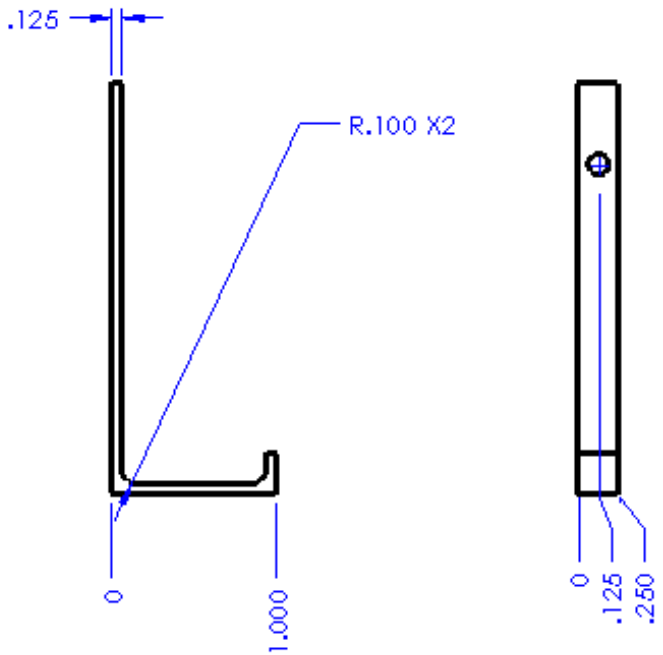
Simple Key Rack

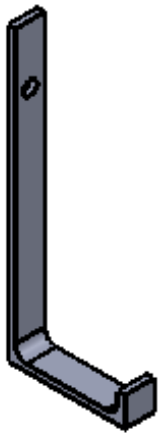




Cal Poly Mechanical Engineering Machine Shop Kit	Material: Pine Wood	Page 2 of 3		Drwn. By: Samantha Kelley
	Thickness: 0.75"	Date: 4/1/14	Scale: 1:1	Project: Simple Key Rack

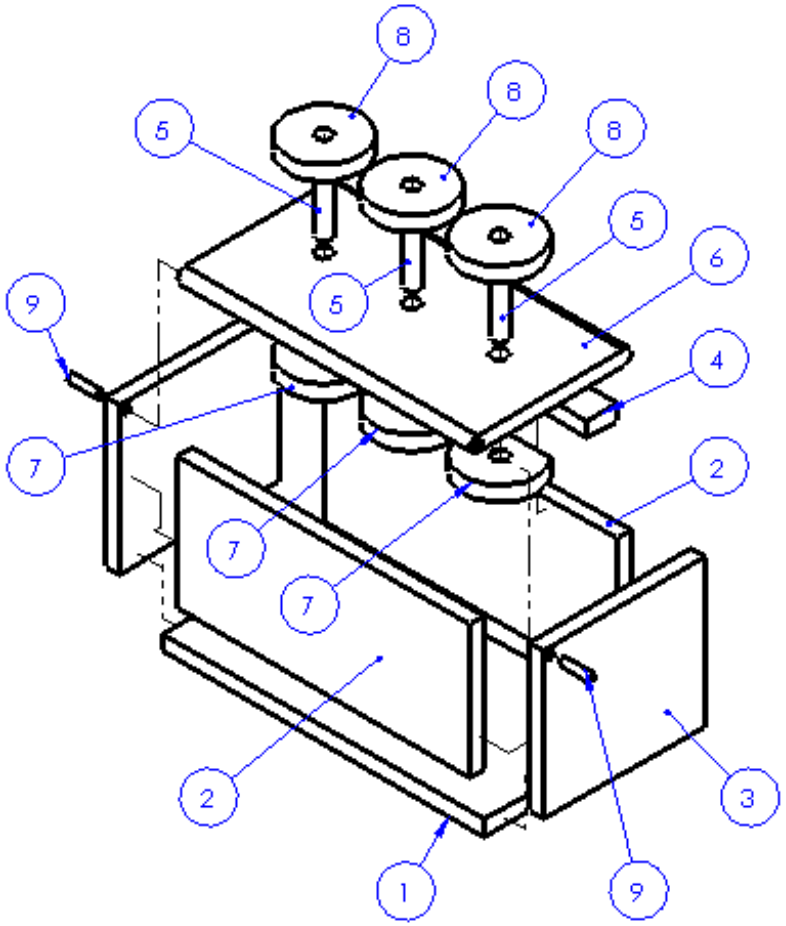
Simple Key Rack

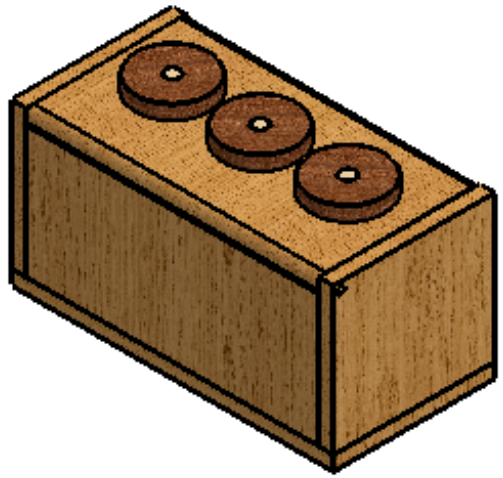




Cal Poly Mechanical Engineering Machine Shop Kit	Material: Low-Carbon Steel	Page 3 of 3		Drwn. By: Samantha Kelley
	Thickness: 0.125"	Date: 4/1/14	Scale: 1:1	Project: Simple Key Rack

Puzzle Box Kit Drawings

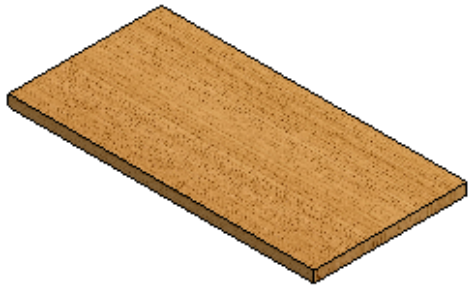


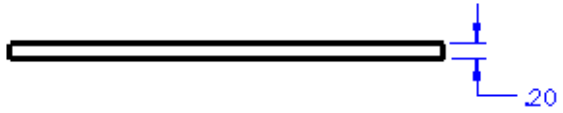


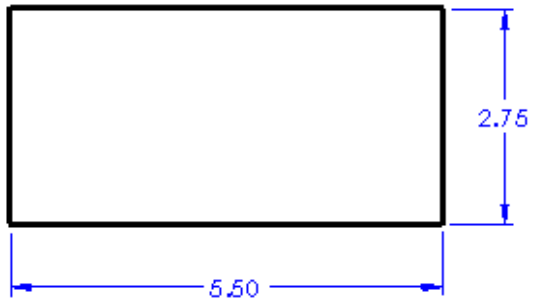
ITEM NO.	PART DESCRIPTION	QTY.
1	Base Panel	1
2	Long Sidewall Panel	2
3	Sidewall Panel	2
4	Inner Ledge	1
5	Dowel	3
6	Top Plate	1
7	Circular Disks w flat edge	3
8	Circular Disks	3
9	Hinge Dowel	2

Cal Poly Mechanical Engineering Machine Shop Kit	Material:	PAGE 1 OF 10		Drwn. By: Ellen Chambers
	Thickness:	Date: 4/1/14	Scale: 1:1	Project: Puzzle Box

Base Panel

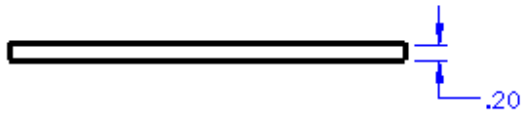


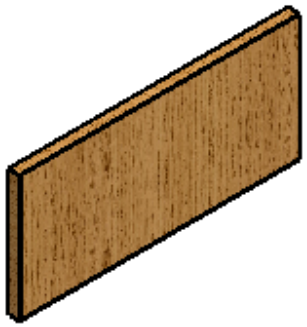


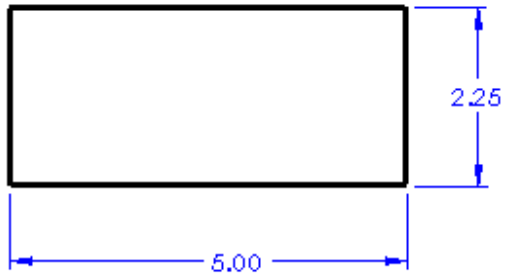


Cal Poly Mechanical Engineering Machine Shop Kit	Material: Walnut Plywood	PAGE 2 OF 10		Drwn. By: Ellen Chambers
	Thickness: 0.203"	Date: 4/1/14	Scale: 1:1	Project: Puzzle Box

Long Sidewall Panel

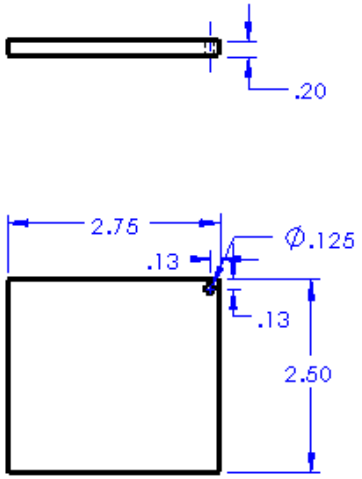






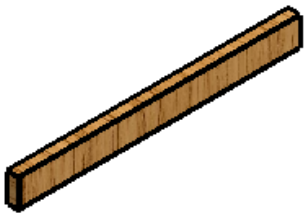
Cal Poly Mechanical Engineering Machine Shop Kit	Material: Walnut Plywood	PAGE 3 OF 10		Drwn. By: Ellen Chambers
	Thickness: 0.203"	Date: 4/1/14	Scale: 1:1	Project: Puzzle Box

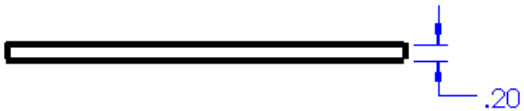
Sidewall Panel

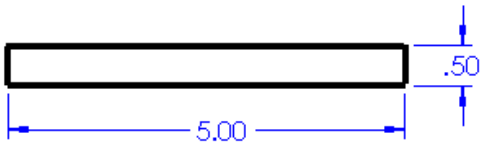


Cal Poly Mechanical Engineering Machine Shop Kit	Material: Walnut Plywood Thickness: 0.203"	PAGE 4 OF 10 Date: 4/1/14	Scale:1:1	Drwn. By: Ellen Chambers Project: Puzzle Box

