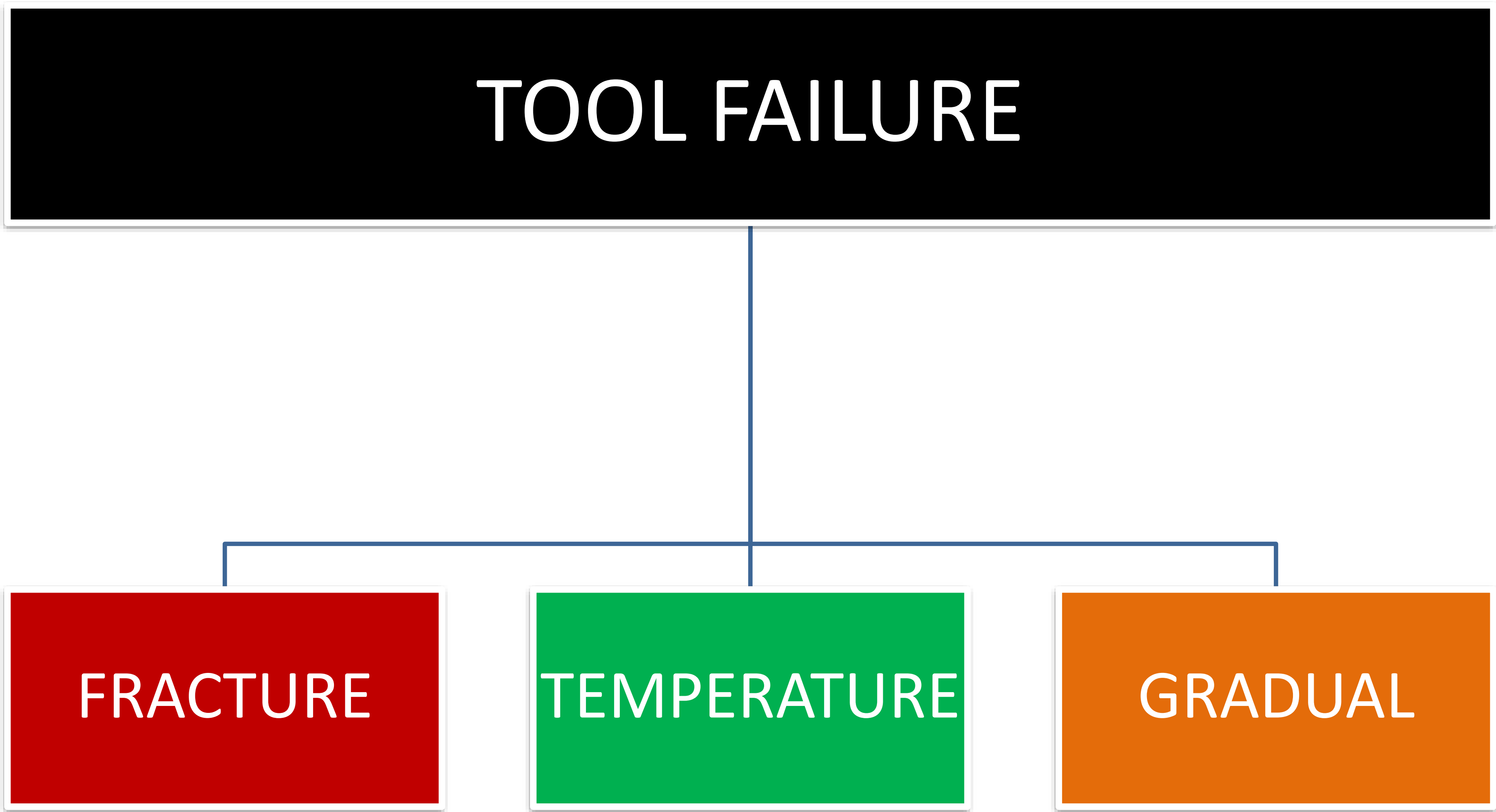
MANUFACTURING PROCESSES

TOOL FAILURE & TOOL LIFE


TOOL FAILURE
FRACTURE
TEMPERATURE
GRADUAL

TOOL FAILURE

1. **FRACTURE FAILURE :** This mode of failure occurs when the cutting force at the tool point becomes excessive, causing it to ***fail suddenly*** by ***brittle fracture***.
2. **TEMPERATURE FAILURE :** This failure occurs when the cutting temperature is too high for the tool material, causing the material at the tool point to ***soften***, which leads to plastic deformation and ***loss of the sharp edge***.

