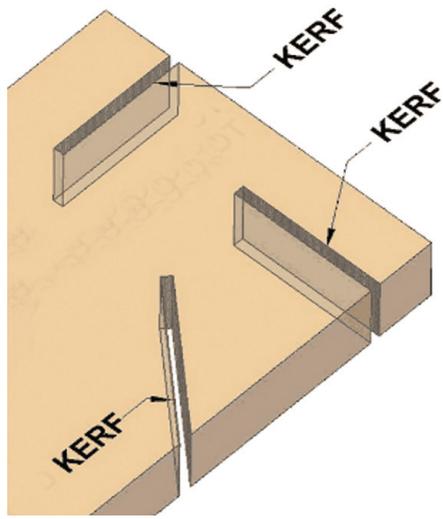


How wide does a laser cut and does it really matter?

By definition, a saw kerf is the width of a saw cut (below), the kerf being wider than the saw blade due to the set of the saw teeth. We are aware of the size of a circular saw kerf, usually around 3 mm material removed for each saw cut, we make allowances for this dimension.



When we cut with saws, we cut on the waste side of 'the line' to ensure correct dimensions after sawing. But what about the size of a laser cut kerf, it is usually assumed to be so small that it doesn't matter, but can we really make this assumption? Laser cutting say a 50 mm square from CAD software, does it really produce a product 50 mm square? What about the laser kerf width, is it a constant? Does it matter if the square is cut externally or internally?

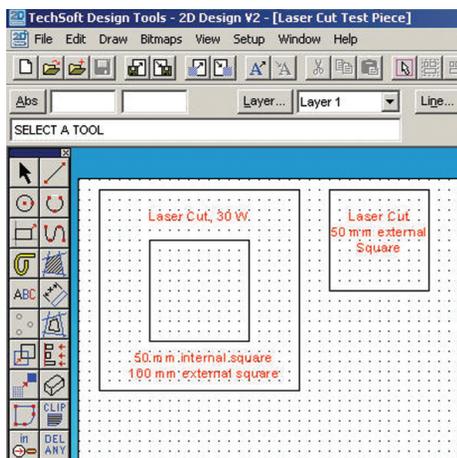


Figure 1 – Two laser-cut test pieces

Using a 30 W powered LaserCAM (Techsoft) cutting 3 mm acrylic, the dimensions of artefacts compared to the original CAD dimensions were investigated.

Laser kerf width is actually a function of the speed of the laser, for 3 mms thick acrylic, cutting is achieved with a 100% power setting and a 3% Speed setting. Light engraving for acrylic is with a 50% Power setting and a 100% speed setting.

A CAD file was produced via 2D Design v2 software. Figure 1 shows two test pieces, a 100 mm square with a 50 mm internal cut, in addition a 50 mm square was produced.

Acrylic (3 mm) was then cut using a laser. The laser beam was focused on the top surface of the acrylic. Using digital callipers, all sizes were measured as shown in Figure 2.

From Figures 2 & 3 and Table 1 it can be seen that as a general rule for 3 mm thick acrylic, external cuts produce smaller artefacts compared to the desired CAD dimensions, while internal cuts are larger than that designed via the CAD system.

In many situations such oversize and undersize after laser cutting is not a problem, however, when inserting for example different colours of acrylic, the laser cut materials produced are far from a 'push fit'. The 50 mm square produced from the laser cut test piece CAD file (Figure 1) can be visually moved inside the '50 mm internal square cut'. Consider Figure 8 there is a 0.42 – 0.39 mm difference in sizes in both the X and Y axis.

Considering the test piece CAD file in Figure 1, measurements were made comparing the 50 mm internal square cut out and the scrap square removed. From Figure 8 the internal square hole measured 50.25 x 50.18 mm while the scrap square removed was measured as 49.84 and 49.78 mm, hence a kerf width of $0.41/2 = 0.205$ mm in the X axis and a width of $0.40/2 = 0.2$ mm in the Y axis was obtained. Laser kerf size actually vary across different materials and also

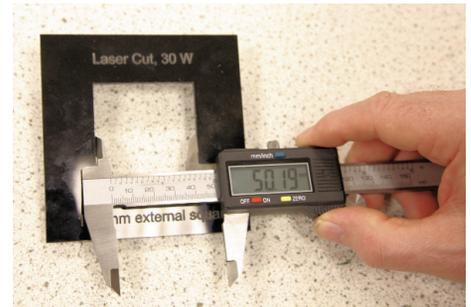


Figure 2 – Measuring the external 50 mm square.

for different thicknesses of materials.



Figure 3 - Measurement of the internal 50 mm square.