Inner Ledge

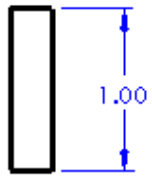


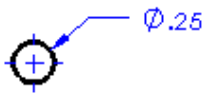




Cal Poly Mechanical Engineering Machine Shop Kit	Material: Walnut Plywood Thickness: 0.203"	PAGE 5 OF 10 Date: 4/1/14	Scale:1:1	Drwn. By: Ellen Chambers Project: Puzzle Box

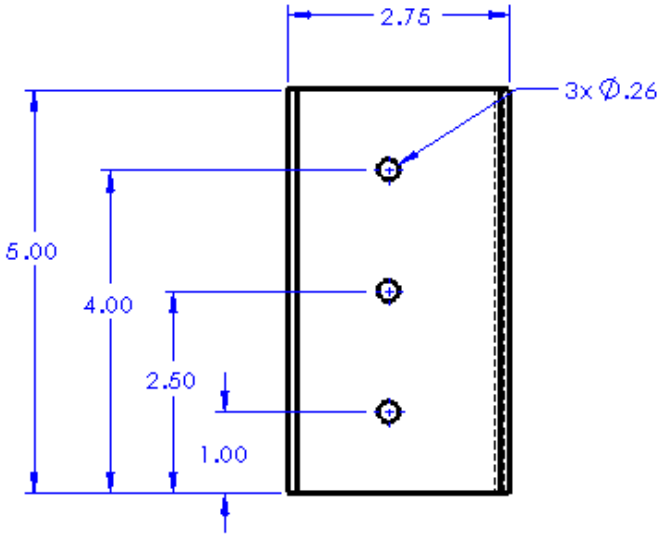
Dowel





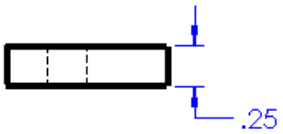
Cal Poly Mechanical Engineering Machine Shop Kit	Material: Oak Wood	PAGE 6 OF 10		Drwn. By: Ellen Chambers
	Diameter: 0.25"	Date: 4/1/14	Scale: 1:1	Project: Puzzle Box

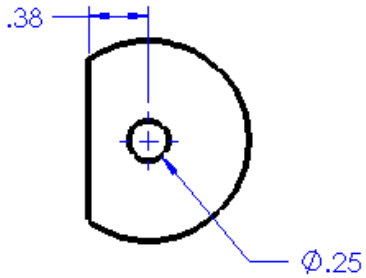
Top Plate



Cal Poly Mechanical Engineering Machine Shop Kit	Material: Walnut Plywood	PAGE 7 OF 10		Drwn. By: Ellen Chambers
	Thickness: 0.203"	Date: 4/1/14	Scale:1:1	Project: Puzzle Box

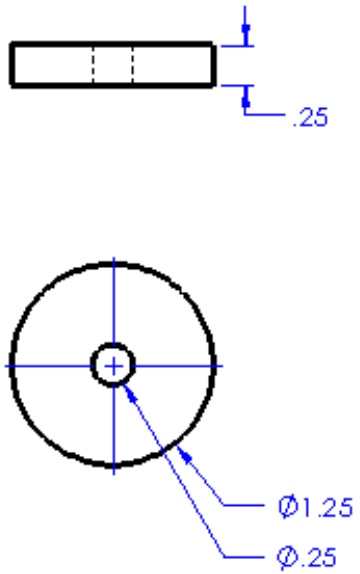
Circular Disk with Flat Edge





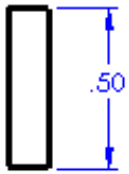
Cal Poly Mechanical Engineering Machine Shop Kit	Material: Unfinished Wood	PAGE 8 OF 10		Drwn. By: Ellen Chambers
	Thickness: 0 .25"	Date: 4/1/14	Scale:1:1	Project: Puzzle Box

Circular Disk



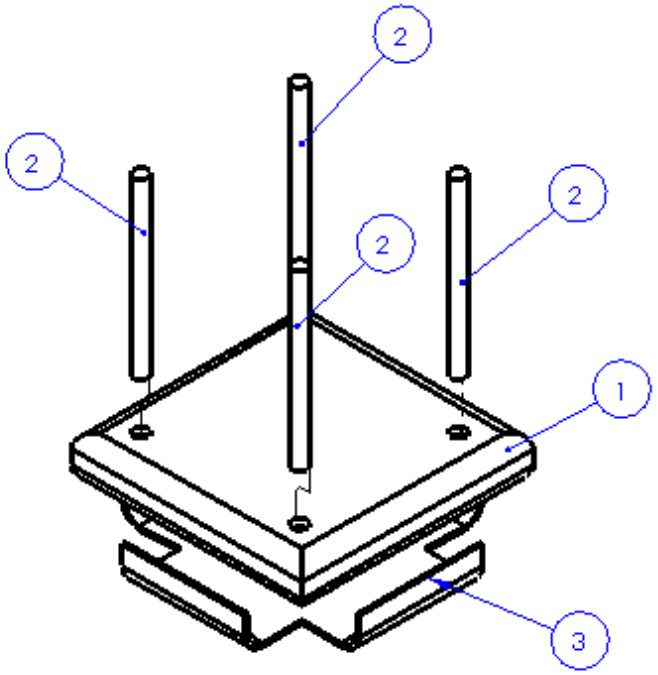
Cal Poly Mechanical Engineering Machine Shop Kit	Material: Unfinished Wood	PAGE 9 of 10		Drwn. By: Ellen Chambers
	Thickness: 0.25"	Date: 4/1/14	Scale: 1:1	Project: Puzzle Box

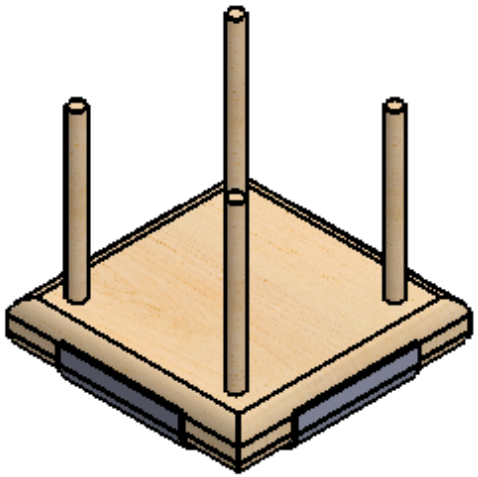
Hinge Dowel



Cal Poly Mechanical Engineering Machine Shop Kit	Material: Birch Dowel	PAGE 10 OF 10		Drwn. By: Ellen Chambers
	Diameter: 1/8"	Date: 4/1/14	Scale:2:1	Project: Puzzle Box

PERSONALIZED WOODEN COASTERS

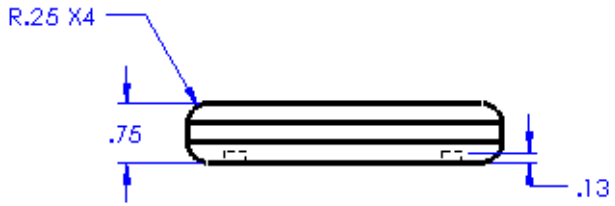


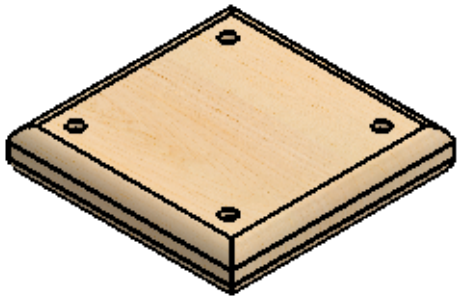


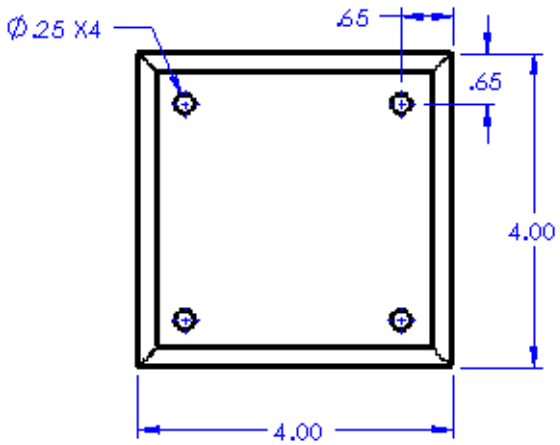
ITEM NO.	PART DESCRIPTION	QTY.
1	Coaster Base	1
2	Coaster Peg	4
3	Bent Metal Coaster Stand	1

Cal Poly Mechanical Engineering Machine Shop Kit	Material:	PAGE 1 OF 7		Drwn. By: Ellen Chambers
	Thickness:	Date: 4/17/14	Scale:1:2	Project: Personalized Wooden Coasters

PERSONALIZED WOODEN COASTERS

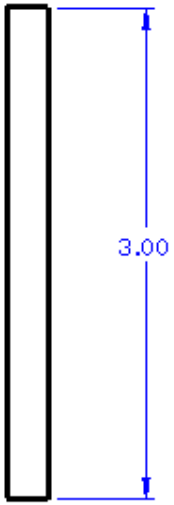






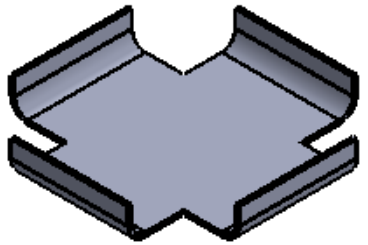
Cal Poly Mechanical Engineering Machine Shop Kit	Material: Pine Wood Thickness: 0.75"	PAGE 2 OF 7 Date: 4/17/14	Scale: 1:2	Drwn. By: Ellen Chambers Project: Personalized Wooden Coasters

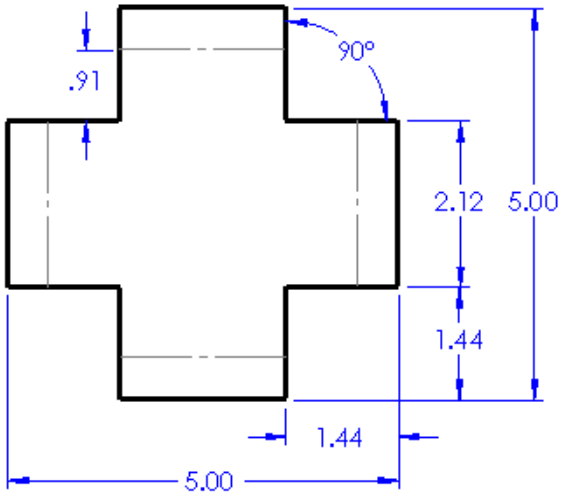
WOODEN PEG



Cal Poly Mechanical Engineering Machine Shop Kit	Material: Oak Dowel	PAGE 3 OF 7		Drwn. By: Ellen Chambers
	Diameter: .25"	Date: 4/17/14	Scale:1:2	Project: Personalized Wooden Coasters