TOOL FAILURE

3. **GRADUAL WEAR :** Gradual wearing of the cutting edge causes ***loss of tool shape***, ***reduction*** in ***cutting efficiency***, an acceleration of wearing as the tool becomes ***heavily worn***, and finally tool failure in a manner ***similar to a temperature failure***.

TOOL FAILURE

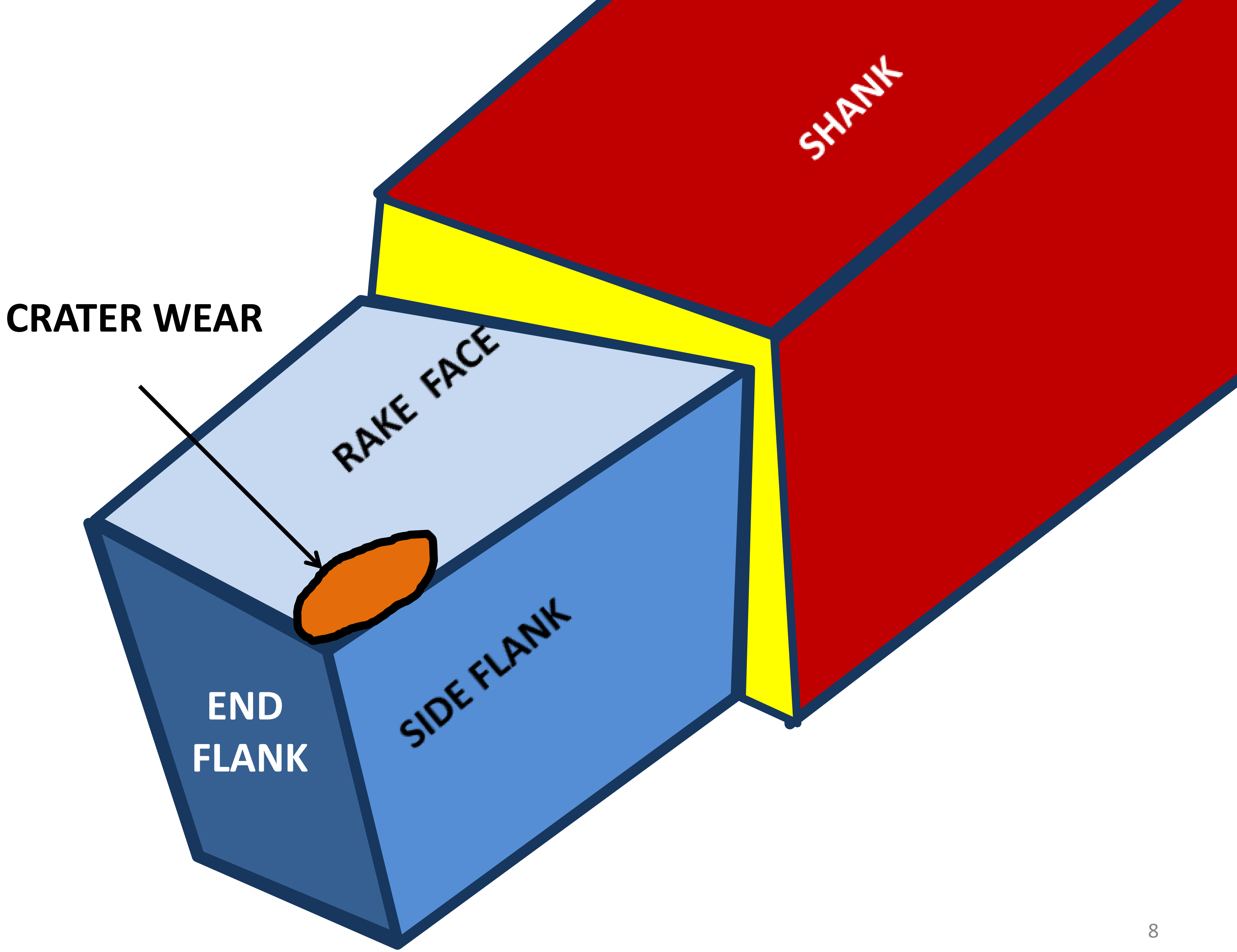
- **Fracture and temperature failures** result in **premature loss** of the cutting tool.
- These two modes of failure are therefore undesirable.
- Of the three possible tool failures, **gradual wear** is **preferred** because it leads to the longest possible use of the tool, with the associated economic advantage of that longer use.

