Economics

Cost depends on

- labor
- location
- materials

Standardize

- reduce cost
- ensure repair

Tolerances

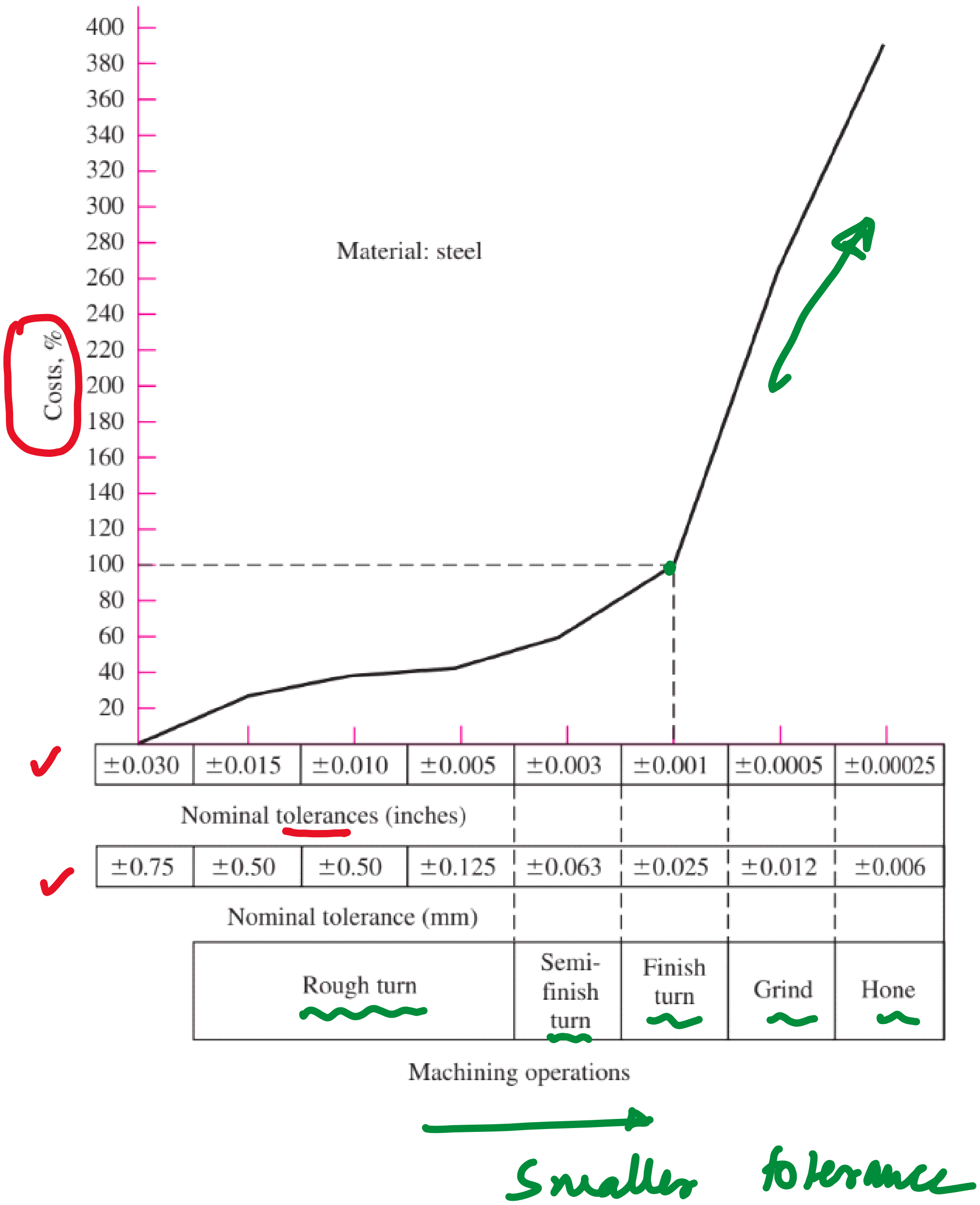
- dimensional variation

more expensive

e.g. 50mm ± 5mm ← smaller tolerance

50mm ± 10mm ← larger tolerance

Cost vs finishing



Break even point

The point measured in cost/time at which 2 processes have the same return.

There are two machines, A and B that may be used to produce a niche product. A has a setup time of 5 hours, produced 20 parts per hour at the cost of $20 per hour. B has no setup time, produces 10 parts per hour at the cost of $60 per hour.