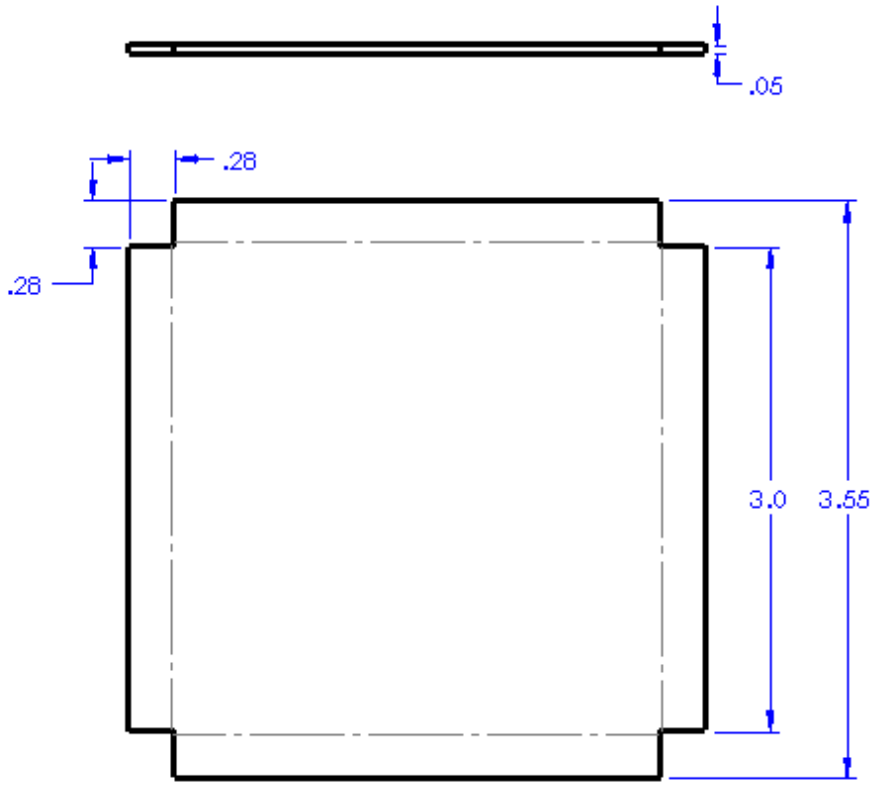
Metal Coaster Stand

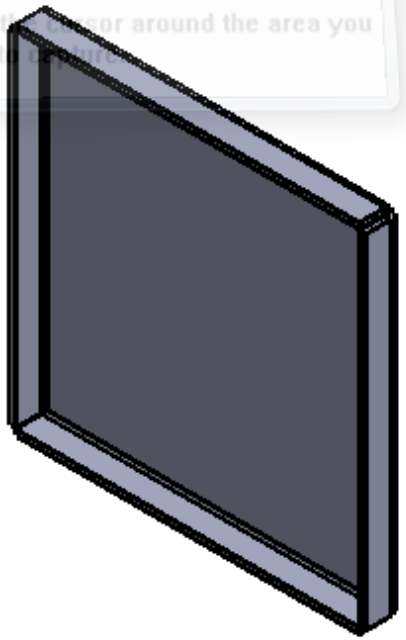




Cal Poly Mechanical Engineering Machine Shop Kit	Material: 1018 Mild Carbon Steel	PAGE 4 OF 7		Drwn. By: Ellen Chambers
	Thickness: .060"	Date: 4/17/14	Scale:1:2	Project: Personalized Wooden Coasters

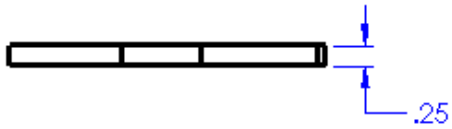
Coaster Option 1: Metal Coaster

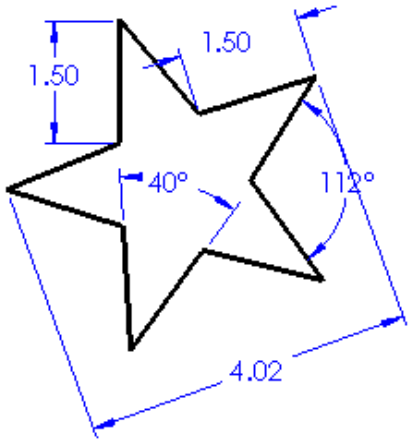




Cal Poly Mechanical Engineering Machine Shop Kit	Material: 1018 Mild Carbon Steel Thickness: .060"	PAGE 5 OF 7 Date: 4/17/14	Scale:1:1	Drwn. By: Ellen Chambers Project: Personalized Wooden Coasters

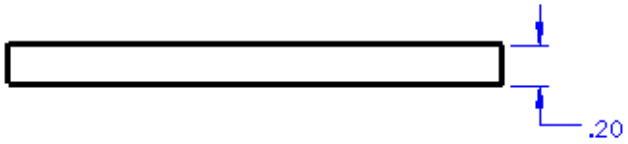
Coaster Option 2: Star Coaster

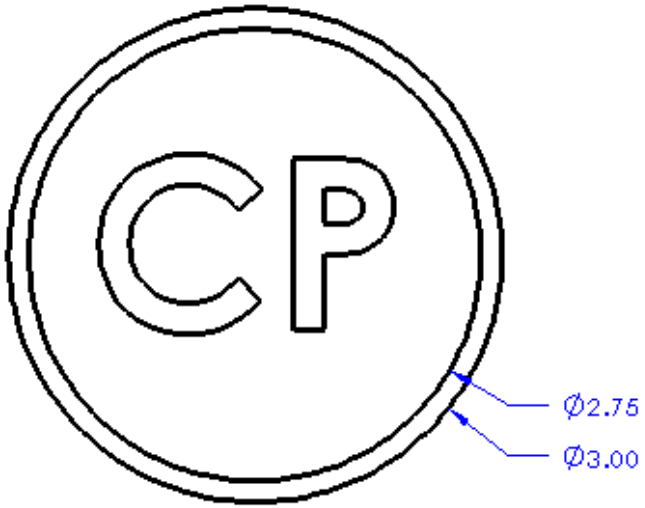




Cal Poly Mechanical Engineering Machine Shop Kit	Material: Optically Fluorescent Cast	PAGE 6 OF 7	Drwn. By: Ellen Chambers
	Thickness: 0.25"	Date: 4/17/14 Scale:1:2	Project: Personalized Wooden Coasters

Coaster Option 3: Circle Coaster





NOTES:
CENTER DESIGN IS ONE EXAMPLE OF
WHAT YOU CAN DO, PLEASE BE CREATIVE.

Cal Poly Mechanical Engineering Machine Shop Kit	Material: Walnut Plywood	PAGE 7 OF 7		Drwn. By: Ellen Chambers
	Thickness: 0.203"	Date: 4/17/14	Scale:1:1	Project: Personalized Wooden Coasters

Appendix C: List of Vendors, Contact information and pricing

Wall Mounted Bottle Opener

Item Description	Material	Size (in)	Cost/Kit	Bulk Cost	Vendor	Contact
Steel Sheet	Corrosion- Reistant formable 3003 Aluminum .063" thick	24"X12"	$ 1.67	$ 13.32	McMaster-Carr	(562) 692-5911
Bottle Opener	Chrome	1	$ 1.19	$ 1.19	WEBstaurantStore.com	717-392-7472
Rivets	Aluminum Countersunk Head Solid Rivet	2	$ 0.02	$ 4.77	McMaster-Carr	(562) 692-5911

Puzzle Box

Item Description	Material	Size (in)	Cost per Kit	Bulk Cost	Vendor	Contact
Wood material	Project Panels Walnut Plywood	4'x4'	$ 7.83	$ 31.30	Home Depot	1-800-(466-3337)
Circular Disks (6)	Unfinished wood round disc cutouts	1.5"	$ 0.96	$ 15.99	Factory Direct Craft	1-800-252-5223
Wooden Dowels	Oak Dowel 1/4"x1/4"x36"	3"	$ 0.11	$ 0.98	McMaster-Carr	(562) 692-5911
Hinge Dowel	BirchDowel Rod 1/8" Diameter, 36" Length	1"	$ 0.01	$ 11.00	McMaster-Carr	(562) 692-5911
Finishing Nails	.08" Shank Diameter, 1/2" Length	1/4"	$ 0.44	$ 4.35	McMaster-Carr	(562) 692-5911
Wood Glue	1-Gallon Jug of Elmer's Glue	gallon	$ 0.10	$ 17.86	McMaster-Carr	(562) 692-5911

Floating Wine Bottle Holder

Item Description	Material	Size (in)	Cost/Kit	Bulk Cost	Vendor	Contact
Wooden Block	Pine, 1" Thick, 4" x 96"	9"x3"	$ 0.36	$ 3.25	Home Depot	1-800-(466-3337)

Key Rack

Item Description	Material	Size (in)	Cost/Kit	Bulk Cost	Vendor	Contact
Wood Material	Pine, 1" Thick, 6" x 96"	5.5"x18"	$ 1.13	$ 5.63	Home Depot	1-800-(466-3337)
Hook Material	Low-Carbon Steel Rectangular Bar 1/8" x 1/4"x6ft	1/4"x4"	$ 1.09	$ 3.25	McMaster-Carr	(562) 692-5911
Wood Screws	Phillips, Zinc-Plated Steel, Number 10, 5/8" Long	5/8"	$ 0.56	$ 8.90	McMaster-Carr	(562) 692-5911

Personalized Wooden Coaster

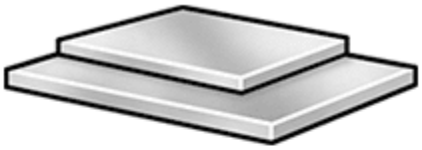
Item Description	Material	Size (in)	Cost/Kit	Bulk Cost	Vendor	Contact
Wooden Dowels	Oak Dowel 1/4"x1/4"x36"	3"	$ 0.11	$ 0.98	Home Depot	1-800-(466-3337)
Wood Coasters	Pine, 1" Thick, 4" x 96"	4"x4"	$ 0.17	$ 3.25	Home Depot	1-800-(466-3337)
Steel Sheet	1018 Mild Carbon Steel Sheet, .060" Thick (12"x12")	5"x10"	$ 4.80	$ 9.60	McMaster-Carr	(562) 692-5911
Plastic for Coaster	Optically Fluorescent Cast Acrylic 1/4" Thick, 12" x 12"	4"x4"	$ 0.84	$ 13.36	McMaster-Carr	(562) 692-5911
Wood for Coaster Base	Project Panels Walnut Plywood (4'x4')	3"x3"	$ 0.12	$ 31.30	Home Depot	1-800-(466-3337)

Appendix D: Vendor supplied Component Specifications and Data Sheets

Wall Mounted Bottle Opener

Corrosion-Resistant Formable 3003 Aluminum

.063" Thick, 12" x 24"



Each

ADD TO ORDER

In stock
$13.32 Each
8973K77

Thickness	0.063"
Thickness Tolerance	±0.004"
Yield Strength	21,000 psi
Hardness	Soft (40 Brinell)
Temper	1/2 Hard (H14)
Additional Specifications	Sheets—Unpolished 12" × 24" Meet ASTM B209

Often used for tanks, heat exchangers, and general sheet metal work, Alloy 3003 offers excellent corrosion resistance with good formability and weldability. It is nonmagnetic and not heat treatable. Temperature range is -300° to 300° F, unless otherwise stated.