TOOL WEAR

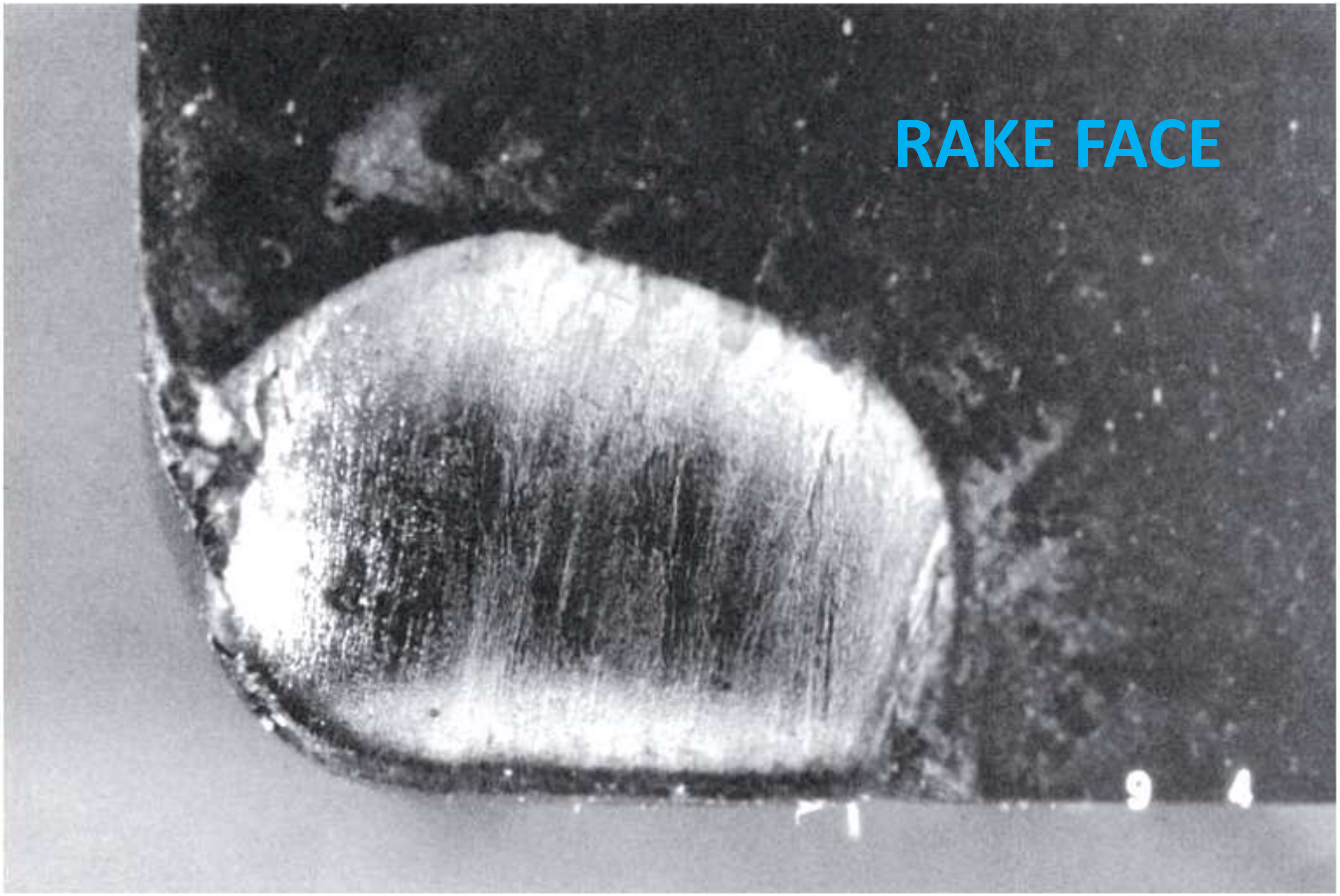
- Gradual wear occurs at two principal locations on a cutting tool: the ***top rake face*** and ***the flank***.
- Accordingly, two main types of tool wear can be distinguished:
  - ***Crater Wear***
  - ***Flank Wear***

CRATER WEAR

- ***Crater Wear*** consists of a ***cavity in the rake face*** of the tool that forms and grows from the action of the chip sliding against the surface.
- ***High stresses*** and ***temperatures*** characterize the tool–chip contact interface, contributing to the wearing action.
- The crater can be measured either by its ***depth or*** its ***area***.


