FLANK WEAR MODELING IN HIGH SPEED HARD TURNING

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Introduction

- The cutting tools can be used only if the surface quality and the tolerances fall in the range of acceptance, therefore the cutting tool reaches its life and must be replaced before the cutting edge of the tool can not give the required roughness and the acceptances tolerance
- Tool life: is the usable time that has elapsed before the criterion value of flank wear is reached (Bouzaid, 2005; Bouzaid et al., 2005).

Introduction

- The prediction of tool wear is performed by calculating tool life through experimental work and empirical tool life equations such as Taylor's equation as well as its extension versions.
- Although Taylor's equation gives the simple relationship between tool life and a certain cutting parameters, and is very easy to use,
- It is limited only on the information about tool life. Besides that, Taylor equations approach also consumed a lot of money and time (Mehrban et al., 2007) and it gives relatively reliable results only in a narrow cutting speed range (Mamalis, 2002).

Research objectives

- The main objectives of creating wear model in this research are:

1. For prediction and detection of tool wear before the tool causes any damage on the machined surface becomes highly valuable in order to avoid: loss of product. damage to the machine tool. loss in productivity
2. To describe the tool wear progress in time .
3. To create a clear understanding about how different cutting parameters affect the wear process.
4. To estimate the tool life.

Developing Flank Wear Model for(HSHT)

- The wear model was developed through the following steps:

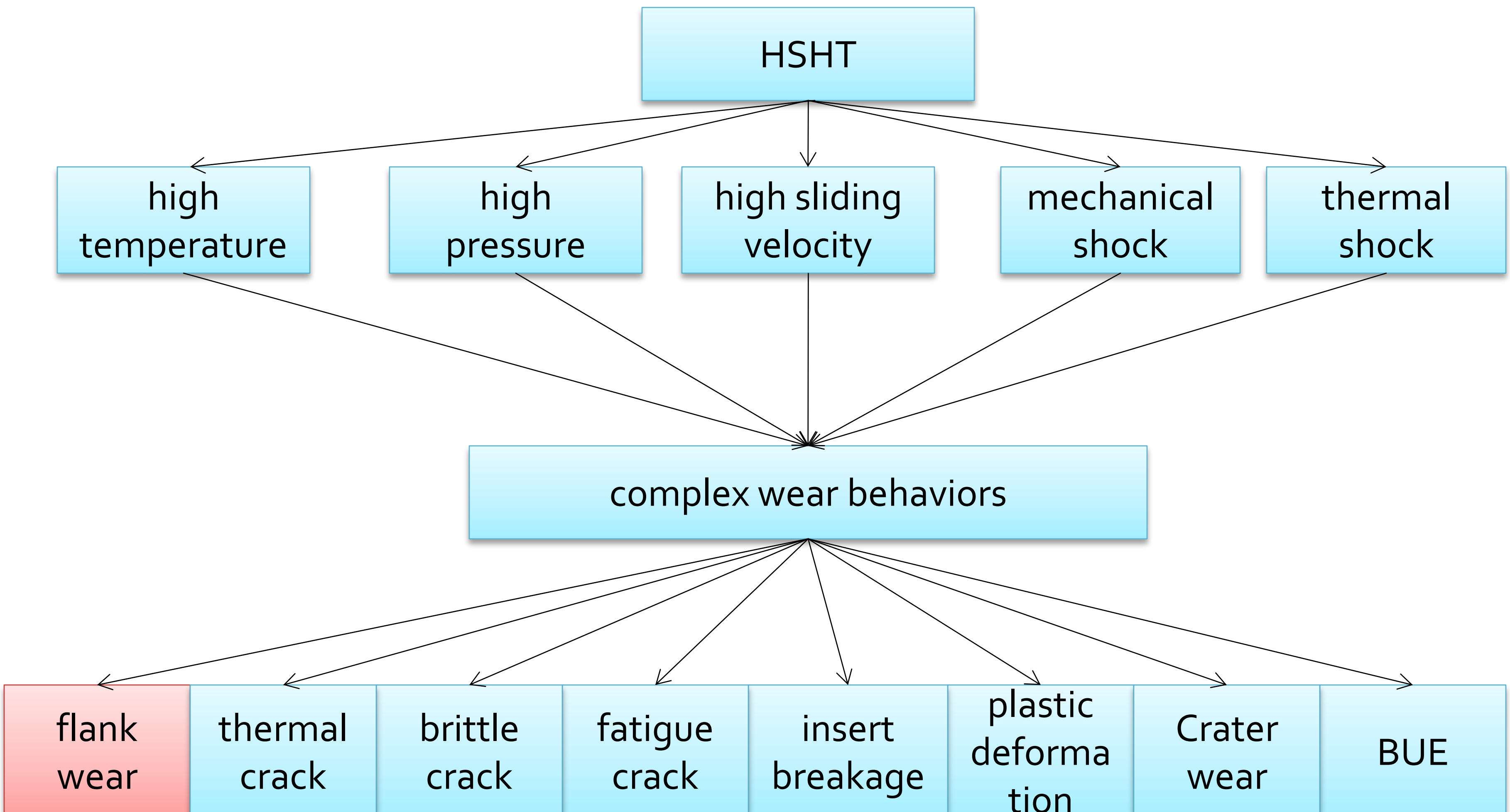
1. Define the dominate wears in HSHT.
2. Determine the flank wear estimation method.
3. Develop logical relationship model.
4. Develop a mathematical model.
5. Do the simulation.