View detailed performance properties and composition for aluminum.

Yield strength is approximate and may vary based on size and shape.

Width and length tolerances for 0.016" to 0.190" thick sheets are ±1/16". Width and length tolerances for 0.025" thick sheets are ±1/4".

1" Wide Foam Applicator

Packs of 12 In stock
$5.78 per pack of 12
ADD TO ORDER 7754T41

1 added to your order 05/15/14.

Bristle	
Width	1"
Length	2"
Thickness	1/2"
Overall Length	6"

For quick touch-ups, use these lightweight, disposable dark gray foam applicators. Handle is wood. Not for use with shellacs or lacquers.

Wall Mount Bottle Opener 4"W X 2"H

Pin it Like 0 +1 3 Tweet 0 Email page Print page Ask a question

Companion Items

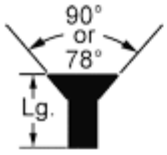
Stainless Steel Bottle Cap Catcher
$13.49/Each
1 ADD TO CART

Details

This chrome, bottle cap opener is wall-mounted and handy for bars or food counters. The mounting screws are included. This bottle opener measures 4"W x 2"H.

Aluminum Countersunk Head Solid Rivet

1/16" Diameter, 1/2" Length



1 Packs of 250

ADD TO ORDER

In stock
$4.77 per pack of 250
97483A045

Rivet Material	Aluminum
Length	1/2"
Head Diameter	0.116"
Head Height	0.033"
Additional Specifications	1/16" Dia.

Head is flush when installed. Length is measured from the top of the head.

Aluminum rivets have a 78° countersunk head. They offer mild corrosion resistance and are nonmagnetic.

Puzzle Box

Project Panels Walnut Plywood (Price Varies by Size)

Model # 2328 Internet # 204635499

★★★★★ (17) | Write a Review +

$31.30 / each

PRODUCT SOLD : Online Only
Item cannot be shipped to the following state(s): AK,GU,HI,PR,VI

SPECIFICATIONS

Actual product thickness (in.)	.203	Actual product width (in.)	48
Assembled Depth (in.)	48 in	Assembled Height (in.)	.203 in
Assembled Width (in.)	48 in	Manufacturer Warranty	Product warranted against glue or bond failure. Product replacement provided.
Plywood Type	Hardwood Plywood	Pressure Treated	No
Product Length (ft.)	4 ft	Product Thickness (in.)	1/4 in
Product Width (ft.)	4 ft	Returnable	90-Day
Tounge and Groove	No		

Unfinished Wood Round Disc Cutouts

Like

Click Here For A Larger View




In Stock ★★★★★ (3 Reviews) Write a Review

Item# JC6212

These unfinished round disc wood cutouts look like old fashioned wooden nickels. Unfinished wood disc circles are ready to paint, stain, dye, and embe...Read More

- Package of 100 pieces
- 1 1/2 inches diameter
- 1/8 inches thick

Choking hazard, small parts, not for children under 3 years of age.

Product Description | **Customer Reviews** | **Tell a Friend**

These unfinished round disc wood cutouts look like old fashioned wooden nickels. Unfinished wood disc circles are ready to paint, stain, dye, and embellish. The round shape of these coin cutouts is perfect for creating jewelry, pins, game pieces, ornaments, key chains and other craft projects. You are only limited to the creations you can make with these round wood coins by your imagination!

You M

Wood

Oak Dowel Rod, 1/4" Diameter, 36" Length

Each

ADD TO ORDER

In stock
$0.80 Each
96825K73

Shape	Dowel Rods
Material	Oak
Color	White to Red
Surface Finish	Smooth
Grain	Straight
Diameter	1/4"
Diameter Tolerance	±0.015"
Length Tolerance	±1/16"
Length	36"

Oak is a heavy wood with high wear resistance and is much harder than birch. The surface is less smooth than birch and typically has a straight grain.

Diameter tolerance is ±0.015" and length tolerance is ±1/16".

Wood

Birch Dowel Rod, 1/8" Diameter, 36" Length

Packs of 50

ADD TO ORDER

In stock
$11.00 per pack of 50
9683K11

Shape	Dowel Rod
Material	Birch
Color	Natural White to Light Brown
Surface Finish	Smooth
Grain	Straight
Diameter	1/8"
Diameter Tolerance	±0.007"
Length Tolerance	±1/32"
Length	36"

Birch is softer than maple and oak. The surface is smooth and has a straight grain.

Diameter tolerance is ±0.007" and length tolerance is ±1/32".

Brass Decorative Finishing Nail

.08" Shank Diameter, 1/2" Length

Packs of 125

ADD TO ORDER

In stock
$3.25 per pack of 125
97936A161

Material	Brass
Length	1/2"
Shank Diameter	0.08" (14 ga.)
Head Diameter	3/16"

Also known as escutcheon pins, these have a domed head for a smooth, finished appearance.Brass nails are decorative and corrosion resistant.

1-Gallon Jug of Elmer's Glue

Each

ADD TO ORDER

In stock
$17.86 Each
7516A4

Size	1-gal. Jug
Begins to Harden	10 sec.
Reaches Full Strength	24 hrs.
Additional Specifications	MSDS

Tackle a variety of repairs and projects with this general purpose white glue that dries clear. It bonds paper, wood, and other porous materials.

Floating Wine Bottle Holder

1 in. x 4 in. x 8 ft. Common Board

Model # 914681 Store SKU # 914681

★★★★★ (2) | Write a Review +

$3.25 / each

260 in Stock at San Luis Obispo #1052
Aisle 20 Bay 001
(change pick up store)

PRODUCT SOLD : In Store Only

SPECIFICATIONS

Actual product thickness (in.)	.203	Actual product width (in.)	48
Assembled Depth (in.)	48 in	Assembled Height (in.)	.203 in
Assembled Width (in.)	48 in	Manufacturer Warranty	Product warranted against glue or bond failure. Product replacement provided.
Plywood Type	Hardwood Plywood	Pressure Treated	No
Product Length (ft.)	4 ft	Product Thickness (in.)	1/4 in
Product Width (ft.)	4 ft	Returnable	90-Day
Tounge and Groove	No		

Key Rack

1 in. x 6 in. x 8 ft. Common Board

Model # 914770 Store SKU # 914770

★★★★★ (3) | Write a Review +

$5.63 / each

151 in Stock at San Luis Obispo #1052
Aisle **20** Bay **001**
(change pick up store)

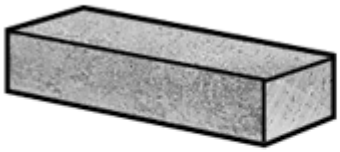
PRODUCT SOLD : In Store Only

SPECIFICATIONS

Actual product thickness (in.)	0.75	Actual product width (in.)	5.5
Assembled Depth (in.)	1 in	Assembled Height (in.)	96 in
Assembled Width (in.)	5.5 in	Manufacturer Warranty	none
Nominal Product H x W (In.)	1x6	Nominal Product Height (In.)	1
Nominal Product Length (ft.)	8	Nominal Product Length (in.)	96
Nominal Width	6 in	Nominal product width (in.)	6
Primed	No	Product Length (ft.)	8 ft
Product Length (in.)	96	Texture	Smooth
Water Resistant	Yes		

Low-Carbon Steel Rectangular Bar

1/8" Thick, 1/4" Width



Each

ADD TO ORDER

In stock
$3.25 Each
8910K389

Width	1/4"
Length	6 ft.
Yield Strength	54,000 psi
Hardness	Medium (Rockwell B70)
Additional Specifications	Rectangular Bars—Unpolished (Cold Drawn) 1/8" Thick Can be surface hardened to Rockwell C60 Meet ASTM A108

One of the most widely used types of steel, low-carbon steel is weldable, machinable, and can be surface hardened by heat treating. It is suitable for a variety of applications, such as structural and power transmission components.

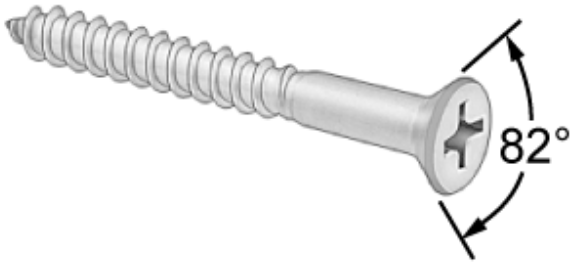
View detailed performance properties and composition for steel.

Warning! Hardness and yield strength are not guaranteed and are intended only as a basis for comparison.

Material is 1018 carbon steel. Thickness and width tolerances are -0.006" for 1/8" to 4" wide bars; they are -0.010" for 4 1/2" to 6" wide bars; and they are -0.013" for bars 7" and wider.

Screw for Wood

Phillips, Zinc-Plated Steel, Number 10, 5/8" Long



Packs of 100

ADD TO ORDER

In stock
$8.90 per pack of 100
90031A244

Length	5/8"
Additional Specifications	Phillips—Zinc-Plated Steel No. 10—#2 Drive

These flat head screws are beveled under the head, so they sit flush with the surface when installed.