CRATER WEAR
RAKE FACE
SHANK
SIDE FLANK
END
FLANK

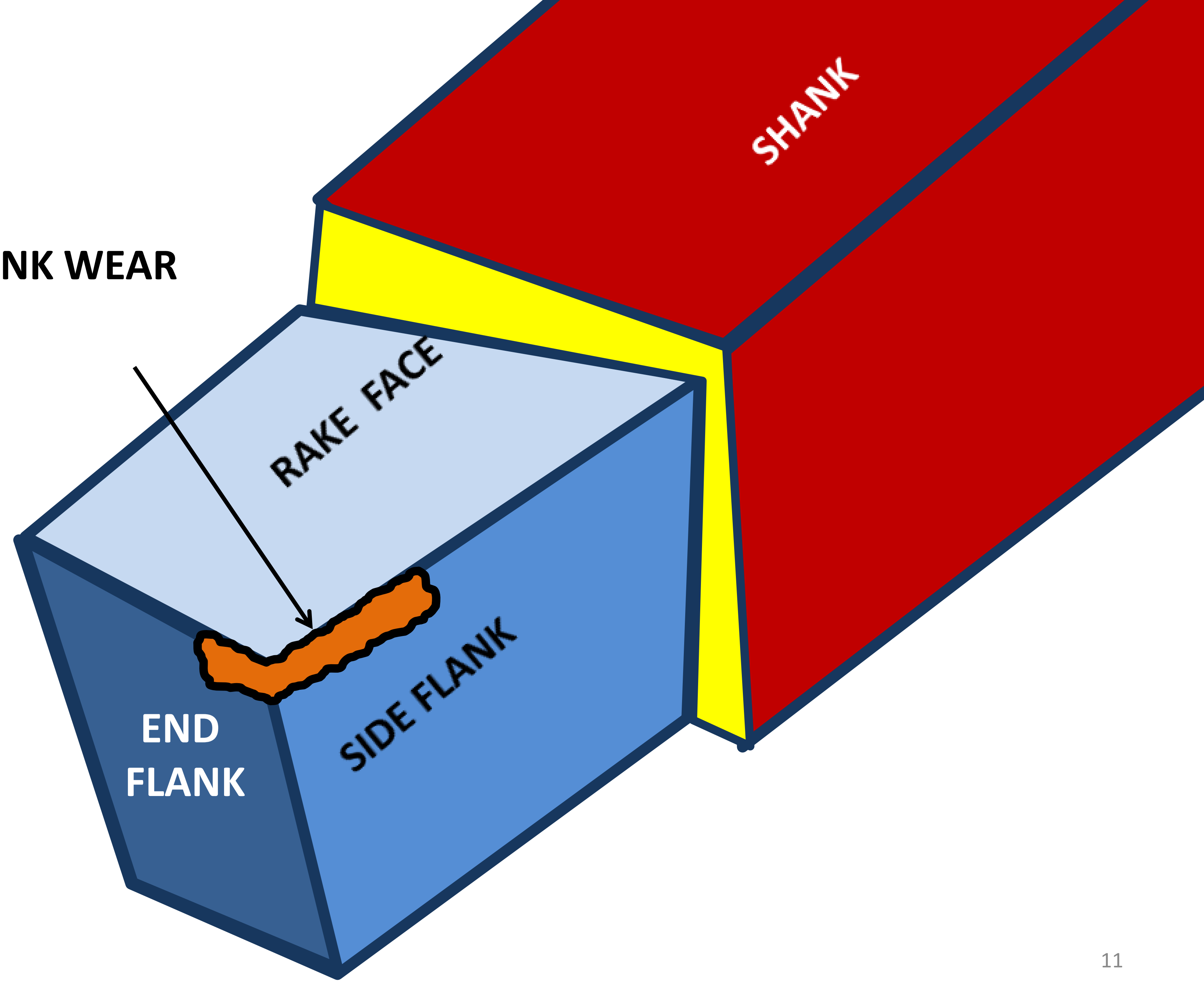
CRATER WEAR



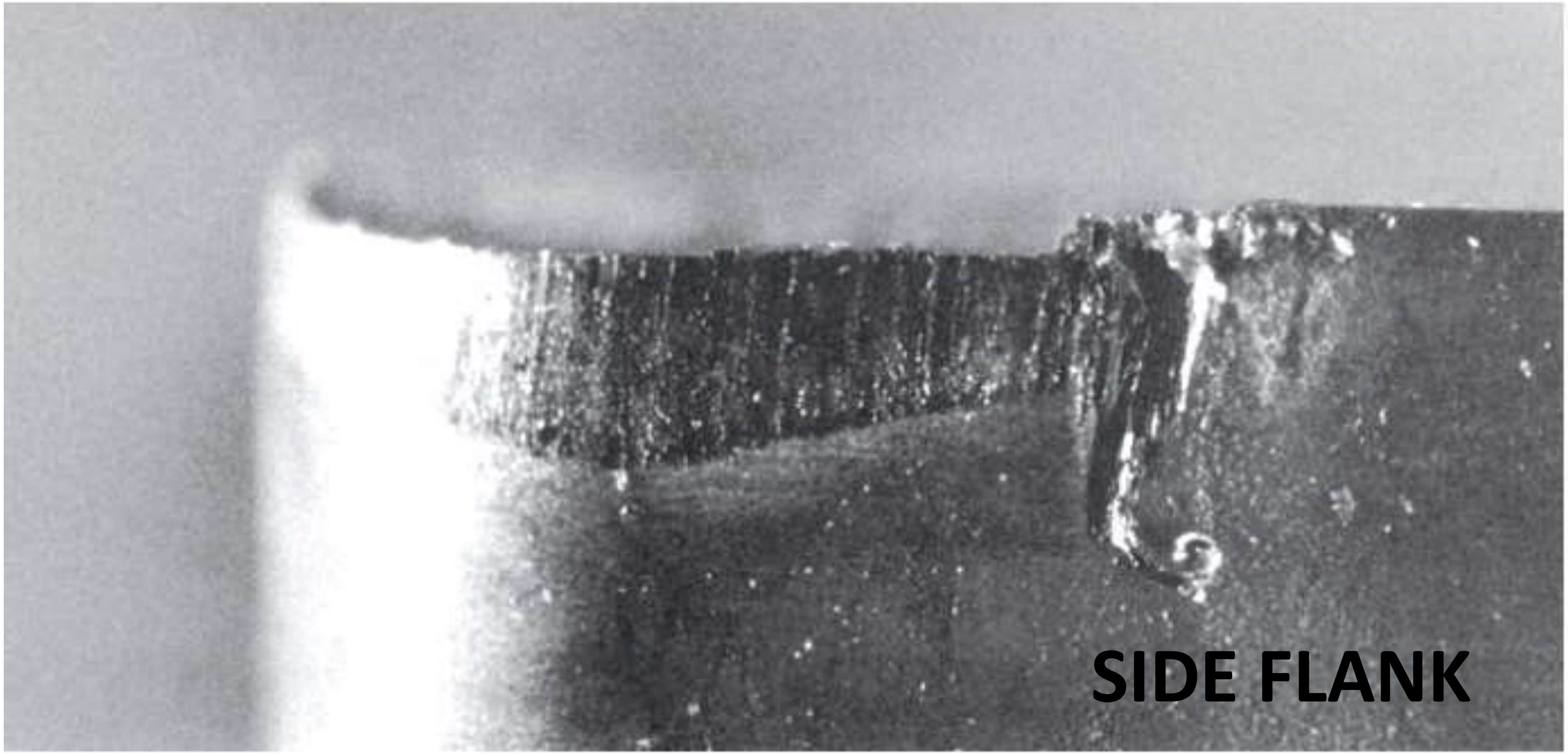
FLANK WEAR

- ***Flank Wear*** occurs on the flank, or relief face, of the tool.
- It results from ***rubbing*** between the newly generated ***work surface*** and the ***flank face*** adjacent to the cutting edge.
- Flank wear is measured by the width of the wear band.
- This wear band is sometimes called the flank wear land.

