We would need to know the methods to characterize the machines to use them for precise cutting. You have detailed out an accurate drawing. Now how do you achieve it in fabrication?

Waterjet cutter

How much abrasive garnet is used in cutting?

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   Selected Machine: ProtoMAX
           Material: Acrylic
     Machineability: 587.7 (Plastic (Brittle
          Thickness: 7.900 mm
        Tool offset: 0.343 mm
           Rotation: 0°

           Estimated time for path:
                  About 16 minutes.

         Estimated abrasive needed:
                     Less than 2 Kg

            Pierces: 13

              Width of path: 114.153 (mm)
             Height of path: 130.245
       Length of tool path: 1870.221
         Length of cutting: 1620.373

(Values reported after tool offset applied.)
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2 kg abrasive used for Volume of 115*130*8 mm3 = 119600 ~ 120000 mm3 = 120 cm3

1 kg abrasive for 60 cm3 of acrylic = 60*1.18 = 70 gm of acrylic.

What is the kerf of the waterjet cutter? What are the factors the kerf is dependent on?

https://knowledgebase.omax.com/protomax/content/wh-protomax/make/measuring_kerf.htm

The tool offset is ½ the kerf width.

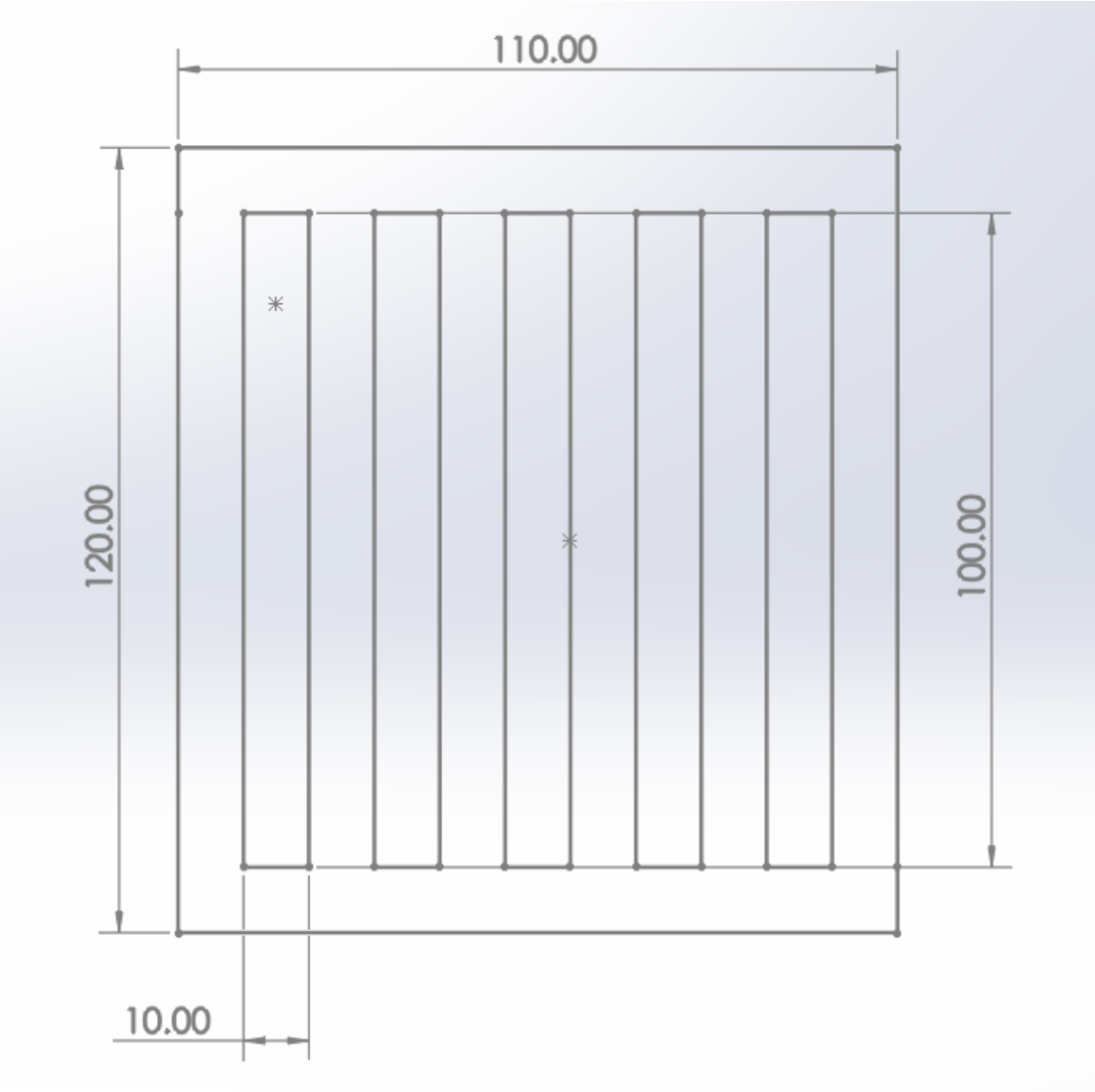
The kerf width can range from 0.021 in. (0.01 mm) to 0.060 in. (0.15 mm), depending upon the nozzle, the thickness of the material being cut, and the amount of wear on the mixing tube. The kerf is typically measured at its widest point:

The nozzle diameter is 0.75 mm which is the kerf width of the Protomax.

https://community.protomax.com/viewtopic.php?t=90

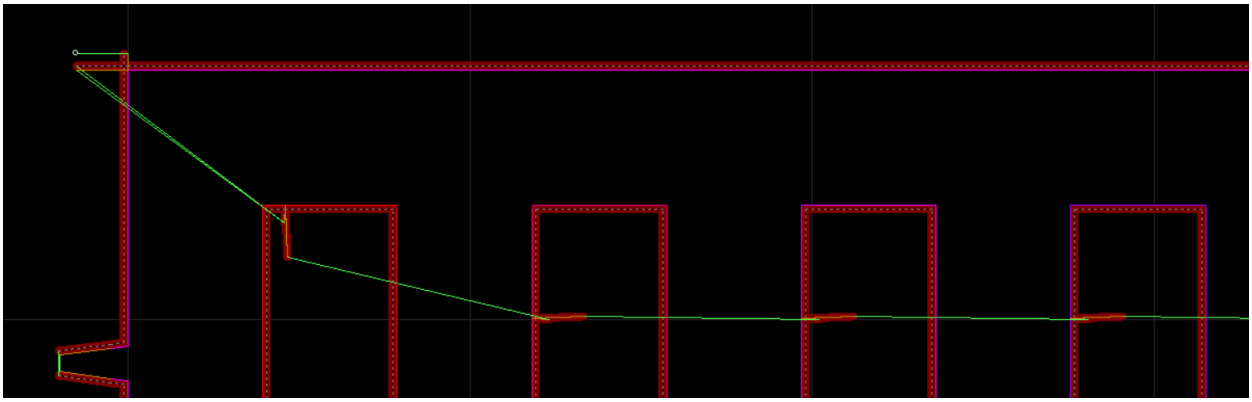
Does the Protomax cut the part as per the dxf drawing dimensions?

Machine offset = .3429 mm (this is the half of the nozzle diameter)



This is the dxf file that was manipulated on Protomax Layout.

kerf_calculation_without_labels_imported_DXF_tabs.dxf and kerf_calculation_without_labels_imported_DXF_tabs.omx files were used.



This figure shows that the outside enclosure piece was cut from outside and the 5 inside pieces were cut from inside. The quality was kept as default of 3.

The accuracy of the digital caliper used was +/- 0.02 mm for < 100 mm and +/- 0.03 mm for 100-200 mm. The resolution of digital caliper is 0.01 mm.

The linear positional accuracy of the waterjet cutter is 0.15 mm.

So, the error ranges from +/- 0.18 mm.

Tabs were given and the results are as follows:

For the outside enclosure piece, the width dimension should have been 110 mm = 110 mm +/- 2*0.18 mm = (109.64, 110. 36 mm). We have measured the value to be 109.78 mm which is within limits.

For the outside enclosure piece, the height dimension should have been 120 mm = 120 mm +/- 2*0.18 mm = (119.64, 120. 36 mm). We have measured the value to be 119.79 mm which is within limits.