Personalized Wooden Coaster

36 in. x 1-1/4 in. Oak Dowel

Model # OAK114-3ED Internet # 202287655

★★★☆☆ (2) | Write a Review +

$7.98 / each

PRODUCT SOLD : Online Only
Item cannot be shipped to the following state(s): AK,CA,GU,HI,PR,VI

SPECIFICATIONS

Assembled Depth (in.)	36 in	Assembled Height (in.)	1.25 in
Assembled Width (in.)	1.25 in	Diameter (in.)	1.25 in
Product Length (in.)	36	Returnable	90-Day
Shape	Round		

Project Panels Walnut Plywood (Price Varies by Size)

Model # 2328 Internet # 204635499

★★★★★ (17) | Write a Review +

$31.30 / each

PRODUCT SOLD : Online Only
Item cannot be shipped to the following state(s): AK,GU,HI,PR,VI

SPECIFICATIONS

Actual product thickness (in.)	0.75	Actual product width (in.)	3.5
Assembled Depth (in.)	1 in	Assembled Height (in.)	96 in
Assembled Width (in.)	3.5 in	Manufacturer Warranty	none
Nominal Product H x W (In.)	1x4	Nominal Product Height (In.)	1
Nominal Product Length (ft.)	8	Nominal Product Length (in.)	96
Nominal Width	4 in	Nominal product width (in.)	4
Primed	No	Product Length (ft.)	8 ft
Product Length (in.)	96	Texture	Smooth
Water Resistant	Yes		

General Purpose Low-Carbon Steel

Sheet, .060" Thick, 12" x 12"

Each

ADD TO ORDER

In stock
$9.60 Each
6544K53

Thickness	0.060"
Thickness Tolerance	±0.005"
Additional Specifications	Sheets—Unpolished (Cold Rolled) 12" × 12" Yield Strength: 0.030" to 0.134" thick sheets: not rated; 1/4" to 3/4" thick sheets: 60,000 psi Hardness: 0.030" to 0.134" thick sheets: not rated; 1/4" to 3/4" thick sheets: medium (Rockwell B80)

One of the most widely used types of steel, low-carbon steel is weldable, machinable, and can be surface hardened by heat treating. It is suitable for a variety of applications, such as structural and power transmission components.

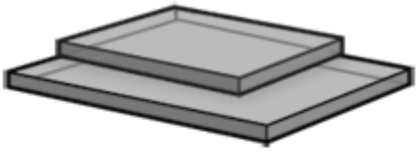
View detailed performance properties and composition for steel.

Warning! Hardness and yield strength are not guaranteed and are intended only as a basis for comparison.

Material is 1006-1026 carbon steel. Width and length tolerances are ±1/8" for 6" × 6" to 10" × 10" sheets; for all others they are ±1/4".

Optically Fluorescent Cast Acrylic

1/4" Thick, 12" x 12"



Color
- Amber
- Blue
- Green
- Red

Each

ADD TO ORDER

$13.36 Each
85635K431

Thickness	1/4"
Thickness Tolerance	+0.004", -0.049"
Color	Semi-clear amber, blue, green, or red
Temperature Range	-40° to 170° F
Tensile Strength	Excellent
Impact Strength	Poor
Additional Specifications	Fluorescent Sheets 12" × 12"

All shapes offer excellent clarity over a wide temperature range. Comparable to Plexiglas® acrylic shapes and Lucite, this material can be used outdoors.

View detailed performance properties for plastics.

Width and length tolerances are ±1/4". **To Order:** Please specify color.

Appendix E: Student Survey passed out to 277 students

Machine Shop Kit Senior Project Survey

What length of time would you want to work in the shop at a time?

Would you prefer one large project or a collection of smaller projects?

On a scale of 1-10, how confident are you walking into a shop on campus?

Approximately how many hours have you spent in the Cal Poly shops?

On a scale of 1-10, how confident are you with wood working?

On a scale of 1-10, how confident are you with metal working?

Do you have any previous shop experience?

Do you have your red/yellow tag?

Please mark your top ten favorite projects you would like to make.

Engraving cell phone case or safety goggles
Puzzle box (it's a puzzle to open it)
Bedside Table
Floating wine bottle holder
Cell phone charging station
Wall mounted bottle opener
Personalized wooden coasters
Small Bookshelf
picture frame
Birdhouse
Wall shelves
Wooden Block Letters (initials/name)
Foot stool
Basket mounted to bicycle
Cutting board
key rack
Crate for storage
Lunch box
Jewelry box
Key holder (box or bowl)
Silverware organizer
Files holder
wall hook
Vegetable Planters
Clothes Drying Rack
pencil case
Pencil holder
Electric plug safety cover
Kitchen spoon holder
Wooden candle holder

List of Resources used for Background Research

(MLA formatting for the library books you checked out)

“Woodworking Projects.” http://www.lowes.com/ideas-how-tos/woodworking-and-crafts/_/N-2zbkj/npc Web. 30 Jan. 2014.

"Woodworking Projects for Beginners." *Instructables.com*. N.p., n.d. Web. 30 Jan. 2014.

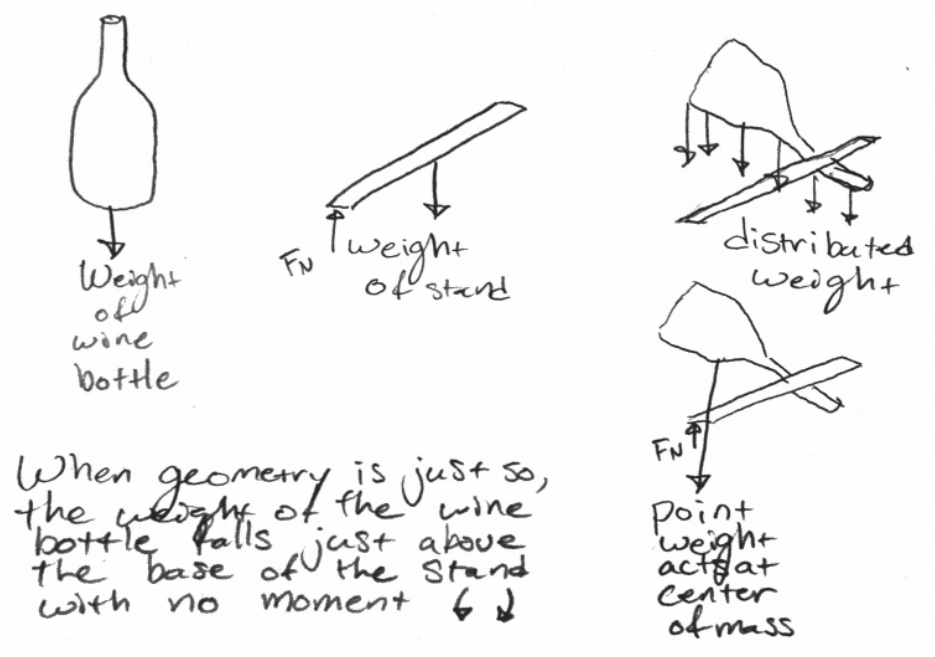
Project Idea Folders provided by Eric Pulse in Mustang 60. For viewing visit his office located in the center of Mustang 60, his email is epulse@calpoly.edu.

Red Tag Manual - https://studentprojectscenters.calpoly.edu/safety-tours-and-tests/red-tag-tool-manual/

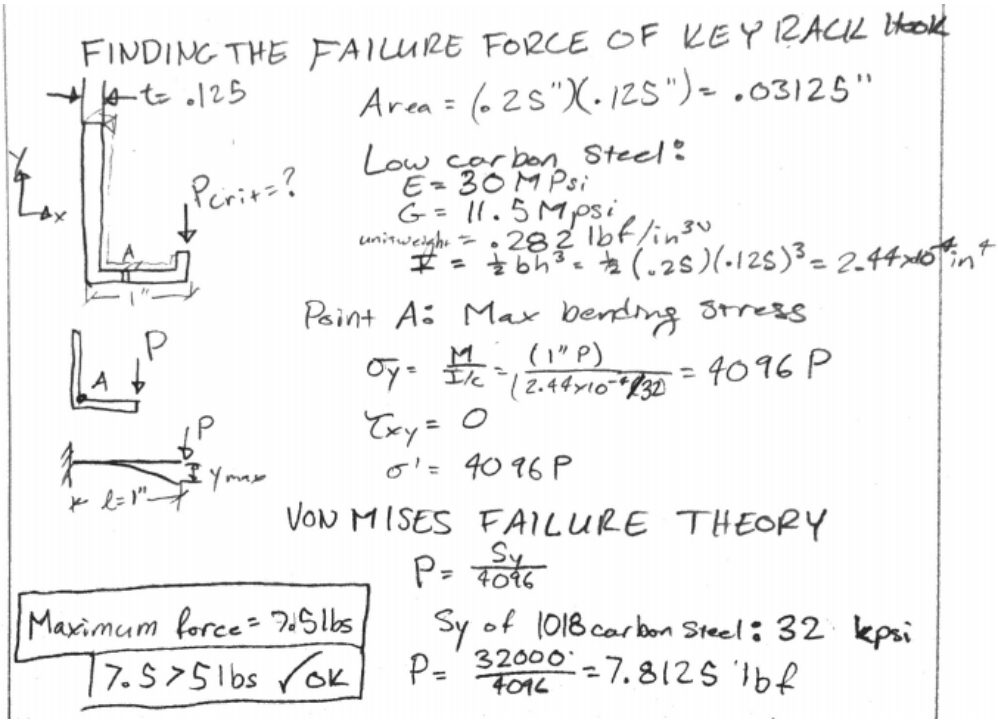
Yellow Tag Manual- https://studentprojectscenters.calpoly.edu/safety-tours-and-tests/yellow-tag-tool-manual/

