WORKSHEET 07 · CAD & ENGINEERING GRAPHICS

CAD/CAM, MODEL DATA & FILE FORMATS

Prepare laser and 3D-print files, work out kerf, yield, mass and cycle time from model data, and choose the right file for each user.

07

COURSE NOTES **CH 07–08** TIME **55 MIN** TOTAL **30 MARKS** EDITION **TYPE-IN**

NAME _____ CLASS _____ DATE _____

LEARN IT **THE ESSENTIALS**

MAKING IT

- **Laser**: closed paths, no duplicates, hairline strokes, colour mapped to cut / score / engrave, text to outlines, inside cuts first, 1:1 mm.
- **Kerf** (k): outer profiles come out k small, holes k big, unless offset by $k/2$.
- **STL**: chord sag = $r(1 - \cos(180° \div n))$; no units; must be watertight.
- **CNC**: rev/min = 1000 × cutting speed ÷ ($\pi \times D$); feed = rev/min × flutes × feed per tooth.

MODEL DATA AND FORMATS

- **Mass** = density × volume: 1000 kg/m³ = 0.001 g/mm³. CAD also reports area and **centre of mass**.
- **Yield** = area of parts ÷ area of sheet × 100.
- .dwg native drawings · .dxf 2D vectors · .stl mesh · .step / .iges exact solids and surfaces between CAD systems · .3ds meshes with materials, lights, cameras · .vrml (.wrl) coloured 3D scenes.

MISSION BRIEF The team is preparing SUMMIT-X for manufacture: acrylic prototype frame plates on the laser cutter, SLS-printed prop guards and CNC-machined motor mounts.

1 The prototype plates are cut from 3 mm acrylic. The kerf is measured as 0.18 mm.

(a) State the size the plate and its holes would be cut if the vectors are not compensated.

2

(b) Describe how the vectors should be compensated for kerf.

1

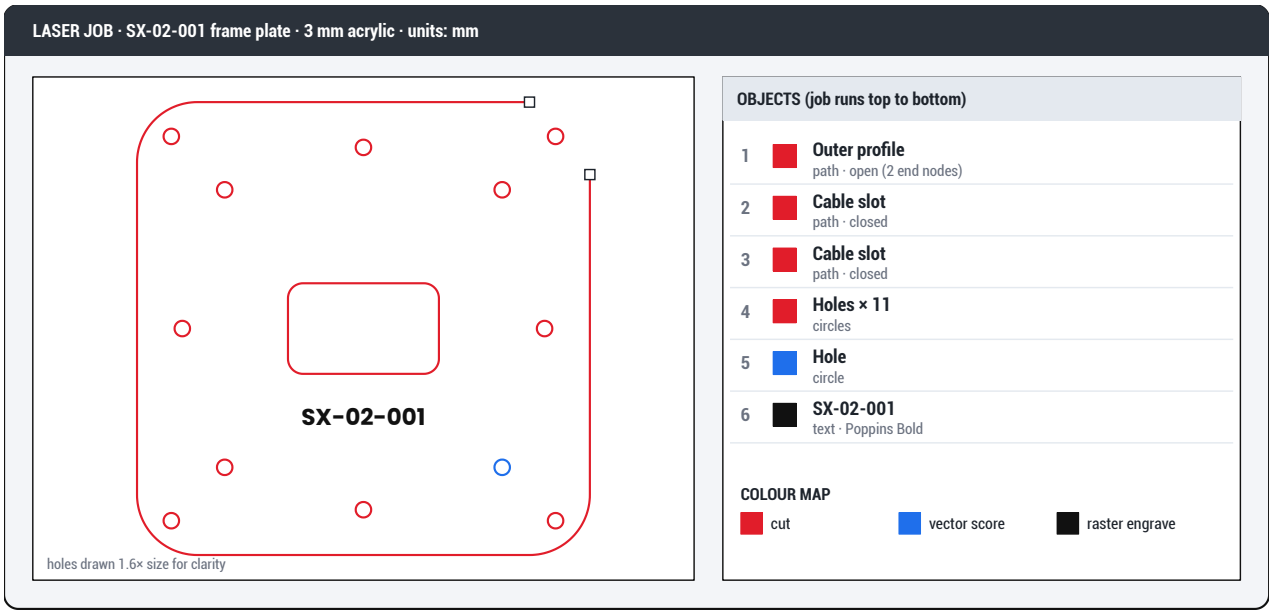

Fig 1 A trainee's laser job for the acrylic prototype plate: artboard and object list. The geometry comes from the real DXF.

2 The job in Fig 1 contains five errors. Identify **four** of them and explain the effect each would have on the cut plate.

4

3 The prop guard ring (outside radius 138 mm) is exported as an STL for SLS printing.

(a) Calculate the chord sag if the export uses 36 facets around the ring.

2

(b) The default export uses 120 facets, giving a chord sag of 0.047 mm. Explain why the designer might still choose 120 facets rather than a much finer setting.

2

4 The net area of one plate is 20 581.6 mm². Plates are nested in rows and columns, without rotating, on a 1000 × 600 sheet with 10 mm margins and 5 mm gaps. Calculate how many plates fit on the sheet and the nesting yield. Show your working.

3

5 The CAD mass properties of the prop guard are: volume 87 877.1 mm³, PA12 density 1015 kg/m³, centre of mass z = 50.86 mm (Fig 2).



Fig 2 Prop guard: ring 3 mm thick, 30 high; two struts below it (sizes from the SUMMIT-X model).

(a) Calculate the mass of one prop guard. Show your working.

2

(b) Explain why the centre of mass is below the mid-height of the ring.

2

6 The top of each motor-mount billet is faced with a Ø16 end mill (3 flutes) at a cutting speed of 250 m/min and 0.05 mm per tooth. The tool-centre path is 210 mm long. Calculate the spindle speed, the feed rate and the time for the facing pass. Show your working.

3

7 SUMMIT-X files are sent to several users.

(a) State the most suitable file format for each user.

(i) Laser technician cutting the acrylic prototype plate

(ii) Architect updating the SUMMIT Base floor plans and their services layers

(iii) Supplier machining the searchlight yoke in a different CAM system

(iv) Artist rendering a launch image with materials, lights and cameras

(v) Charity web page showing a coloured 3D model visitors can spin

(vi) Print bureau building the hand controller by SLS

3

(b) The yoke supplier's software can read both STEP and IGES. Explain why STEP is the better file to send.

2

(c) Explain why the yoke supplier should not be sent an STL file.

2

8 Explain how the team could use information from the CAD model to reduce the environmental impact of the prop guards before any are printed.

2

EXAM INTEL **CALCULATIONS AND CONCLUSIONS**

Write the formula, substitute with units, then answer to a sensible accuracy: "mass = 0.001015 g/mm³ × 87 877.1 mm³ = 89.2 g". To explain a format choice, link **what it stores** to **what the receiver must do** with it.

designclass design | engineering | technology © DesignClass 2026 · designclass.co.uk · Free for use in Scottish schools

TOTAL 30 MARKS