(a) What is the break-even point? (cost)

(b) Which machine will you use for 10 units and which one for 30 units production.

A: setup time 5 hrs.
20 parts per hour @ $20 per hour

B: no setup time
10 parts per hour @ $60 per hour.

C — cost
x — parts

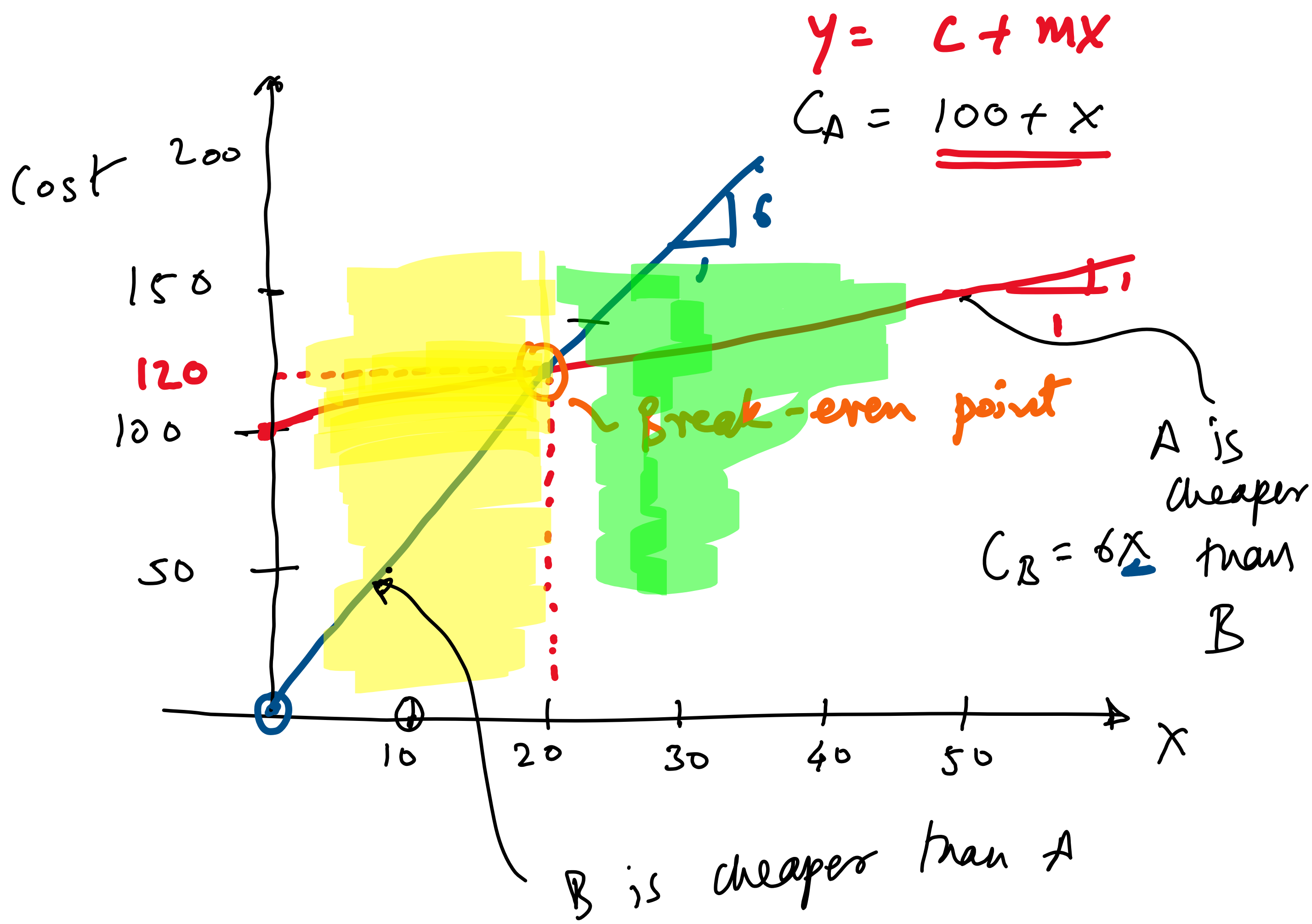
$$C_A = 100 + (x \text{ parts})\left(\frac{20\ \$/hr}{20\ part/hr}\right) = 100 + x$$

($\$/part$; $\$$)

$$C_B = 0 + (x \text{ part})\left(\frac{60\ \$/hr}{10\ parts/hr}\right) = 6x$$

(a) Break even point:

$$C_A = C_B$$
$$100 + x = 6x$$
$$\Rightarrow x = \frac{100}{5} = 20$$



(b) For 10 units use B

$$C_B = 6(10) = 60$$

For 30 units use A

$$C_A = 100 + 30 = 130$$

Stress and Strength

Stress: Force per unit area at a specific point in the body

Strength: Force per unit area for the object as a whole.