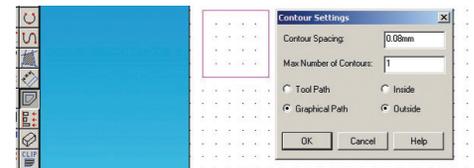


Figure 4 - Creating a contour around the 50 mm square

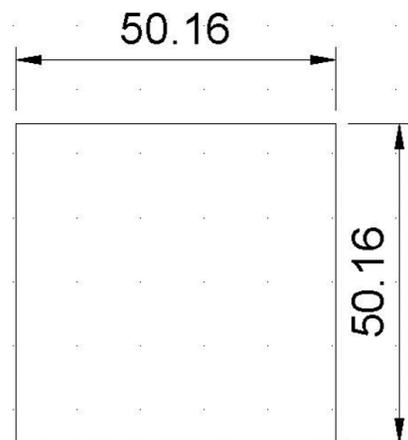


Figure 5 - CAD Dimensions of a 50 x 50 mm square after using a 0.08 mm contour setting

How wide does a laser cut...?



External Square 100 mm	External Square 100 mm	Internal Square 50 mm	Internal Square 50 mm	External Square 50 mm	External Square 50 mm
X axis	Y axis	X axis	Y axis	X axis	Y axis
99.64 mm	99.67 mm	50.19 mm	50.17 mm	49.83 mm	49.79 mm

Table 1- Actual measurements taken from test pieces.

CAD 100 mm External Square, X axis, actual size	Undersize X axis	CAD 100 mm External Square, Y axis, actual size	Undersize X axis
99.64 mm	0.36 mm	99.67 mm	0.36 mm

Table 2- Comparison of CAD sizes with actual laser cut sizes, 100 mm external cut.

CAD 50 mm Internal Square, X axis, actual size	Oversize X axis	CAD 50 mm Internal Square, Y axis, actual size	Oversize X axis
50.19 mm	0.19 mm	50.17 mm	0.17 mm

Table 3- Comparison of CAD size for an internal 50 mm square cut.

CAD 50 mm External Square, X axis, actual size	Undersize X axis	CAD 50 mm External Square, Y axis, actual size	Undersize X axis
49.83 mm	0.17 mm	49.79 mm	0.21 mm

Table 4- Comparison of CAD size with actual size of a 50 mm external square cut.

Internal 50 mm Square (A)	Internal 50 mm Square (B)	External 50 mm X axis (C)	External 50 mm Y axis (D)	Difference in X axis (A-C)	Difference in Y axis (B-D)
Actual X axis	Actual Y axis	Actual X axis	Actual Y axis	mm	mm
50.25 mm	50.18 mm	49.83 mm	49.79 mm	0.42	0.39

Table 5- Distance differences between the internal and external squares of the test piece.

CAD Size (mm)	Actual size of square (mm)	Width 0.08 mm contour setting	Width 0.15 mm contour setting	Width 0.20 mm contour setting
50 x 50 mm	49.83 x 49.79	50.06 x 49.95	50.2 x 50.06	50.25 x 50.21

Table 6- Actual measurements taken from test pieces.

Considering 3 mm acrylic, if push fit quality was to be obtained then the quality from using correct CAD sizes and the difference in actual sizes obtained is too large and adjustments need to be made. Thankfully the 2D Design software has a 'contour icon' (Figure 4) which enables additional size to be added to a sketch.

With a contour spacing of 0.08 mm as shown in Figure 5 the CAD system redraws the shape, drawn around the outside of the original (Note - 'Outside' set in Figure 5). The distance from the original shape equals the 'contour spacing' setting. Hence, for a 50 mm square, the new square would have the dimensions in the CAD software shown in Figure 10, as:

$$50 + (2 * \text{contour spacing setting})$$

Table 6 shows the actual sizes after laser cutting of a 50 x 50 mm external square

cut, initially using the CAD sizes and then using three 'contour spacings' 0.08 mm, 0.15 mm and 0.2 mm.

In order to obtain a good 'push fit' the internal 50 x 50 square which is actually 50.25 x 50.23 mms (Table 5), requires the fitting piece to be of greater dimension than 50 x 50. From Table 6, the 0.20 mm contour setting obtains 50.25 x 50.21, this in fact gives a good push fit. This contour setting (0.20 mm) is the laser kerf size previously considered.

Sequence for the 'Contour Icon Tool'

- Using the CAD software, draw a 50 x 50 mm square;
- Highlight/select the square;
- Select the Contour Icon, set the required contour setting size; select 'Outside'
- Zoom in and see an additional square drawn outside the original 50 x 50 mm square.

- Delete the original square (50 x 50 mm)
- This gives a square of 50 + (2*contour setting) each side.

Testing with various materials and thicknesses in this manner will obtain the required 'Contour Setting' in order to ensure a push fit.

Laser kerf width is a function of the speed of the laser, long straight edges tend to have a narrower kerf than slowly cut curved edges. Using circles rather than squares in this exercise, it would be expected to produce a slightly wider laser kerf.

Further details on prices and ordering details for the equipment and software mentioned will be made available on the SSERC website.