CAID TO CAM

PROJECT 2
PULLEY DRAWING &
PROTOTYPE

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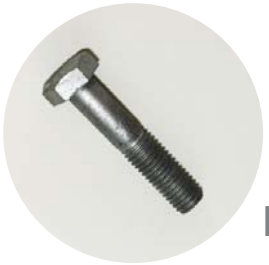
To satisfy the prototyping component of this project, I decided to manufacture the whole pulley model in 1:1 scale. Considering the material choice, balsa wood and transparent acrylic sheet are chosen to create a natural and earthy tone. The side plates and formed bracket are made of transparent acrylic to allow internal parts be seen from outside. The model is assembled using two pairs of M10 nut and bolt with a depth of 50mm, purchased from Bunnings warehouse.

GA-01 GENERAL ASSEMBLY



P08 M10 BOLT

P09 M10 NUT

In order to assemble the pivot pin with the formed bracket and the washer, it has to be split into two parts. It was done in Solidworks and saved into separate files. The pivot pin was sliced up from the middle of the right plane with an interval of 2mm. The cut parts were nested in illustrator for laser cutting. Balsa wood was chosen for this prototyping because of its low density. After gluing together, the rugged edges could then be easily rounded off using sanding paper. As some of the sliced parts are very tiny, they can drop into the holes of the rack or be blown away by the powerful laser and the vacuum at the back. To prevent this from happening, I chose to laser cut at 1mm so that the cut parts were slightly attached to the sheet and could be popped out manually.

P01 PIVOT PIN

2mm balsa wood · sanding · laser cutting · illustrator file

The washer was sliced up from the top plane with an interval of 2mm for laser cutting. This easy part can actually be produced by using a sheet of 5mm balsa wood. However, considering the gaps when I nested the other cut parts in illustrator, the washer could be fit into those spaces and reduce the waste of material. When the cut parts were glued together, the washer resulted in a height of 6mm, which is 1mm extra of the specified dimension. Therefore it had to be sanded off, as well as the fillet (2.5mm radius) at the top and the 45° slanted internal wall at the bottom.

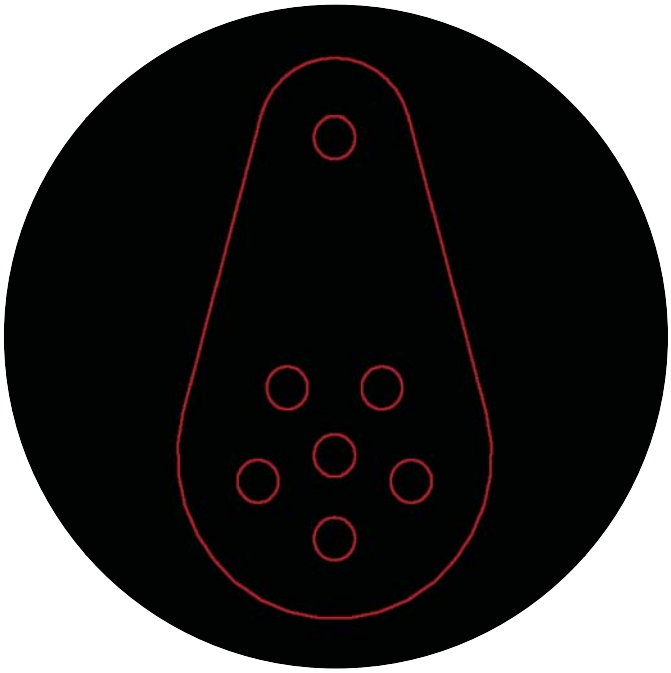
P02 WASHER

2mm balsa wood · sanding · laser cutting · illustrator file

The shallow depth of 2mm of the side plate does not require slicing and can be output to illustrator directly. A 2mm thick transparent acrylic sheet was used to laser cut this part. As the acrylic sheet was not cut thoroughly at the first cut, it had to be cut the second time to successfully separate the side plate from the sheet. The cut part was slightly charred and it was cleaned using alcoholic sanitizer.

P03 SIDE PLATE

2mm transparent acrylic · plain finish · laser cutting · illustrator file



Besides using illustrator, the side plate could be output as a dxf file for laser cutting or CNC milling. The dxf file that is exported from Solidworks needs to be modified in autocad to ensure the lines are joined. The lines are colour coded according to RMIT Gossard workshop's CNC requirement, where red indicates cutting the outer edge.