Width wise Piece No.	Hole range (mm)	Hole actual (mm)	Piece range (mm)	Piece actual (mm)
1	10 +/- 0.17*2	10.08	10-0.343*4 +/- 2*0.17 = 9.32 +/- 0.34 = (8.30, 9.00)	8.59
2	10 +/- 0.17*2	10.02		8.47
3	10 +/- 0.17*2	9.84		8.25
4	10 +/- 0.17*2	10.05		8.56
5	10 +/- 0.17*2	10.08		8.55

Height wise Piece No.	Hole range (mm)	Hole actual (mm)	Piece range (mm)	Piece actual (mm)
1	100 +/- 0.17*2	99.90	100-0.343*4 +/- 2*0.17 = 98.64 +/- 0.34 = (98.30, 99.00)	98.33
2	100 +/- 0.17*2	99.89		98.30
3	100 +/- 0.17*2	99.80		
4	100 +/- 0.17*2	99.88		98.33
5	100 +/- 0.17*2	99.93		98.36

Table xx

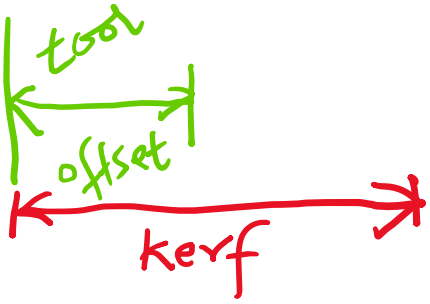
Average hole width = 99.88 mm.

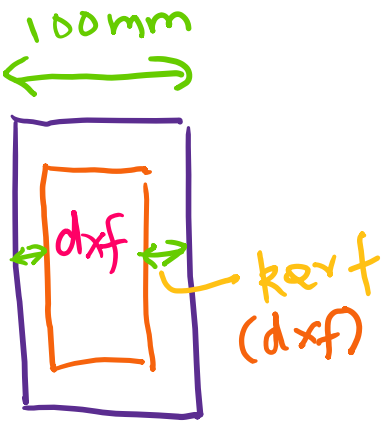
Average piece width = 98.33 mm.

Insights:

The desired dimension is within the error range. This is heartening to know. The width dimension is 0.16/2 mm off at the most on each side ~ 0.08%. The height dimension is 0.20/2 mm off on each side ~ 0.10%.

Protomax determines the kerf. But we can compute the actual dimension to find out the kerf and accordingly, change the tool offset to make accurate parts if precise parts are to be made. For example, for hole 1, the calculations would be: Please also see highlighted cells in Table xx above.