Technical analysis

Floating Wine Bottle holder statics analysis

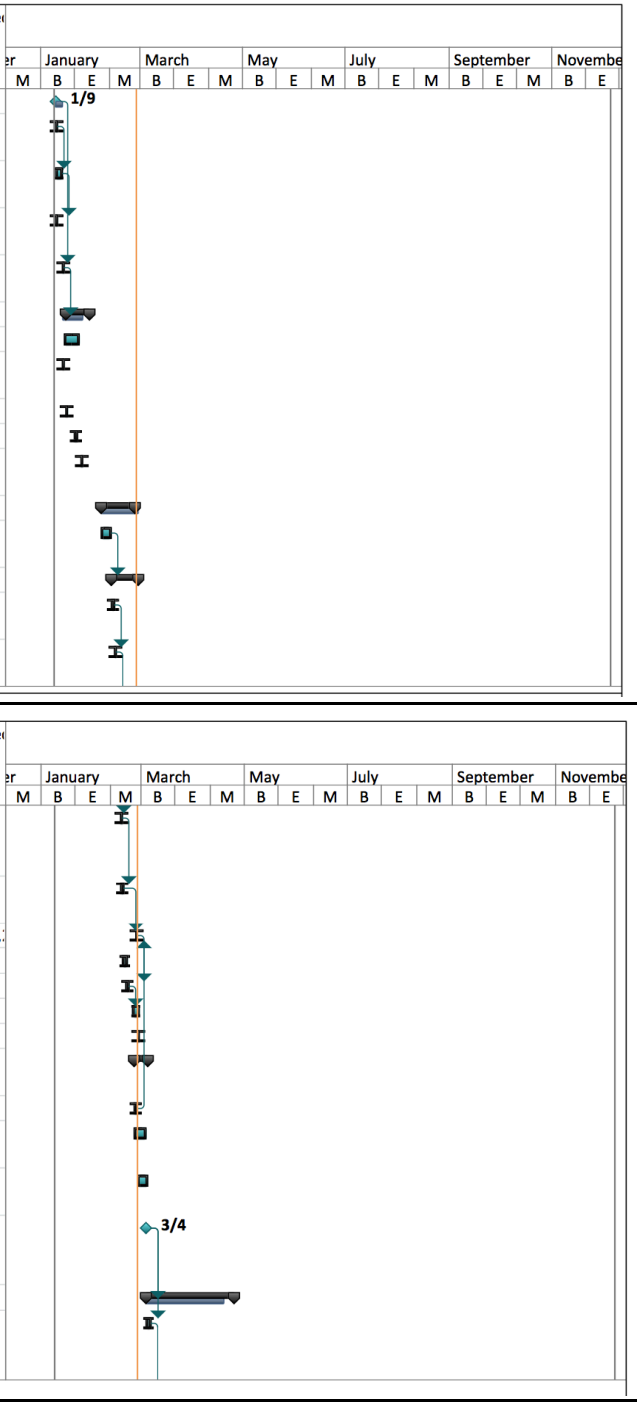


Key Rack Hook failure mode

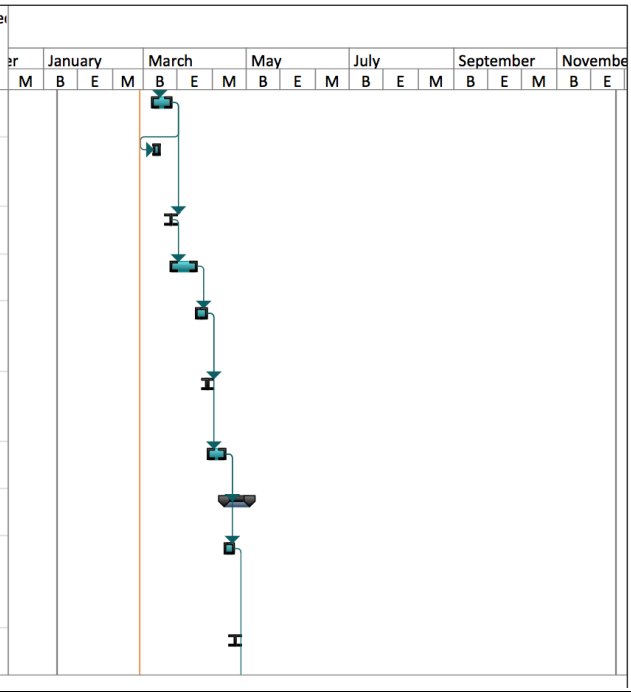


Appendix F: Gantt Chart with summary of time spent so far, time planned, percentages complete of all sub-tasks

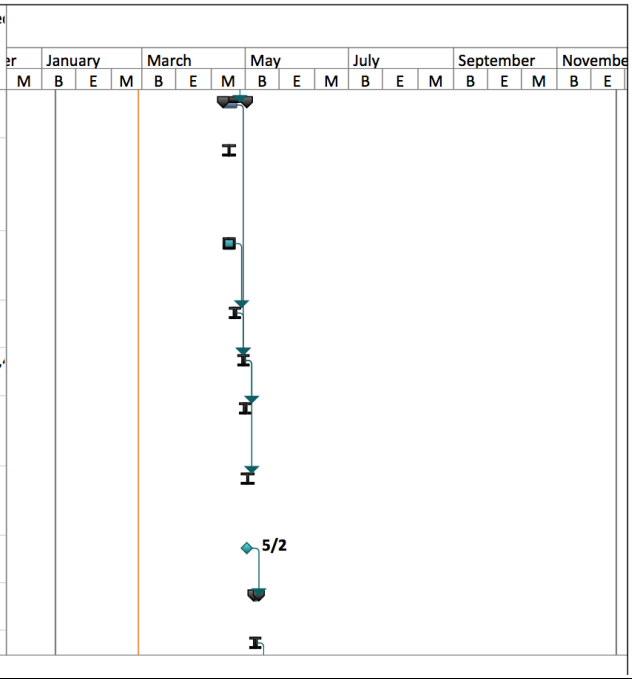
ID	WBS	Task Name	Duration	Start	Finish	Pre
1	**1**	**Choose Project**	**0 days**	**Thu 1/9/14**	**Thu 1/9/14**	
2	1.1	Watch Project Presentations	1 day	Fri 1/10/14	Fri 1/10/14	
3	1.2	Fill out Project Preference Form	2 days	Fri 1/10/14	Mon 1/13/14	2
4	1.3	Turn in Project Preference Form	1 day	Fri 1/10/14	Fri 1/10/14	3
5	2	Write Letter of Introduction	1 day?	Tue 1/14/14	Tue 1/14/14	1
6	**3**	**Problem Definition**	**10 days**	**Wed 1/15/1**	**Wed 1/29/1**	**5**
7	3.1	Background Research	7 days	Wed 1/15/1	Thu 1/23/14	
8	3.2	Prepare for Customer Interview	1 day	Tue 1/14/14	Tue 1/14/14	
9	3.3	Interview Customer	1 day	Wed 1/15/1	Thu 1/16/14	
10	3.4	QFD	2 days	Tue 1/21/14	Wed 1/22/1	
11	3.5	Meet with Lead Shop Technician	1 day	Sat 1/25/14	Sat 1/25/14	
12	**4**	**Conceptualize Solutions**	**14 days**	**Thu 2/6/14**	**Tue 2/25/14**	
13	4.1	Brainstorm Possible Solutions	4 days	Thu 2/6/14	Tue 2/11/14	
14	**4.2**	**Survey Students**	**12 days**	**Tue 2/11/14**	**Thu 2/27/14**	**13**
15	4.2.1	Create Student Survey	2 days	Tue 2/11/14	Thu 2/13/14	
16	4.2.2	Survey Senior Project Classes	1 day	Fri 2/14/14	Fri 2/14/14	15
17	4.2.3	Email Davol, Harding, Mello to ask about surveying their	1 day	Mon 2/17/14	Mon 2/17/14	16
18	4.2.4	Survey Intermediate Design	2 days	Mon 2/17/14	Tue 2/18/14	17
19	4.2.5	Survey Intro to ME	1 day	Wed 2/26/1	Wed 2/26/1	18,
20	4.2.6	Prototyped Models	3 days	Tue 2/18/14	Thu 2/20/14	
21	4.2.7	Pugh Charts	2 days	Thu 2/20/14	Fri 2/21/14	19
22	4.2.8	Decision Matrix	4 days	Mon 2/24/1	Thu 2/27/14	21
23	5	Pick a Solution	1 day	Thu 2/27/14	Thu 2/27/14	
24	**6**	**Conceptual Design Report**	**6 days**	**Tue 2/25/14**	**Tue 3/4/14**	
25	6.1	Analyse survey data	2 days	Tue 2/25/14	Wed 2/26/1	
26	6.2	Format previous report	5 days	Tue 2/25/14	Mon 3/3/14	
27	6.3	create class presentation	4 days	Thu 2/27/14	Tue 3/4/14	
28	6.4	Completed Cenceptual Design Report	0 days	Tue 3/4/14	Tue 3/4/14	
29	**7**	**Detail Design**	**38 days**	**Tue 3/4/14**	**Thu 4/24/14**	**28**
30	7.1	research design variations of selected projects	3 days	Tue 3/4/14	Thu 3/6/14	28



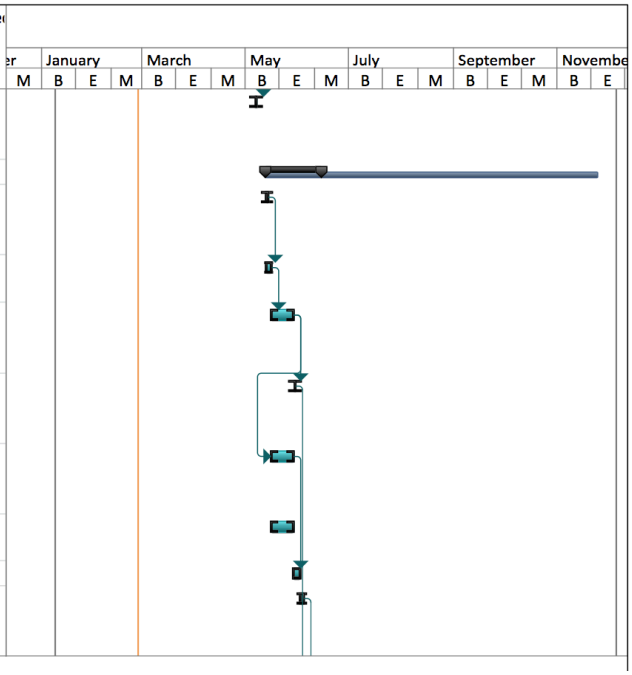
ID	WBS	Task Name	Duration	Start	Finish	Pre
31	7.2	finalize design of selected projects	8 days	Thu 3/6/14	Mon 3/17/14	30
32	7.3	create files for each project to keep organized	2 days	Fri 3/7/14	Mon 3/10/14	31
33	7.4	create material list for each project	1 day	Mon 3/17/14	Mon 3/17/14	31
34	7.5	create solid works parts	12 days	Mon 3/17/14	Tue 4/1/14	33
35	7.6	create solid works drawings (w/ dimensions)	5 days	Tue 4/1/14	Mon 4/7/14	34
36	7.7	email sponsor to clarify the previous drawings	2 days	Mon 4/7/14	Tue 4/8/14	35
37	7.8	create a cost analysis per kit	9 days	Tue 4/8/14	Fri 4/18/14	35
38	**8**	**Prepare Critical Design Review**	**11 days**	**Fri 4/18/14**	**Fri 5/2/14**	**37**
39	8.1	Reformat previous concept design report with updated information	4 days	Fri 4/18/14	Wed 4/23/14	37
40	8.2	organize meeting w/ sponsor	1 day	Thu 4/24/14	Thu 4/24/14	