P03 SIDE PLATE

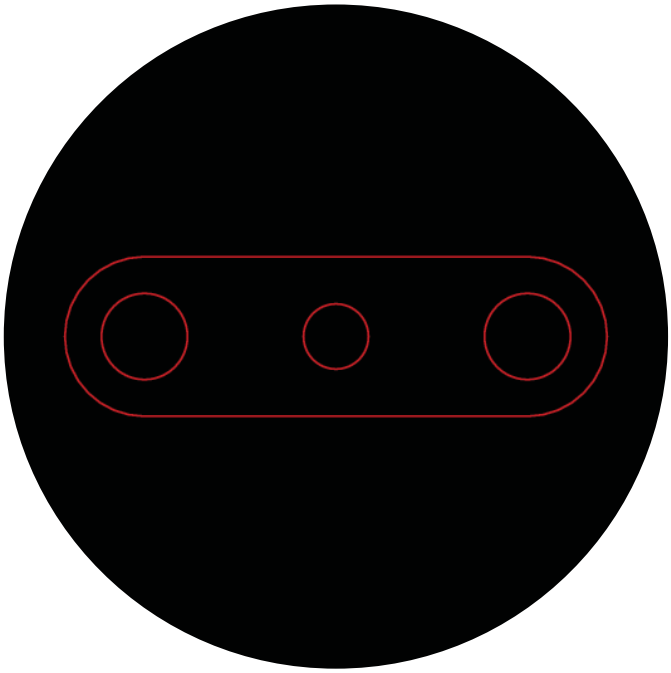
2mm transparent acrylic · plain finish · laser cutting · DXF file (autocad) or CNC milling

ALTERNATIVE OUTPUT & PROCESS

The formed bracket was produced similarly to the side plate. From the illustrator file, the flat patterned bracket was laser cut at 3mm on a transparent acrylic sheet twice to ensure it popped out easily. It was then bent in Gossard workshop using a heat bending machine. To ensure the bracket is bent correctly at the right place, I stuck a scrap paper with measured dimensions onto the acrylic and bent accordingly. After bending, the acrylic had to be hold in place for a while to let it cool down and set at the desired angle. The charred edges were also cleaned using alcoholic sanitizer.

P04 FORMED BRACKET

3mm transparent acrylic · heat bending · laser cutting · illustrator file



Similar to the side plate, the formed bracket could be output as a dxf file for laser cutting or CNC milling. The lines are joined in autocad and colour coded according to RMIT Gossard workshop's CNC requirement. The red lines indicates cutting the outer edge.

P04 FORMED BRACKET

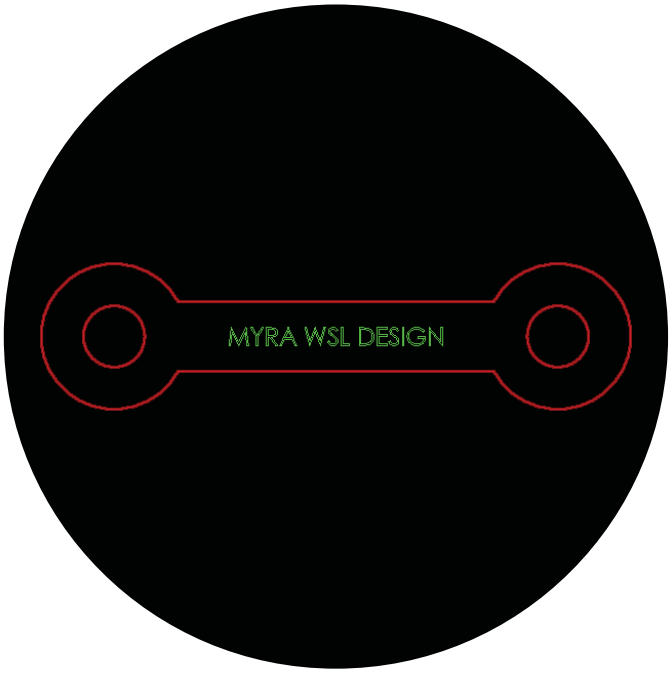
3mm transparent acrylic · plain finish · laser cutting · DXF file (autocad) or CNC milling

ALTERNATIVE OUTPUT & PROCESS

2.5 mm balsa wood was available for purchase in Melbourne Artist's Supplies, therefore the reinforcing plate does not require slicing and can be exported to illustrator directly. In order to do the etching, the text has to be separated from the outlines and put into a separate layer in illustrator. By hiding the outlines layer and showing the text only, I inserted the etching command to the laser cutter and the name was etched onto the balsa wood. In similar fashion, with only the outlines layer shown, the balsa wood was laser cut at 4mm to ensure it was cut thoroughly. The edges were slightly sanded to give it a smoother look.

P05 REINFORCING PLATE

2.5mm balsa wood · sanding · laser cutting + etching · illustrator file



The reinforcing plate could be output as a dxf file for laser cutting or CNC milling. The lines were joined in autocad and colour coded according to RMIT Gossard workshop's CNC requirement. To distinguish the commands for cutting and etching, red represents cutting the outer edge and green represents etching. Also, if it were to be produced using CNC router, a denser wood, such as MDF, should be used instead of balsa wood.

