IE-352
Section 1, CRN: 13536
Section 2, CRN: 30521
First Semester 1432-33 H (Fall-2011) – 4(4,1,1)
MANUFACTURING PROCESSES - 2

Sample Final Exam Question

Name:	Student Number: 42

You have been hired as a manufacturing Engineering consultant for a large metal cutting firm which mainly uses carbide tools. The company complains that they having been suffering from losses lately now that the price of carbides has gone significantly up. You have asked them to provide information which may help you to make suggestions in your report. You have arrived at the following data for the type of carbide tool they are using: $n = 0.25$, cutting speed: $300\ \frac{m}{min}$, resulting in a tool life of only $10\ min$.

Explain using calculations how you evaluate the current situation, as well as redesign and significantly improve their metal cutting processes, showing percent increases in tool life and cut material. Assume any data you feel is missing.

Given:

carbide tool
$n = 0.25$
$C = ?$
$V_1 = 300\ \frac{m}{min}$
$T_1 = 10\ min$

Required:

Redesign metal cutting process by

- increasing tool life, i.e.
  - $T_2 = ?$
  - $V_2 = ?$
  - $\frac{T_2 - T_1}{T_1} = ?$
- and increasing cut material, i.e.
  - $mat_2 = ?$
  - $\frac{mat_2 - mat_1}{mat_1} = ?$

Solution:

- *Taylor Equation* for tool life: $\boldsymbol{VT^n = C}$

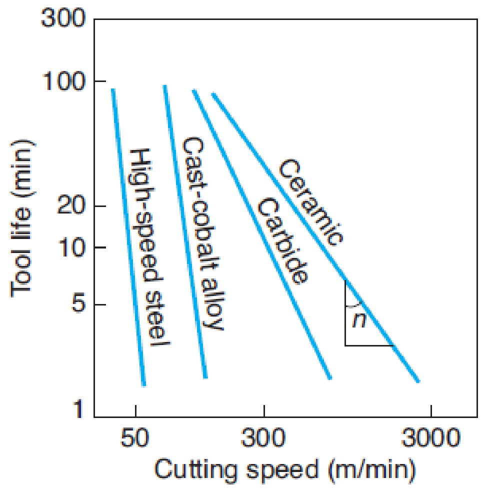
  Substituting values for n, V_1, and T_1:

  $\Rightarrow \boldsymbol{C = (300)(10)^{0.25} = 533.48}$
- $\Rightarrow$ New equation for tool life:

  $\mathbf{VT^{0.25} = 533.48}$
- Material cut using initial variables:

  $mat_1 = V_1 * T_1 = \left(300\ \frac{m}{\cancel{min}}\right)(10\ \cancel{min}) = 3{,}000\ \text{m}$
- Redesign the cutting process
  - redesign requires significantly increasing tool life
  - Note, for carbide recommended tool life is between 30-60 min (*see slide 60*)
  - This can be confirmed from the provided figure, shown on the right (extending approx. from 2-100 min for HSS).
  - For convenience we will target for an optimal tool life of **60 min**.

    $\Rightarrow \boldsymbol{T_2 = 60\ min}$
  - Alternatively, anything close to 100 min should be acceptable according to this figure.



- New variables for redesigned cutting process
  - $\boldsymbol{V_2} = \frac{C}{T^n} = \frac{533.48}{60^{0.25}} = \mathbf{191.68}\ \boldsymbol{\frac{m}{min}}$
  - $\boldsymbol{mat_2} = V_2 * T_2 = 191.68\ \frac{m}{\cancel{min}} * 60\ \cancel{min} = \mathbf{11{,}501}\ \boldsymbol{m}$
- Increase in tool life is, thus:
  - $\frac{T_2 - T_1}{T_1} = \frac{\mathbf{60}\ \boldsymbol{min} - \mathbf{10}\ \boldsymbol{min}}{10\ min} = 5$
  - $i.e. redesign\ resulted\ in\ a\ \mathbf{5} - \boldsymbol{fold}\ increase\ in\ tool\ life$
- Increase in tool life is:
  - $\frac{11{,}501\ m - 3{,}000\ m}{3{,}000\ m} = 2.83$
  - $i.e. redesign\ resulted\ in\ a\ \mathbf{2.8} - \boldsymbol{fold}\ increase\ in\ cut\ material$

- *Comment*: note that these significant changes were achieved by reducing the cutting speed by an amount of only $\frac{300-191.68}{300} = 36\%$ (i.e. about a third reduction) from its initial value