Formula Sheet:

Thermoforming:

Consider heating a sheet using a heating lamp. The lamp power is P and the absorption coefficient of the sheet is a. The amount of heat delivered to the sheet per unit area is: $q = P.a$

The time it takes to rise the temperature in the sheet from T_0 (initial temperature) to T_f (the final or forming temperature) is: $t_{heat} = \frac{\rho h C_p}{aP}(T_f - T_0)$

Consider a heater with length L_{heater}, then in continuous process the feed rate is: $V_{feed} = \frac{L_{heater}}{t_{heat}}$

Casting:

The solidification time, based on Chvorinov's rule:

Sand casting: $t_{solidify} = B.(\frac{V}{A})^2$

Die casting : $t_{solidify} = B.(\frac{V}{A})$

V: volume of the part being casted, **A:** Surface area of the part being casted, **B:** mold constant

Forging:

Consider a block of height h_0. The force required to compress it to height h can be estimated by:

$F = K_f.K.\epsilon^n.A$

Where A is the cross-section area of the workpiece, K is the strength coefficient of material, and n is the strain hardening exponent. ϵ is the true strain and can be computed by: $\epsilon = \ln\frac{h_0}{h}$

K_f is the forging shape factor and can be calculated for open-die forging by: $K_f = 1 + \frac{0.4\mu D}{h}$

μ is the friction coefficient between the workpiece and the die surface.

Rolling:

$Maximum\ thickness\ reduction = \mu^2 R$

$Power = \frac{2\pi N}{60} R(t_0 - t_1) W_0 \frac{K}{1+n}\left(ln\frac{t_0}{t_1}\right)^n$

R: radius of the rolls, W and t are the width and thickness of the plate, and N is the rotation speed of the roller in RPM. ϵ is the true strain and here is estimated by: $\epsilon = \ln\frac{t_0}{t_1}$