FLANK WEAR



FLANK WEAR



MECHANISM OF TOOL WEAR

- The mechanisms that cause wear at the tool–chip and tool–work interfaces in machining can be summarized as follows:-

1. ***ABRASION*.** This is a mechanical wearing action caused by hard particles in the work material gouging and removing small portions of the tool.

   This abrasive action occurs in both flank wear and crater wear; it is a significant cause of flank wear.

MECHANISM OF TOOL WEAR

2. ***ADHESION.*** When two metals are forced into contact under high pressure and temperature, adhesion or welding occur between them.

   These conditions are present between the chip and the rake face of the tool.

   As the chip flows across the tool, small particles of the tool are broken a way from the surface, resulting in attrition of the surface.

MECHANISM OF TOOL WEAR

3. ***DIFFUSION.*** This is a process in which an exchange of atoms takes place across a close contact boundary between two materials.

   In the case of tool wear, diffusion occurs at the tool–chip boundary, causing the tool surface to become depleted of the atoms responsible for its hardness.

   As this process continues, the tool surface becomes more susceptible to abrasion and adhesion. Diffusion is believed to be a principal mechanism of crater wear.

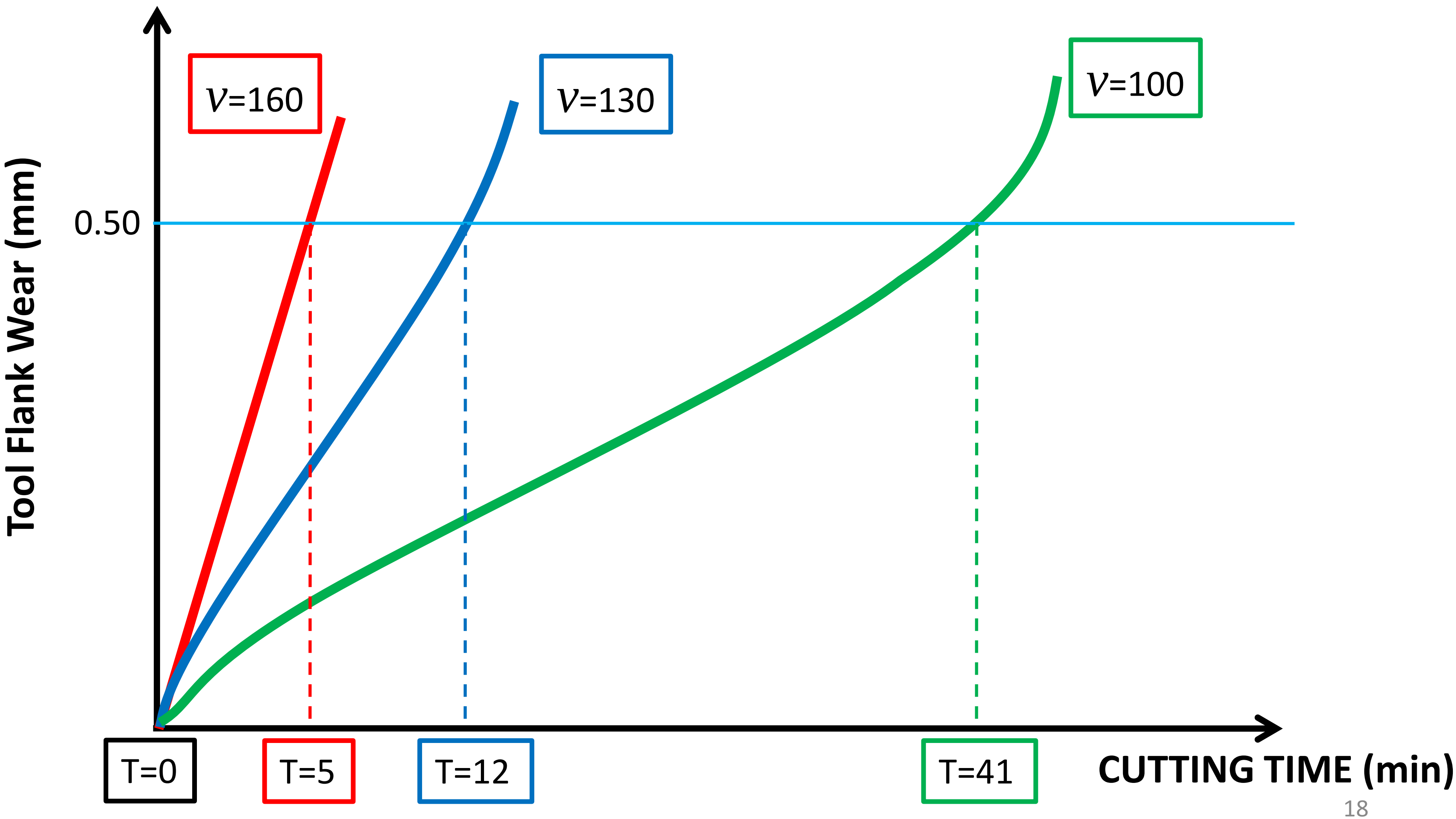
TOOL LIFE (T)