1. Define the dominate wears in HSHT.

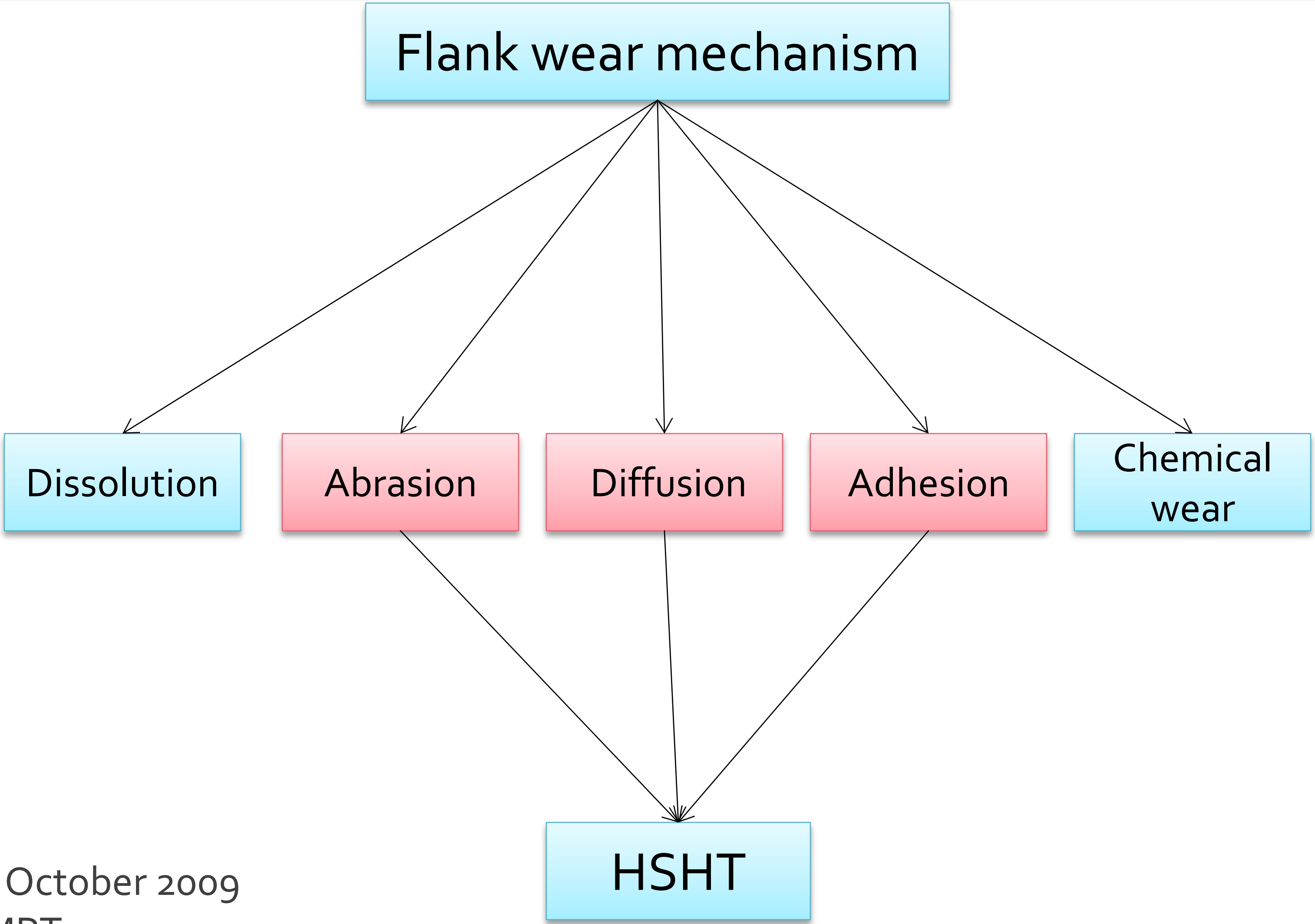
- During high speed hard turning the temperature in both work material and cutting tool increases substantially due to severe cutting condition
- this is because that (HSHT) different from the conventional method in three main factors:

1. Higher cutting speed.
2. Work piece hardness .
3. Cutting tool hardness.

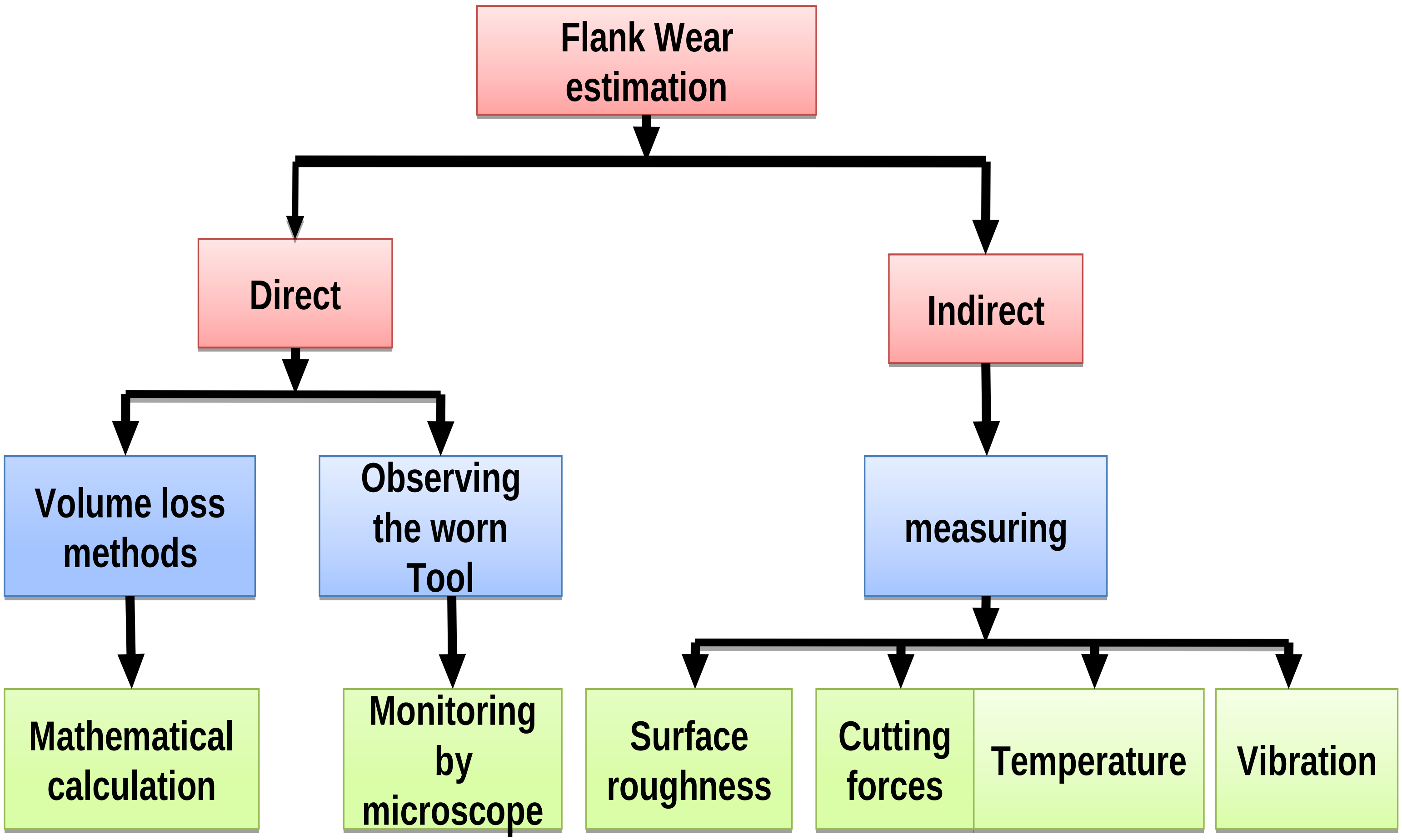
1. Define the dominate wears in HSHT



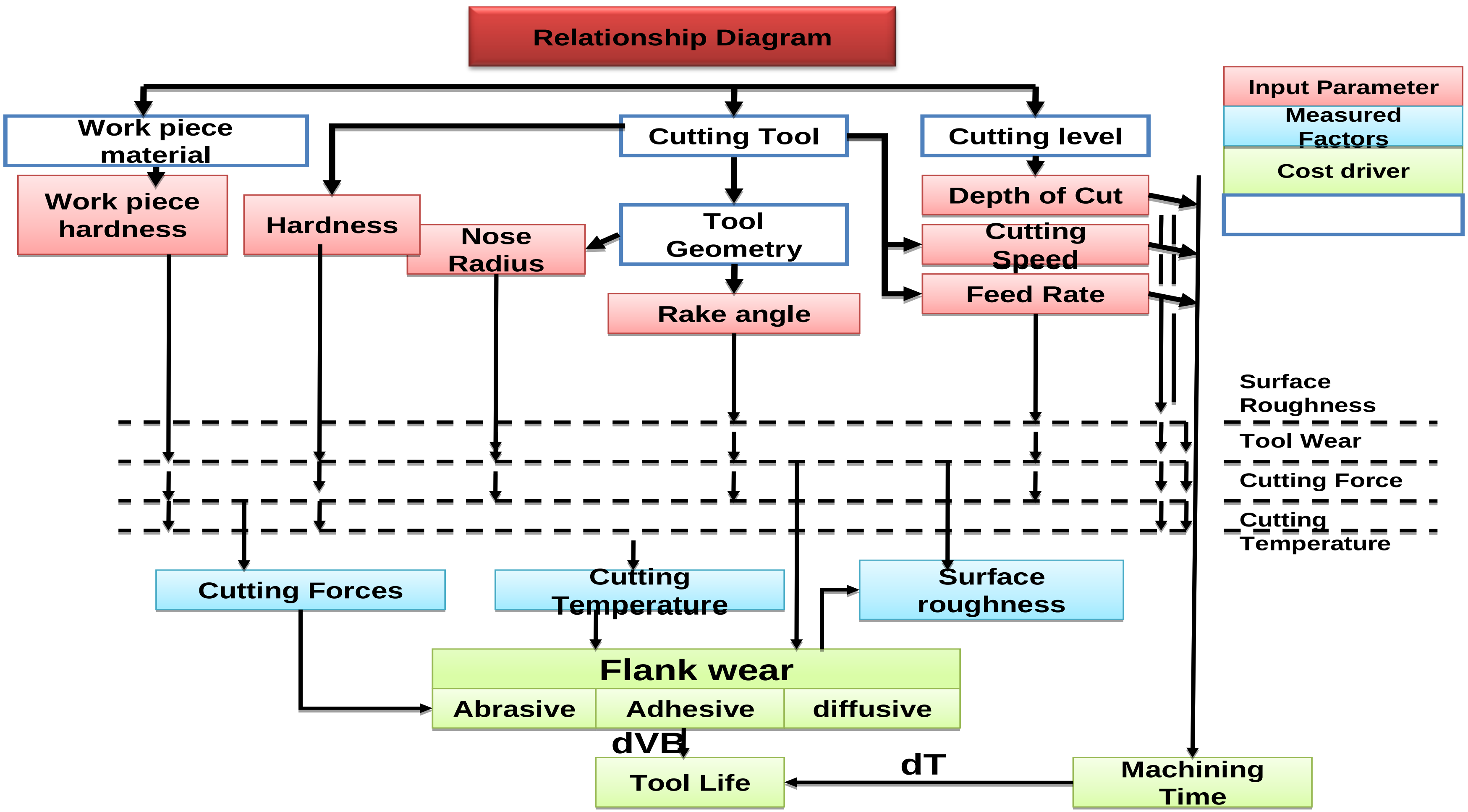
Flank Wear Mechanism



2. Flank Wear Estimation Methods



3. Develop the Logical Model



4.Develop a Mathematical Model

- Based on the logical model,the mathematical model is created in two steps:

1. Derive a function of volume change in time.
2. Derive a geometric volume change on the insert.

a) Volume change in time