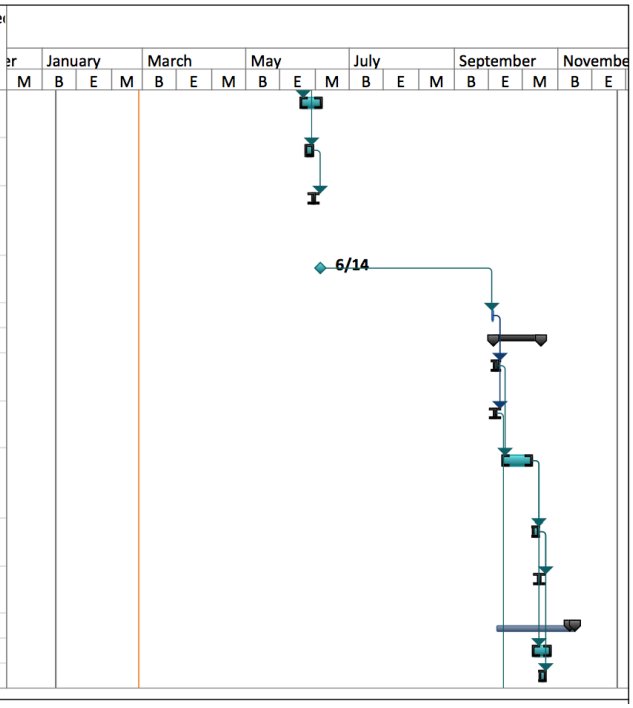
ID	WBS	Task Name	Duration	Start	Finish	Pre
41	**8.3**	**insert new information into CDR**	**10 days**	**Fri 4/18/14**	**Thu 5/1/14**	**39**
42	8.3.1	review senior project success document for additional sections	1 day	Mon 4/21/14	Mon 4/21/14	
43	8.3.2	format dimensioned drawings	5 days	Fri 4/18/14	Thu 4/24/14	
44	8.3.3	include solid model drawings	2 days	Thu 4/24/14	Fri 4/25/14	43
45	8.4	send rossman rough draft for notes	2 days	Tue 4/29/14	Wed 4/30/14	44,
46	8.5	Review CDR and make suggested changes	2 days	Wed 4/30/14	Thu 5/1/14	45
47	8.6	submit final report and email to sponsor	1 day	Fri 5/2/14	Fri 5/2/14	45
48	8.7	Final Design Report Submitted	0 days	Fri 5/2/14	Fri 5/2/14	
49	**9**	**Schedule Final Design Review**	**3 days**	**Tue 5/6/14**	**Thu 5/8/14**	**48**
50	9.1	email sponsor	2 days	Tue 5/6/14	Wed 5/7/14	



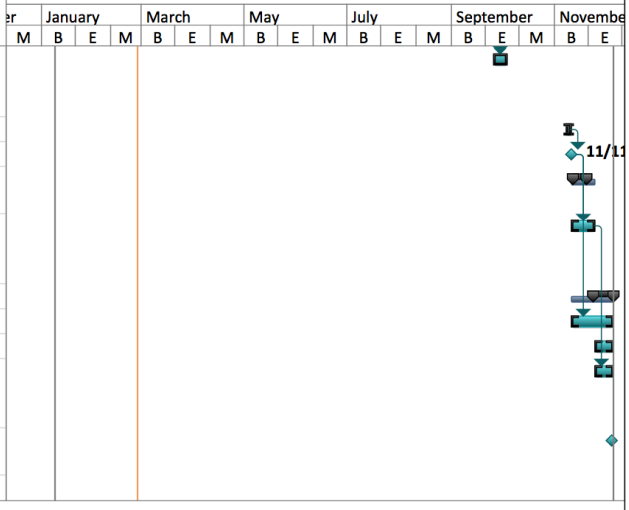
ID	WBS	Task Name	Duration	Start	Finish	Pre
51	9.2	create zimbra calendar event to confirm meeting	1 day	Wed 5/7/14	Wed 5/7/14	50
52	**10**	**Build Project Prototypes**	**25 days**	**Tue 5/13/14**	**Sat 6/14/14**	
53	10.1	Organize funding to purchase protoype materials	2 days	Tue 5/13/14	Wed 5/14/14	
54	10.2	assemble materials for prototypes	4 days	Tue 5/13/14	Fri 5/16/14	53
55	10.3	build each of the five projects in the machine shops	10 days	Fri 5/16/14	Thu 5/29/14	54
56	10.4	finalize any design changes for ease of design	1 day	Fri 5/30/14	Fri 5/30/14	55
57	10.5	write instructions for each project during construction	10 days	Fri 5/16/14	Thu 5/29/14	55
58	10.6	take picture of assembly process	10 days	Fri 5/16/14	Thu 5/29/14	
59	10.7	Type instructions	3 days	Thu 5/29/14	Mon 6/2/14	57
60	10.8	finish packet to be included w/ each kit	3 days	Mon 6/2/14	Wed 6/4/14	



ID	WBS	Task Name	Duration	Start	Finish	Pre
61	10.9	Type kit assembly instructions	11 days	Mon 6/2/14	Sat 6/14/14	56
62	10.10	peer review packets for clarity	3 days	Thu 6/5/14	Mon 6/9/14	60
63	10.11	Put together Instruction kits for each project	2 days	Mon 6/9/14	Tue 6/10/14	62
64	10.12	Learning Kits Final Assembly Done	0 days	Sat 6/14/14	Sat 6/14/14	
65	10.13	Kit Testing	1 day	Tue 9/23/14	Tue 9/23/14	64
66	**10.14**	**Organize Testing**	**20 days**	**Wed 9/24/1**	**Tue 10/21/1**	
67	10.14.1	contact Intro to ME professor	3 days	Wed 9/24/14	Fri 9/26/14	65
68	10.14.2	contact Senior Project Professors	2 days	Wed 9/24/14	Thu 9/25/14	65
69	10.14.3	orgainze a two weekend event to test kits	14 days	Mon 9/29/14	Thu 10/16/14	67
70	10.14.4	work w machine shop for dates	2 days	Fri 10/17/14	Mon 10/20/14	69
71	10.14.5	get a location secured	2 days	Mon 10/20/14	Tue 10/21/14	70
72	**10.15**	**Testing Event**	**2 days**	**Sat 11/8/14**	**Mon 11/10/**	
73	10.15.1	list of names	7 days	Fri 10/17/14	Mon 10/27/	69
74	10.15.2	organize materials	4 days	Tue 10/21/1	Fri 10/24/14	70



ID	WBS	Task Name	Duration	Start	Finish	Pred
75	10.15.3	have surveys for student experience	6 days	Fri 9/26/14	Fri 10/3/14	68
76	10.15.4	Testing Event	2 days	Sat 11/8/14	Mon 11/10/	
77	10.15.5	obtain feedback	0 days	Tue 11/11/1	Tue 11/11/1	76
78	**10.16**	**Type results of testing**	**6 days?**	**Wed 11/12/14**	**Wed 11/19/14**	
79	10.16.1	Make any necessary changes to kit instructions	10 days	Tue 11/11/14	Mon 11/24/14	77
80	**11**	**Prepare for Design Expo**	**10 days**	**Mon 11/24/**	**Fri 12/5/14**	
81	11.1	organize kit prototypes	19 days	Tue 11/11/1	Fri 12/5/14	77
82	11.2	make poster	9 days	Tue 11/25/1	Fri 12/5/14	
83	11.3	finalize all reports and print for reference	9 days	Tue 11/25/14	Fri 12/5/14	79
84	11.4	Senior Project Complete	0 days	Fri 12/5/14	Fri 12/5/14	
85	11.5					



Project: Machine Shop Kits
Date: Thu 2/27/14

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress

Page 7

Appendix G: **FMEA and DVP&R**

Potential
Failure Mode and Effect Analysis

__X_ System	(Design FMEA)	FMEA Number:	1
___ Subsystem			
___ Component	Design Responsibility: Sam Kelley	Page 1 of 1	
Model Year(s)/Vehicle(s): Personalized Wooden Co	Key Date: #####	Prepared By:	SK
Core Team: Ellen Chambers and Sam Kelley		FMEA Date (Orig.)	####

									Action Results			
Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s) / Mechanism(s) of Failure	Occur	Crit	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken	Sev	Occur	Crit
Coaster Stand	Wrong size	Does not understand instructions	5	Unclear instructions	2	10	Write clear instructions	SK-October	Clear instructions	1	1	1
		Does not know how to use a tool	5	Unclear instructions	2	10	Write clear instructions	SK-October	Clear instructions	1	1	1
	Pegs do not hold coasters	Used tool wrong	3	Unclear instructions	1	3	Write clear instructions	SK-October	Clear instructions	1	1	1
		Assembled at the wrong angle	3	Unclear instructions	1	3	Write clear instructions	SK-October	Clear instructions	1	1	1
	Looks bad	Student dissatisfaction	1	Laziness	1	1	Encourage student to sand	SK-October	Include pictures of before and after	1	1	1
Coasters	Looks bad	Student dissatisfaction	1	Laziness	1	1	Encourage student to sand	SK-October	Include pictures of before and after	1	1	1
	Uneven	Student dissatisfaction	1	Unclear instructions	1	1	Write clear instructions	SK-October	Clear instructions	1	1	1
	Not properly rounded	Not fit in the holder	4	Unclear instructions	1	4	Write clear instructions	SK-October	Clear instructions	1	1	1
Kit assembly for shop technicians	Missing components	Not able to complete the kit	2	Things accidently left out	1	2	Have a supply of extras in the shop	SK-October	Create supply	1	1	1

Potential
Failure Mode and Effect Analysis
(Design FMEA)

_X_ System
___ Subsystem
___ Component

Design Responsibility: Ellen Chambers

Wall Mounted Bottle Opener

Key Date: 3/14/2014

Core Team: Ellen Chambers and Sam Kelley

FMEA Number: 2

Page 1 **of** 1

Prepared By: Ellen Chambers

FMEA Date (Orig.) 3/11/2014

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s) / Mechanism(s) of Failure	Occur	Crit	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occur	Crit
Assembling Kit End Product by student	Made the backing plate wrong	part looks bad, hangs on wall poorly	3	Didn't read instructions, didn't fully understand, used laser incorrectly.	5	15	In beginning stress importance of fully reading instructions.	EC-October	Write more clear instructions and addition of pictures. In addition to stressing the importance of fully reading instructions at beginning of kit.	3	3	9
	Made the bottle opener wrong	removes bottle caps poorly or not at all	6	Didn't read instruction, didn't fully understand instructions, didn't understand how to properly use machinery.	3	18	Ask shop technicians for support and clarify instructions.	EC-October	Write more clear instructions and addition of pictures. In addition to stressing the importance of fully reading instructions at beginning of kit.	6	2	12
		looks bad	2	Didn't read instruction, didn't fully understand instructions, didn't understand how to properly use machinery.	4	8	Ask shop technicians for support and clarify instructions.	EC-October	Write more clear instructions and addition of pictures. In addition to stressing the importance of fully reading instructions at beginning of kit.	2	2	4
	Backing plate fell apart	poor welds	7	Didn't read instruction, didn't fully understand instructions, didn't understand how to properly use machinery.	2	14	Ask shop technicians for support and clarify instructions.	EC-October	Write more clear instructions and addition of pictures. In addition to stressing the importance of fully reading instructions at beginning of kit.	8	1	8
	Backing plate seperated from bottle opening feature	part looks bad and has very short life	7	Poor assembly technique	2	14	Ask shop technicians for support and clarify instructions.	EC-October	Write more clear instructions and addition of pictures. In addition to stressing the importance of fully reading instructions at beginning of kit.	8	1	8
metal back plate	Student makes it look ugly	student dissatisfaction	3	Student used the plasma cutter scanner feature incorrectly.	5	15	Provide extra instructions on using plasma cutter	EC-October	Provide extra instructions on using plasma cutter	3	2	6
bottle opening feature	Metal isnt strong enough to overcome bottle cap tension	doesn't properly open bottles	7	incorrect metal used or student manufactures incorrectly	3	21	do stress calculations on this feature to ensure metal is sufficient	EC-October	do stress calculations on this feature to ensure metal is sufficient	7	3	21
Assembling kit by student technicians	Do not include all necessary parts and materials	student can not assemble kit correctly	7	We didn't explicitly state quantity of materials.	3	21	Write list with specific bill of materials.	EC-October	Write list with specific bill of materials.	7	1	7

