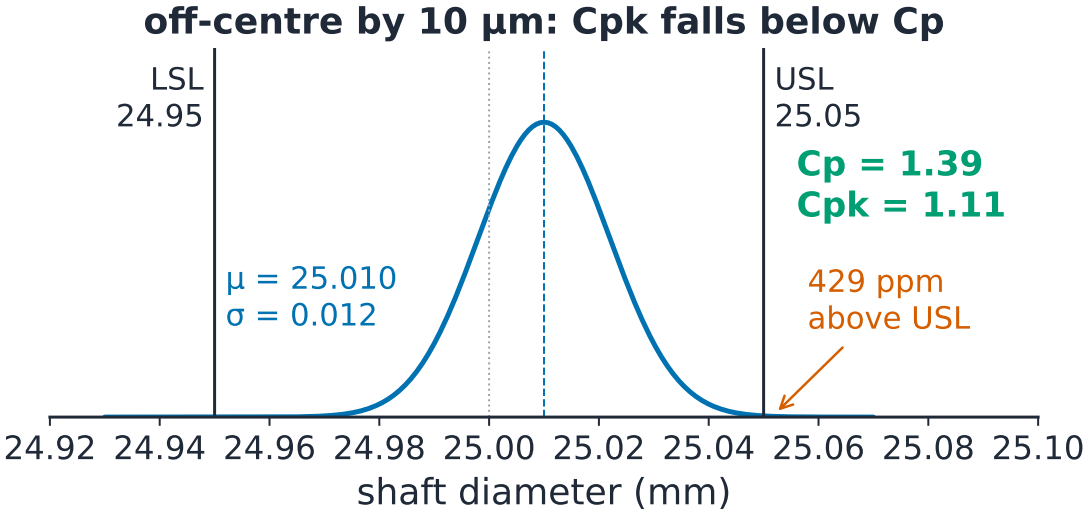
Exercise walk-through

8.6
Process planning and quality

University Mechanical Engineering

Quality: does the process fit the tolerance?



25.00 ± 0.05, $\mu = 25.010$, $\sigma = 0.012$: $C_p = \mathbf{1.39}$ but $C_{pk} = \mathbf{1.11}$, with **429** ppm above USL. Re-centred: $C_{pk} = 1.39$ and **31** ppm.

Keeping it centred

1. **Plan** Stock $\to$ rough turn $\to$ heat treat $\to$ finish grind $\to$ inspect, each from its **datum**.
2. **Chart** $n = 5$ per hour: $\bar{x}$ limits $\mu \pm 3\sigma/\sqrt{n} = \mathbf{24.994}$ to $\mathbf{25.026}$ mm.
3. **Act** A point outside, or seven in a row on one side, means the process changed - find the cause.

Check yourself

- The **fit** and the stack? (7-41 µm clearance; ±0.15 worst case, ±0.079 RSS.)
- The **riser** and the wire? (55.4 mm, 1.70 min; 124 MPa, 2.44 kN.)
- The pass, the tool, the weld? (955 rpm, 3.5 kW, 0.84 min; 50.6 vs 16 min; 123 kN.)
- The print and the grinder? (300 layers, 0.141 mm, break-even 14; Cp 1.39, Cpk 1.11, 429 ppm.)

Exercises 2.1·2.3

2.1 Find C_p and C_{pk} (two decimals). [4]

2.2 Find the parts per million above the USL and below the LSL. [3]

2.3 Set the $\bar{x}$ chart limits for samples of $n = 4$ (three decimals, mm). [3]

Exercises 2.1·2.3

2.1 Find C_p and C_{pk} (two decimals). [4]

2.1

- $C_p = (USL - LSL)/6\sigma = 0.06/0.048 = \mathbf{1.25}$.
- $C_{pk} = (USL - \mu)/3\sigma = (12.030 - 12.006)/0.024 = \mathbf{1.00}$.

2.2 Find the parts per million above the USL and below the LSL. [3]

2.2

- Above: $z = (USL - \mu)/\sigma = (12.030 - 12.006)/0.008 = 3.0$, tail 0.00135: **1350** ppm.
- Below: $z = (\mu - LSL)/\sigma = (12.006 - 11.970)/0.008 = 4.5$: **3.4** ppm.

2.3 Set the $\bar{x}$ chart limits for samples of $n = 4$ (three decimals, mm). [3]

2.3

- $\mu \pm 3\sigma/\sqrt{n} = 12.006 \pm 3 \times 0.008/2 = 12.006 \pm 0.012$: **11.994** to **12.018** mm.

Exercise 3.1

3.1 The lathe is re-centred to 12.000 mm. Find the new C_{pk} and the total ppm out of specification. The customer demands $C_{pk} \geq 1.33$: what σ is needed, and what would you change to get it? [6]

Exercise 3.1

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3.1

- Centred: $C_{pk} = C_p = \mathbf{1.25}$.
- Each side $z = 0.03/0.008 = 3.75$: total $2 \times 88.4 = \mathbf{177}$ ppm.
- $C_{pk} = 0.03/3\sigma \geq 1.33$ gives $\sigma \leq 0.03/4 = \mathbf{0.0075}$ mm.
- Reduce the spread: a stiffer set-up, a sharper or more stable tool, temperature control, or a finishing pass.