Design factor (n_d) / Factor of safety (n)

$$n_d \text{ or } n = \frac{\text{Strength}}{\text{Allowable stress}} = \frac{S}{\sigma}$$

no units

n_d → computed before the design is built

n → computed after the design is built.

Because of standardization n_d need not be equal to n.

A mechanical system requires a shaft. The shaft is subject to normal force of 10 N, has a strength of 2000 N/m^2, a design factor of 2. Find

- (a) shaft diameter
- (b) factor of safety

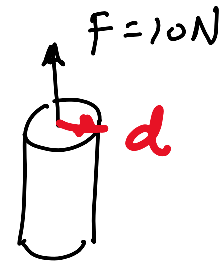
$F = 10\ N$

$S = 2000\ N/m^2$

$n_d = 2$ ~ before design is built.

(a) $n_d = \frac{S}{\sigma} \Rightarrow 2 = \frac{2000}{\sigma}$

$\Rightarrow \sigma = 1000\ N/m^2$



$\sigma = \frac{F}{\pi d^2/4} \Rightarrow d = \sqrt{\frac{4F}{\pi \sigma}} = \sqrt{\frac{4(10)}{3.14(1000)}}$

$d = 112.8\ mm$

$d = 120\ mm$ (standardized)

(b) $n = \frac{S}{\sigma} = \frac{2000}{\frac{10}{(\pi (0.12)^2/4)}} = 2.26$

$n = 2.26$

$n \neq n_d$ Because of standardization

Table A-17.

Fraction of Inches

$\frac{1}{64}$, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{9}{16}$, $\frac{5}{8}$, $\frac{11}{16}$, $\frac{3}{4}$, $\frac{7}{8}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2, $2\frac{1}{4}$, $2\frac{1}{2}$, $2\frac{3}{4}$, 3, $3\frac{1}{4}$, $3\frac{1}{2}$, $3\frac{3}{4}$, 4, $4\frac{1}{4}$, $4\frac{1}{2}$, $4\frac{3}{4}$, 5, $5\frac{1}{4}$, $5\frac{1}{2}$, $5\frac{3}{4}$, 6, $6\frac{1}{2}$, 7, $7\frac{1}{2}$, 8, $8\frac{1}{2}$, 9, $9\frac{1}{2}$, 10, $10\frac{1}{2}$, 11, $11\frac{1}{2}$, 12, $12\frac{1}{2}$, 13, $13\frac{1}{2}$, 14, $14\frac{1}{2}$, 15, $15\frac{1}{2}$, 16, $16\frac{1}{2}$, 17, $17\frac{1}{2}$, 18, $18\frac{1}{2}$, 19, $19\frac{1}{2}$, 20

Decimal Inches

0.010, 0.012, 0.016, 0.020, 0.025, 0.032, 0.040, 0.05, 0.06, 0.08, 0.10, 0.12, 0.16, 0.20, 0.24, 0.30, 0.40, 0.50, 0.60, 0.80, 1.00, 1.20, 1.40, 1.60, 1.80, 2.0, 2.4, 2.6, 2.8, 3.0, 3.2, 3.4, 3.6, 3.8, 4.0, 4.2, 4.4, 4.6, 4.8, 5.0, 5.2, 5.4, 5.6, 5.8, 6.0, 7.0, 7.5, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20

Millimeters

0.05, 0.06, 0.08, 0.10, 0.12, 0.16, 0.20, 0.25, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 1.0, 1.1, 1.2, 1.4, 1.5, 1.6, 1.8, 2.0, 2.2, 2.5, 2.8, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 8.0, 9.0, 10, 11, 12, 14, 16, 18, 20, 22, 25, 28, 30, 32, 35, 40, 45, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300

↑ larger of 100, 120

$d = 112.8$

$d = 120\,mm$