- The total volume of tool material removed is the summation of the three wear models; abrasive, adhesive and diffusive. This may be expressed as follows:

$$\Delta V_{Totalwear} = \Delta V_{abras} + \Delta V_{adhs} + \Delta V_{diff}$$

b) Geometric Definition

- The previous equations gives the volume wear rate on an insert and to be able to describe the growth of the flank wear one need to define a geometric expression of the volume worn away on every increment of flank wear (VB). For the simplicity, the tool chosen to be analyzed here is a simple triangular turning insert with flat chip and relief surface

Final Equation

$$\frac{dVB}{dt}=\frac{(\cot\alpha+\tan\gamma)R}{(VB(R-VB\tan\alpha))}\left(k_{abr}k\left(P_a^{n-1}/P_t^{n}\right)V_cVB\sigma+k_{adh}e^{at}V_c\sigma+k_{dif}\sqrt{V_cVB}e^{-k_Q(T+273)}\right)$$

Tool Life Estimating

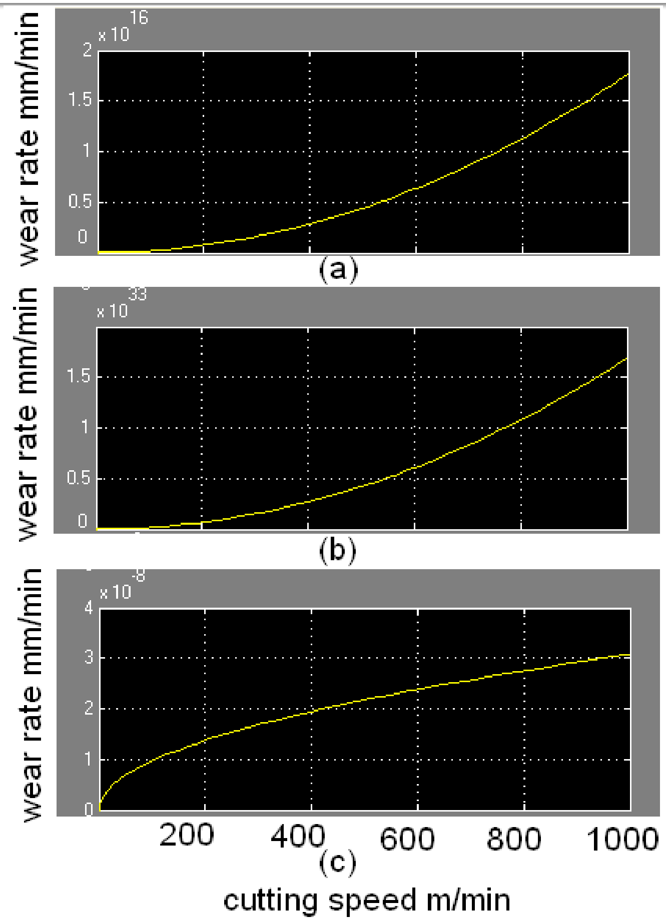
- The wear rate is increased with the time, and then the tool life will be
- $$\Delta VB = r_w \Delta t$$
  $$L = VB / r_w$$
- As a result the tool life can be estimated from the following formula;

