Exercise walk-through

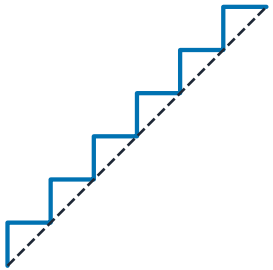
8.5
Additive manufacturing

University Mechanical Engineering

Additive: layers make a staircase

0.2 mm layers

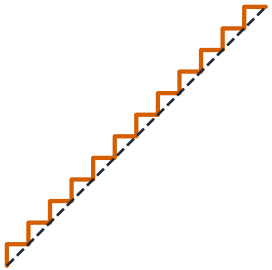
design surface 45°



cusp 0.141 mm, 300 layers

0.1 mm layers

design surface 45°



cusp 0.071 mm, 600 layers

60 mm tall: 0.2 mm layers give $\mathbf{300}$ layers and a 45° cusp $c = t\cos\theta = \mathbf{0.141}$ mm; 0.1 mm gives $\mathbf{600}$ layers and $\mathbf{0.071}$ mm.

Print or machine?

1. **Print** About €40 per part, no set-up, internal channels possible.
2. **Machine** €400 set-up plus €12 per part for a simpler two-part version.
3. **Break-even** $400/(40-12) = \mathbf{14.3}$: print up to 14 parts, machine from 15.

Exercises 2.1·2.2

2.1 A part 45 mm tall is printed in 0.15 mm layers at 30 s per layer. Find the number of layers and the build time (min). [3]

2.2 Find the cusp height on a wall at 60° to the build plate with 0.2 mm layers (two decimals, mm), and on a 30° wall (three decimals, mm). Which wall looks rougher? [3]

Exercises 2.1·2.2

2.1 A part 45 mm tall is printed in 0.15 mm layers at 30 s per layer. Find the number of layers and the build time (min). [3]

2.1

- Layers $= 45/0.15 =$ **300**.
- Time $= 300 \times 30 = 9000$ s $=$ **150** min.

2.2 Find the cusp height on a wall at 60° to the build plate with 0.2 mm layers (two decimals, mm), and on a 30° wall (three decimals, mm). Which wall looks rougher? [3]

2.2

- 60°: $c = t\cos\theta = 0.2\cos 60° =$ **0.10** mm.
- 30°: $c = 0.2\cos 30° =$ **0.173** mm, so the shallower wall is rougher.

Exercises 2.3·3.1

2.3 Printing costs €55 a part with no set-up; machining costs €300 of set-up plus €15 a part. Up to how many parts is printing cheaper? [3]

3.1 The machined design of 2.3 is two parts that need an extra €20 assembly step each; the printed part is one piece. Find the new break-even, and which route is cheaper for an order of 20, with both totals. Name one property risk of the printed part. [6]

Exercises 2.3·3.1

2.3 Printing costs €55 a part with no set-up; machining costs €300 of set-up plus €15 a part. Up to how many parts is printing cheaper? [3]

2.3

- Break-even $= 300/(55 - 15) = 7.5$ parts.
- Printing is cheaper up to **7** parts.

3.1 The machined design of 2.3 is two parts that need an extra €20 assembly step each; the printed part is one piece. Find the new break-even, and which route is cheaper for an order of 20, with both totals. Name one property risk of the printed part. [6]

3.1

- Machined unit cost becomes $15 + 20 = €35$: break-even $= 300/(55 - 35) =$ **15** parts.
- For 20: printing $20 \times 55 = €1100$; machining $300 + 20 \times 35 = €1000$. Machining is cheaper by €**100**.
- Anisotropy: the printed part is weaker across its layers, so a load across them needs checking.