- **TOOL LIFE** is defined as the ***length of cutting time*** that the tool can be used.
- Tool life T is the period of ***time***, expressed in ***minutes,*** for which the ***cutting edge,*** affected by the cutting procedure, ***retains*** its ***cutting capacity between sharpening*** operations.
- The cutting edge remains functional until a certain amount of wear has occurred.

TOOL LIFE (T)

- The Tool Life is affected by work material and cutting conditions.
- Harder work materials cause the wear rate to increase.
- Increased speed, feed, and depth of cut have a similar effect, with speed being the most important of the three.
- If the tool wear curves are plotted for several different cutting speeds, the results appear as in figure.
- As cutting speed is increased, wear rate increases so the same level of wear is reached in less time.

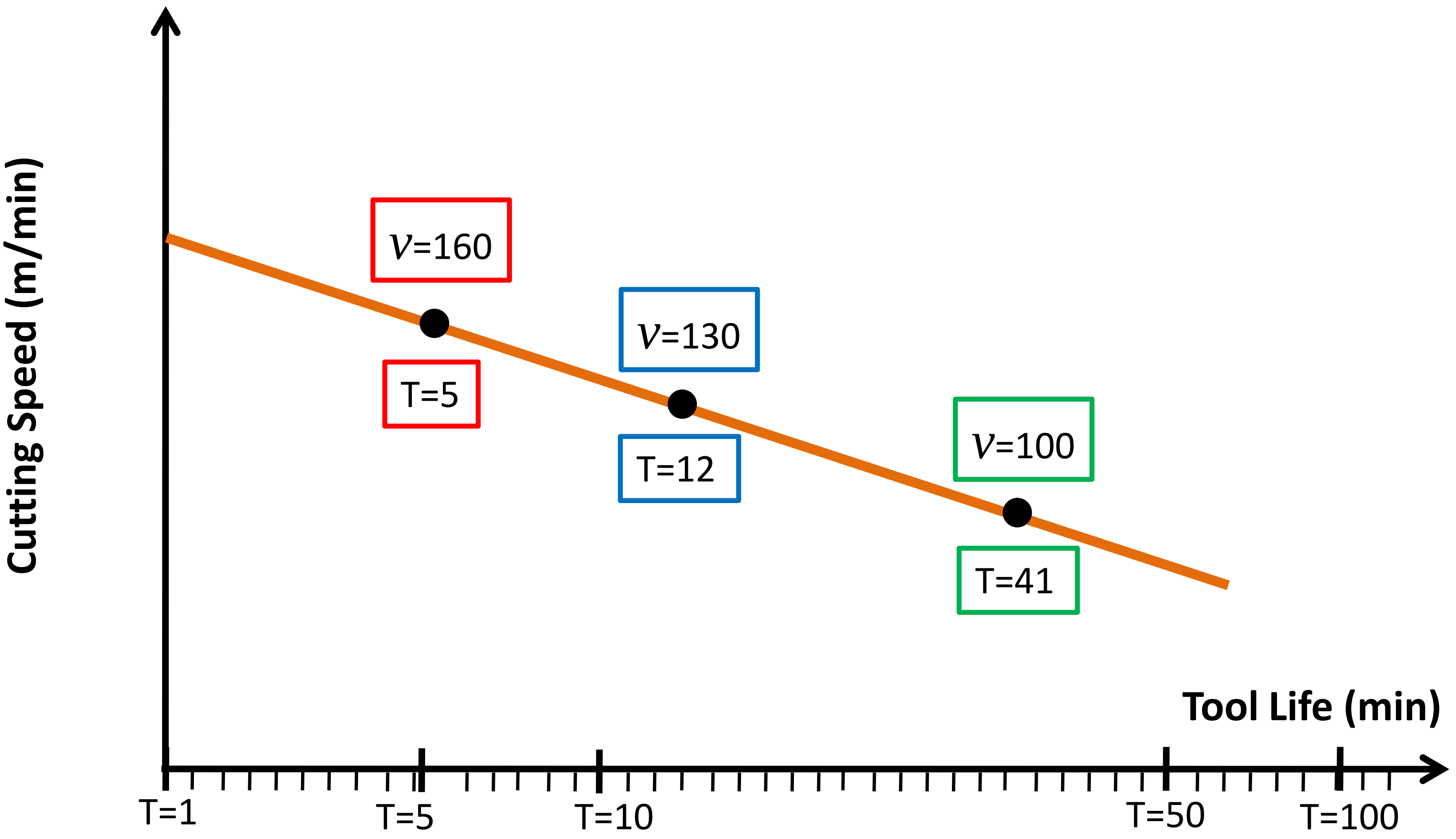
TOOL WEAR Vs. CUTTING TIME



TOOL LIFE (T)

- If the tool life values for the three wear curves in previous figure are plotted on a natural log–log graph of cutting speed versus tool life, the resulting relationship is a straight line as shown in next figure.

(Log-Log Plot) CUTTING SPEED Vs. TOOL LIFE



TAYLOR TOOL LIFE EQUATION

- The discovery of this relationship around 1900 is credited to F. W. Taylor.
- It can be expressed in equation form and is called the Taylor tool life equation:

$$v T^n = C$$

TAYLOR TOOL LIFE EQUATION

- ***v*** **=** cutting speed , m/min
- ***T*** **=** tool life, min
- ***n and C*** are parameters whose values depend on feed, depth of cut, work material, tooling (material in particular), and the tool life criterion used.

TAYLOR TOOL LIFE EQUATION

- Basically, Taylor tool life equation states that higher cutting speeds result in shorter tool lives.