$$L = VB \Big/ \frac{(\cot\alpha + \tan\gamma)R}{(VB(R - VB\tan\alpha))} \left(k_{abr} k \left(P_a^{n-1} / P_t^n \right) V_c VB\sigma + k_{adh} e^{at} V_c \sigma + k_{dif} \sqrt{V_c VB} e^{-k_Q (T+273)} \right)$$

5. Matlab Simulink

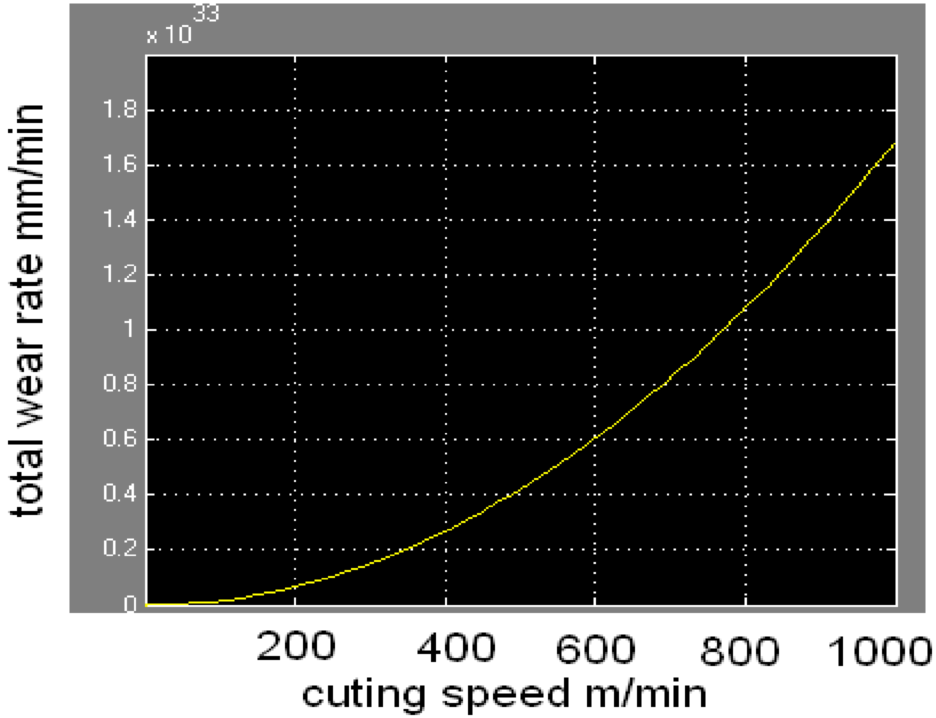
- By using the matlab simulink a model was developed to simulate the flank wear rates with increasing the cutting speed in cutting hard materials.

Simulation Results



- (a) abrasive (b) adhesive (c) diffusive

Simulation



- the total wear rate increased with cutting speed

Conclusion

- By using the volume loss method in estimating the tool life the result becomes more accurate because of:

1. Joining all the different factors in one model.
2. It takes the wear rate in three different types (abrasive, adhesive, diffusive) that as a reference for estimating the tool life.
3. Wear rate is reflecting the whole processing parameters (cutting speed, feed rate, depth of cut, work piece hardness, and cutting tool hardness).

Thank You

Discussion

- At higher speed, higher heat is generated but each mechanism has different behavior:

1. The abrasive wear is increased because in the high temperature the hardness of the cutting tool reduced due to the increasing of the temperature in the cutting zone, and that will reduce the abrasive resistance and that will reduce the ratio between the tool hardness and the work piece, then increasing the abrasive wear.
2. The adhesive is increasing because in high temperature the micro welded point is increased so during the cutting the adhesive wear will also increase.
3. The diffusion between the cutting tool and the work piece increased proportional with the increasing of the temperature.

b) Geometric Definition