P05 REINFORCING PLATE

2.5mm MDF · plain finish · laser cutting · DXF file (autocad) or CNC milling

ALTERNATIVE OUTPUT & PROCESS

The bush was sliced from the middle of front plane with an interval of 2mm. The sliced parts were doubled when exported to illustrator. It was also due to the minimization of wasted material, 2mm was chosen instead of thicker balsa wood. Also, another consideration of thicker wood is that the laser cutter does not always cut thoroughly. Therefore it is better to have more layers and laser cut with thinner material. The cut parts were glued and rounded off using sanding paper.

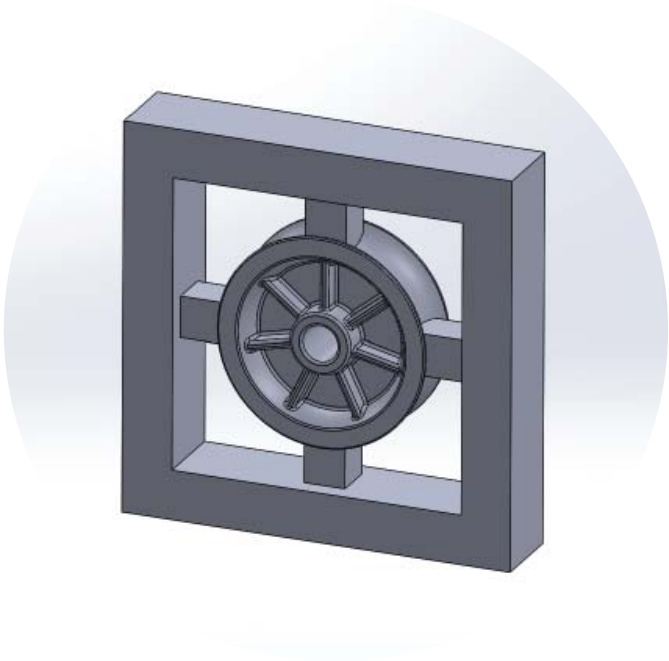
P06 BUSH

2mm balsa wood · sanding · laser cutting · illustrator file

The acetal pulley was sliced from the middle of right plane with an interval of 2mm. When the pulley was sliced, the top two layers, each consists of one big and one small ring, had to be approached with caution. The big and small rings on the same layer had to be separated into two bodies and cut separately. While some sliced parts had double rings shown on the outer edge, the inner ring had to be deleted in illustrator to ensure it was not cut off when laser cutting. Balsa wood was used to produce this part due to its low density, which made it easier to round off by sanding.

P07 ACETAL PULLEY

2mm balsa wood · sanding · laser cutting · illustrator file



I decided to manufacture the pulley using CNC router and arranged an appointment with the technical staff two weeks before submission. The staff explained that to produce a pulley, which is in a similar form of cylinder, I had to create four tabs (width and thickness of 15mm) from the side of the pulley and link it to a square box (thickness of 18mm) 15mm away from the outer ring. The staff also explicated that the CNC router will drill on one side first and flip over to drill the other side as they are identical to each other. The box and the tabs will then be cut off manually and the curved surface requires sanding. I planned to use pine wood for the milling as it is stronger, matches the thickness of the pulley and available in the workshop. I successfully exported the pulley as an IGES file, which the staff required, and scheduled for CNC milling on Monday 4th of May. However, due to the breakdown of machine, the part could not be produced with this method.

P07 ACETAL PULLEY

146 x 146 x 30 mm pine wood · sanding · CNC milling · IGES file

ALTERNATIVE OUTPUT & PROCESS

Technical drawing was not as simple as I thought and many considerations have to be taken in mind to create a clear and concise drawing. I took initiatives to search some examples of engineering drawing online and by reading through them and the engineering drawing handbook, I managed to customise my own title block and create a clear layout for the sheet format. The peer assessment really helped to point out areas for improvement and also consolidated my knowledge about drawing as I corrected other's drawing.

Making the pulley prototype was the most interesting part of the project. I planned ahead and undertook the laser cutter training early in Week 3. However, when I first used the machine, I encountered a few obstacles. I realised that I had to first decide on the thickness of materials and check out if it is available in the shop before slicing the parts up in Solidworks. I have learned from mistakes and gained some tips about laser cutting by speaking with other design students in the laser cutting room.

I also decided to produce the acetal pulley with CNC milling, so I went to Gossard two weeks before submission to enquire about the production method. The technical staff kindly taught me the kind of file I had to produce and the way to create a manufacturable part. I had successfully output my file and scheduled for CNC milling on Monday the 4th of May. However, due to breakdown of the machine, the model was not produced. Overall, I think I have managed my time well and achieved the criteria for this project.

SELF-REFLECTION