Potential
Failure Mode and Effect Analysis
(Design FMEA)

__X_ System
___ Subsystem
___ Component

FMEA Number: 3

Design Responsibility: Sam Kelley

Page 1 **of** 1

Model Year(s)/Vehicle(s): Floating Wine Holder

Key Date: 3/14/2014

Prepared By: SK

Core Team: Ellen Chambers and Sam Kelley

FMEA Date (Orig.) **(Rev.)** 11-Mar

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s) / Mechanism(s) of Failure	Occur	Crit	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
									Actions Taken	Sev	Occur	Crit
Assembling Kit by student	Completes wood angle wrong	Looks bad	1	Does not understand instructions	2	2	Write clear instructions	SK-October	Clear instructions and pictures	1	1	1
			1	Does not understand how to use the tool	4	4	Encourage to ask shop technician in instructions	SK-October	Clear instructions and pictures	1	1	1
		Doesn't work	4	Does not understand instructions	2	8	Write clear instructions	SK-October	Clear instructions and pictures	3	2	6
			4	Does not understand how to use the tool	4	16	Encourage to ask shop technician in instructions	SK-October	Clear instructions and pictures	3	2	6
	Hole for wine bottle in the wrong place	Looks bad	1	Does not use tool correctly	4	4	Write clear instructions	SK-October	Clear instructions and pictures	1	1	1
		Doesn't work	4	Does not measure correctly	2	8	Write clear instructions	SK-October	Clear instructions and pictures	3	2	6
	Ugly	Looks bad	1	Laziness in sanding	2	2	Encourage to sand and add before and after pictures	SK-October	Clear instructions and pictures	1	1	1
Assembling Kit by technician	Does not add enough wood	Student cannot make kit	5	Poor measuring practice	1	5	Allow for generous wood in kit, indicate specific measureing device	SK-October	Specific measuring device	2	1	2

Potential
Failure Mode and Effect Analysis
(Design FMEA)

_X_ System
___ Subsystem
___ Component

Design Responsibility: **Ellen Chambers**

Puzzle Box

Key Date: **3/14/2014**

Core Team: **Ellen Chambers and Sam Kelley**

FMEA Number: **4**

Page **1** **of** **1**

Prepared By: **Ellen Chambers**

FMEA Date (Orig.) **3/11/2014**

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s) / Mechanism(s) of Failure	Occur	Crit	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
									Actions Taken	Sev	Occur	Crit
Assembling Kit End Product by student	Incorrectly manufacture side walls and bottom piece	The sides don't match properly for assembly	3	Didn't understand current instructions or misused measuring tools.	4	12	Write clearer instructions and how to properly use machinery and measurement instruments	EC- October	Write clearer instructions and how to properly use machinery and measurement instruments	3	2	6
	wood is sanded incorrectly	looks ugly, causes splinters	2	Didn't understand current instructions or misused measuring tools.	5	10	Explain further how to correctly use sandpaper	EC- October	Explain further how to correctly use sandpaper	2	3	6
	cut circular disks wrong	puzzle wont work, top wont open	5	Didn't understand current instructions or misused measuring tools.	4	20	Write clearer instructions and how to properly use machinery and measurement instruments	EC- October	Write clearer instructions and how to properly use machinery and measurement instruments	5	2	10
	ledge is placed incorrectly	puzzle feature wont work, lid wont lock	6	Didn't understand current instructions or misused measuring tools.	5	30	Write clearer instructions and how to properly use machinery and measurement	EC- October	Write clearer instructions and how to properly use machinery and measurement	6	2	12
	hinges attached incorrectly	Looks ugly, top mismatched from bottom	3	Didn't understand current instructions or misused measuring tools.	4	12	Write clearer instructions and how to properly use machinery and measurement instruments	EC- October	Write clearer instructions and how to properly use machinery and measurement instruments	3	1	3
	Box doesn't hold together	Box breaks	6	Doesn't wait long enough for glue to set or doesn't use enough glue	3	18	Write clearer instructions and how to properly use glue, encourage student to ask shop technition for help	EC- October	Write clearer instructions and how to properly use glue, encourage student to ask shop technition for help	6	1	6
	cut dowels at wrong length	Circular disks at different length, if higher than ledge that circular disk wont possess locking capability.	2	not clear instructions	4	8	Write clearer instructions and how to properly use machinery and measurement instruments	EC- October	Write clearer instructions and how to properly use machinery and measurement instruments	2	2	4
Assembling kit by shop technitian	Do not include all necessary parts and components necessary for student assembly	Student can not correctly assemble kit	5	Not clear bill of materials	3	15	Write very clear bill of materials	EC- October	Write very clear bill of materials	5	1	5

Potential
Failure Mode and Effect Analysis
(Design FMEA)

__X_ System
___ Subsystem
___ Component

Design Responsibility: Sam Kelley

FMEA Number: 5

Page 1 **of** 1

Model Year(s)/Vehicle(s): Key Rack

Key Date: 3/14/2014

Prepared By: SK

Core Team: Ellen Chambers and Sam Kelley

FMEA Date (Orig.) 11-Mar

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s) / Mechanism(s) of Failure	Occur	Crit	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
									Actions Taken	Sev	Occur	Crit
Assembling kit by student	Wood Backing	Ugly	1	Student dissatisfaction	2	2	Encourage to sand	SK-October	Pictures before and after	1	1	1
		Poor hook placement	2	Does not operate effectively	1	2	Encourage to use measuring device	SK-October	Pictures of examples	1	1	1
		Cracking in wood	5	Hooks are not secure	2	10	Encourage and give good instructions to use drill at appropriate speeds	SK-October	Clear instructions	2	1	2
	Metal Hooks	Ugly	1	Student dissatisfaction	2	2	Encourage student to file	SK-October	Pictures before and after	1	1	1
		Hole punched incorrectly (not a full circle in the metal)	2	Does not operate effectively	1	2	Write clear instructions	SK-October	Clear instructions	1	1	1
		Not the proper shape for holding things	4	Does not operate effectively	1	4	Write clear instructions and encourage to ask shop technician for help	SK-October	Clear instructions and pictures	1	1	1
	Holes in back for mounting	Cannot hold up key rack	5	Does not operate effectively	1	5	Write clear instructions	SK-October	Clear instructions	2	1	2
		Not level	6	Student dissatisfaction	3	18	Write clear instructions and specify to use a level	SK-October	Clear instructions	2	1	2
	Screws	Stripped threads	5	Difficult to remove screws	1	5	Write clear instructions	SK-October	Clear instructions	1	1	1
		Poor quality screws in kit	3	More screws needed	1	3	Have a supply of extra screws in the shop	SK-October	Account for extras in price	1	1	1
Assembling kit by shop technician	Not enough materials required	Cannot complete kit before acquiring more	3	Kit cannot be completed	1	3	Have a supply of extras in the shop	SK-October	Account for extras in price	1	1	1

ME428 DVP&R Format

Report	Project	Date	3/13/2014	Sponsor	Eric Pulse	Mechanical Engineering Department	Component/Assembly		REPORTING ENGINEER:	Ellen Chambers & Sam Kelley

TEST PLAN

TEST REPORT

Item No		Specification or Clause Reference	Test Description	Acceptance Criteria	Test Responsibi	Test Stage	SAMPLES		TIMING		TEST RESULTS			NOTES
							Quantity	Type	Start date	Finish date	Test Result	Quantity Pass	Quantity Fail	
1	Key Rack	Misunderstand directions	Organize a weekend event where a group of Freshmen and Seniors will complete a kit and we shall review the results	Visual & Functionality	SK	PV	1	C	11/8/2014	11/10/2014	TBA			
2		*Poor hook placement*												
3		*Cracking in wood*												
4		*Poor appearance & Rough edges for safety*												
5		Hook weight capacity	Hanging weight test (prototype)	5 lbs		CV	3	A	11/1/2014	11/5/2014				
6	Wooden Coasters	Misunderstand directions	Organize a weekend event where a group of Freshmen and Seniors will complete a kit and we shall review the results	Visual & Functionality	SK & EC	PV	1	C	11/8/2014	11/10/2014	TBA			
7		*Incorrect peg angling*												
8		*Wrong coaster dimensions*												
9		*Poor appearance & Rough edges for safety*												
10	Floating Wine Holder	Misunderstood directions	Organize a weekend event where a group of Freshmen and Seniors will complete a kit and we shall review the results	Visual & Functionality	SK	PV	1	C	11/8/2014	11/10/2014	TBA			
11		*Poor appearance*												
12		*Incorrect angle cut*												
15		*Rough surface & edges for safety*												
16		*Poor hole placement*												
17	Bottle Opener	Misunderstood directions	Organize a weekend event where a group of Freshmen and Seniors will complete a kit and we shall review the results	Visual & Functionality	EC	PV	1	C	11/8/2014	11/10/2014	TBA			
18		*Poor appearance & Rough edges for safety*												
19		*Loose opener attachment*												
20		*Weak welds*												
21		*Uneven backing plate*												
22		Bottle opening function	Process test	Opens 10 bottles		CV	10	A	10/5/2014	10/10/2014				
23	Puzzle Box	Misunderstood directions	Organize a weekend event where a group of Freshmen and Seniors will complete a kit and we shall review the results	Visual & Functionality	EC	PV	1	C	11/8/2014	11/10/2014	TBA			
24		*Sides don't match in size*												
25		*Rough edges for safety*												
26		*Improper ledge placement*												
27		*Improper dowel length*												
28		*Unround discs*												
29		*Poor appearance*												