As per dxf, 100 − 2× kerf = piece width

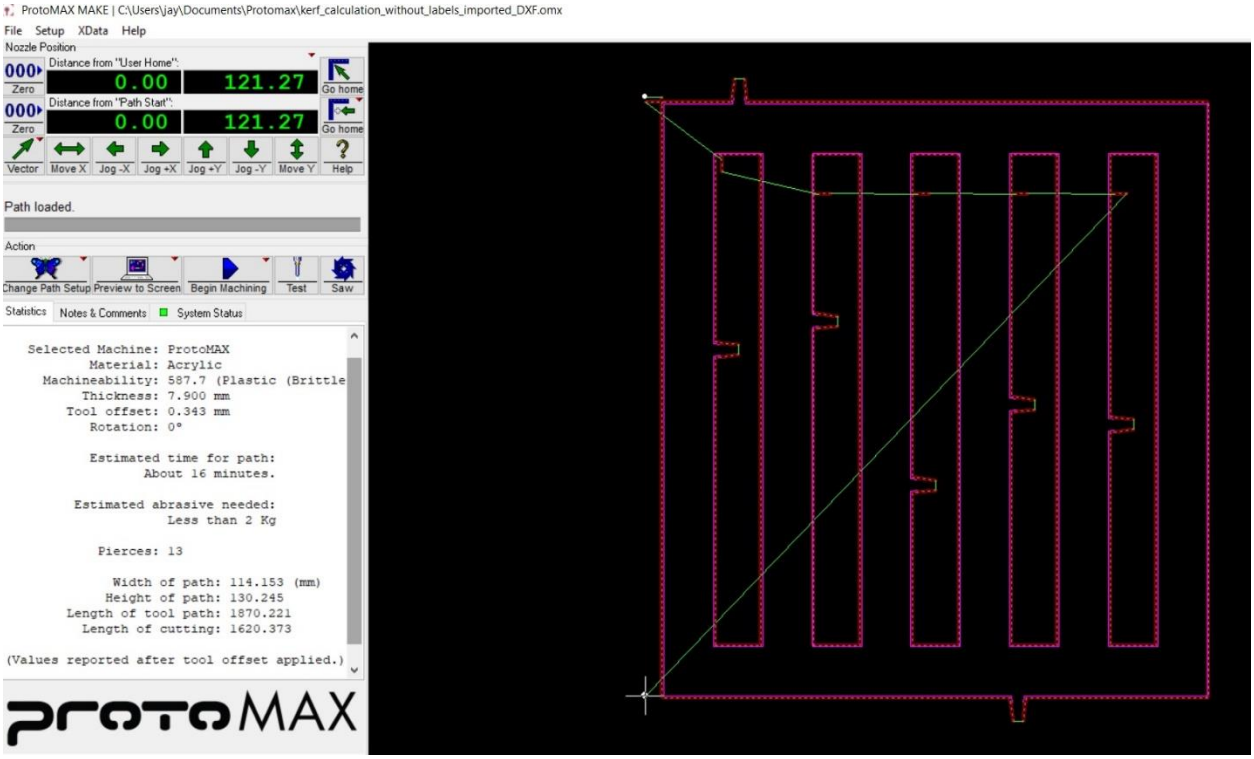
In reality, 99.88 − 2×kerf* = 98.33

or kerf* = 0.78

Tool offset should be 0.78/2 = 0.39 mm.


109.68mm
119.68 mm
10.08mm
(hole)
99.90 mm
(hole)
1
2
3
4
5

Vary the quality from 5 to 1 and find out the effect of quality on kerf.



Width wise Quality	Hole range (mm)	Hole actual (mm)	Piece range (mm)	Piece actual (mm)
1	10 +/- 0.17*2		10-0.343*2 +/- 2*0.17 = 9.32 +/- 0.34 = (8.98, 9.66)	
2	10 +/- 0.17*2	9.93	10-0.343*2 +/- 2*0.17 = 9.32 +/- 0.34 = (8.98, 9.66)	
3	10 +/- 0.17*2	10.01	10-0.343*2 +/- 2*0.17 = 9.32 +/- 0.34 = (8.98, 9.66)	
4	10 +/- 0.17*2	9.95	10-0.343*2 +/- 2*0.17 = 9.32 +/- 0.34 = (8.98, 9.66)	
5	10 +/- 0.17*2	10.04	10-0.343*2 +/- 2*0.17 = 9.32 +/- 0.34 = (8.98, 9.66)	8.41

Why is the offset dimension off? Grade of acrylic different?