- Relating the parameters ***n*** and ***C*** to the previous figure, ***n*** is the slope of the plot (expressed in linear terms rather than in the scale of the axes), and C is the intercept on the speed axis.
- ***C*** represents the cutting speed that results in a 1min tool life.

TOOL LIFE NUMERICAL 1

- A cutting tool cutting at ***25m/min*** gave a life of ***1hour*** between regrinding when operating on roughening cuts with mild steel. What will be its probable life when engaged on light finish cuts? Take ***n= 1/8 for rough cuts*** and ***1/10 for finishing cuts.***

TOOL LIFE NUMERICAL 1

$$v\,T^{n} = C$$

For rough cuts

v = 25m/min , T = 60 min, n= 1/8

For finish cuts

v = 25m/min , T = ???, n= 1/10

Ans:-168min

TOOL LIFE NUMERICAL 2

- If the relationship for ***HSS*** tool is $v\,T^{1/8} = C_1$, and for ***Tungsten carbide*** tool is $v\,T^{1/5} = C_2$, and assuming that at a speed of ***25m/min*** the tool life was ***3hrs*** in each case, compare their cutting lives at ***32m/min***.

Ans.

HSS= 24.98 mins

Ans.

Tungsten= 52.39 mins

TOOL LIFE NUMERICAL 3

- A carbide tool with mild steel workpiece was found to give life of ***2hrs*** while cutting at ***50 m/min.*** Compute the tool life if the same tool is used at a speed of ***25% higher*** than previous one. Also determine the value of cutting speed if the tool is required to have tool life of 3hrs. Assume Taylors exponent ***"n"=0.27***.

Ans.

T= 52.51 mins

Ans.

v= 44.81 m/mins

TOOL LIFE NUMERICAL 4

- Schematically show the different types of tool wear occurring on different faces of single point cutting tool.
- A 50 mm diameter bar of steel was turned at 284 RPM and tool failure occurred in 10 min. The speed was changed to 132 RPM and the tool failed in 30 min of cutting. Assume that a straight line relationship exists. What cutting speed should be used to obtain a 60 min tool life of V_{60}?