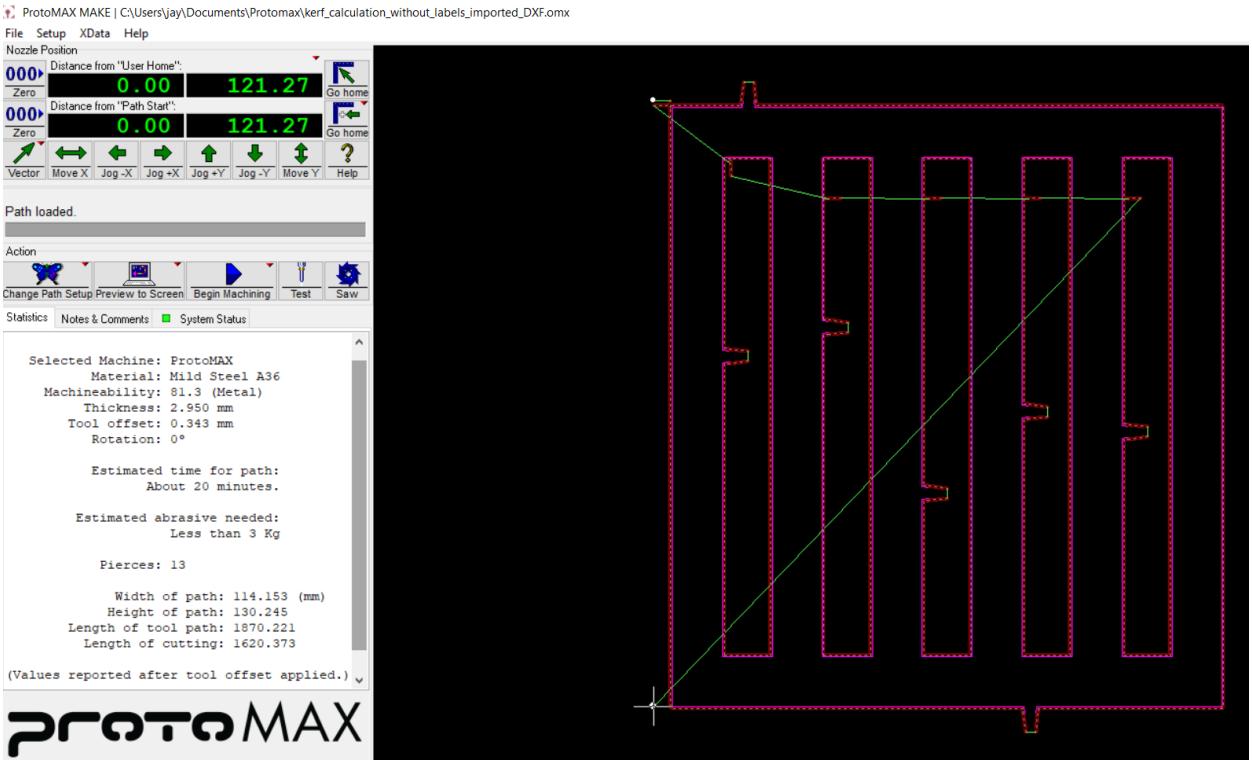
Height wise Quality	Hole range (mm)	Hole actual (mm)	Piece range (mm)	Piece actual (mm)
1	100 +/- 0.17*2		100-0.343*2 +/- 2*0.17 = 99.32 +/- 0.34 = (98.98, 99.66)	
2	100 +/- 0.17*2	99.87	100-0.343*2 +/- 2*0.17 = 99.32 +/- 0.34 = (98.98, 99.66)	
3	100 +/- 0.17*2	99.88	100-0.343*2 +/- 2*0.17 = 99.32 +/- 0.34 = (98.98, 99.66)	
4	100 +/- 0.17*2		100-0.343*2 +/- 2*0.17 = 99.32 +/- 0.34 = (98.98, 99.66)	
5	100 +/- 0.17*2	99.86	100-0.343*2 +/- 2*0.17 = 99.32 +/- 0.34 = (98.98, 99.66)	98.26

Insights:

I didn’t find much difference with quality change. Parts with all quality were within error range.

Brittle material acrylic not cut properly.

MS sheet.



3 kg abrasive used for Volume of 115*130*3 mm3 = 44850 ~ 45000 mm3 = 45 cm3

1 kg abrasive for 15 cm3 of MS = 15*7.85 = 120 gm of mild steel.

Rule of thumb: 1 kg abrasive for 100 gm of material. 1 kg abrasive costs INR 20. So, INR 1 for 5 gm of material.

The accuracy of the digital caliper used was +/- 0.02 mm for < 100 mm and +/- 0.03 mm for 100-200 mm. The resolution of digital caliper is 0.01 mm.

The linear positional accuracy of the waterjet cutter is 0.15 mm.

So, the error ranges from +/- 0.18 mm.

Tabs were given and the results are as follows:

For the outside enclosure piece, the width dimension should have been 110 mm = 110 mm +/- 2*0.18 mm = (109.64, 110. 36 mm). We have measured the value to be 109.87 mm which is within limits.

For the outside enclosure piece, the height dimension should have been 120 mm = 120 mm +/- 2*0.18 mm = (119.64, 120. 36 mm). We have measured the value to be 120.02 mm which is within limits.

Width wise Piece No.	Hole range (mm)	Hole actual (mm)	Piece range (mm)	Piece actual (mm)
1	10 +/- 0.17*2	9.96	10-0.343*4 +/- 2*0.17 = 9.32 +/- 0.34 = (8.30, 9.00)	8.65
2	10 +/- 0.17*2			
3	10 +/- 0.17*2			
4	10 +/- 0.17*2			
5	10 +/- 0.17*2			

Height wise Piece No.	Hole range (mm)	Hole actual (mm)	Piece range (mm)	Piece actual (mm)
1	100 +/- 0.17*2	99.90	100-0.343*4 +/- 2*0.17 = 98.64 +/- 0.34 = (98.30, 99.00)	97.40
2	100 +/- 0.17*2			
3	100 +/- 0.17*2			
4	100 +/- 0.17*2			
5	100 +/- 0.17*2			

99.90 – 2*kerf = 97.40 or kerf = 2.50/2 = 1.25 mm. So, tool offset should be 1.25/2 = 0.625 mm in this case. Other parts of the table can be filled.