



# Cutting Tool Wear

STEM4inclusive schools  
WP2 – Toolbox

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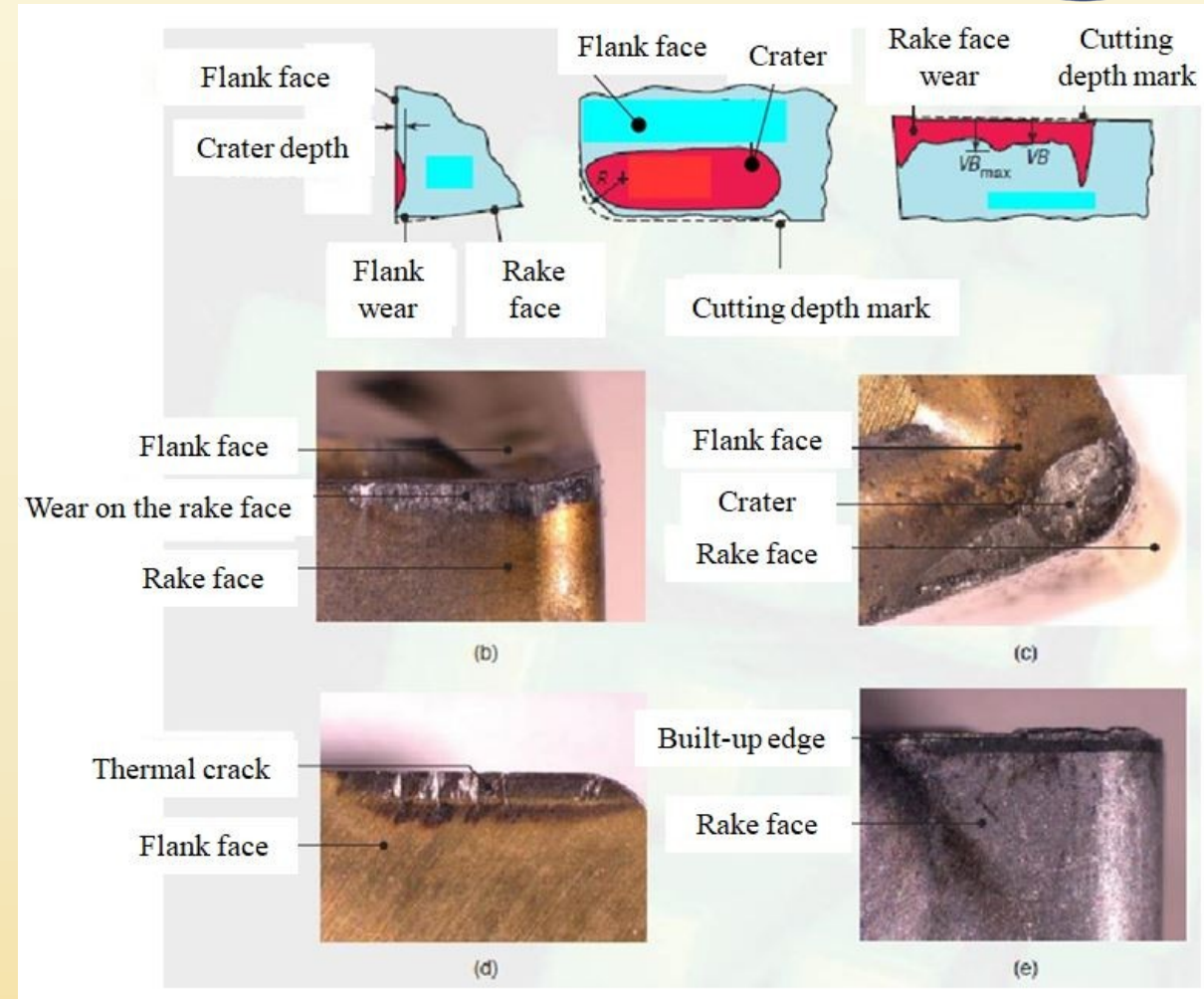
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# Types of wear

- a). wear on the seating face;
- b). crater wear;
- c). pitting wear;
- d). thermal stress cracks;
- e). edge deposits;
- f). catastrophic wear.

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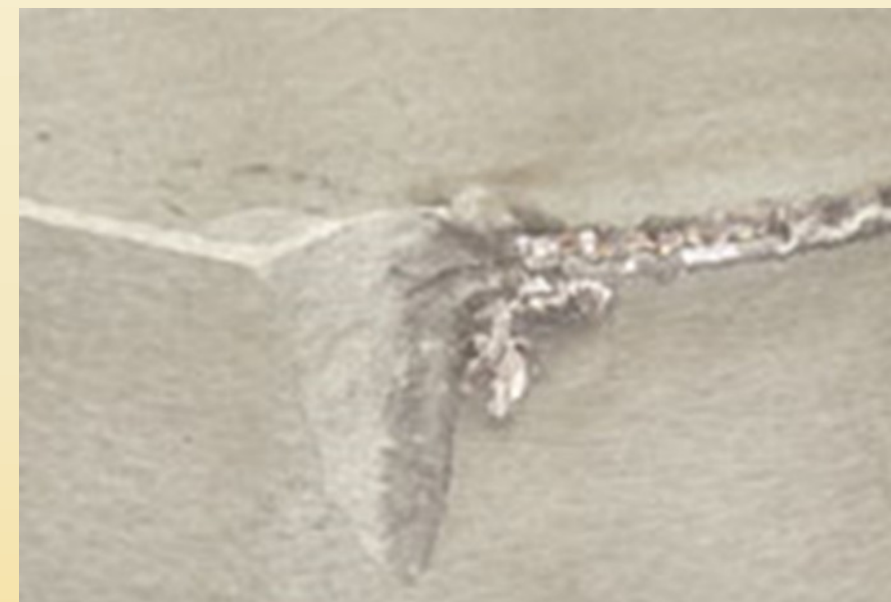


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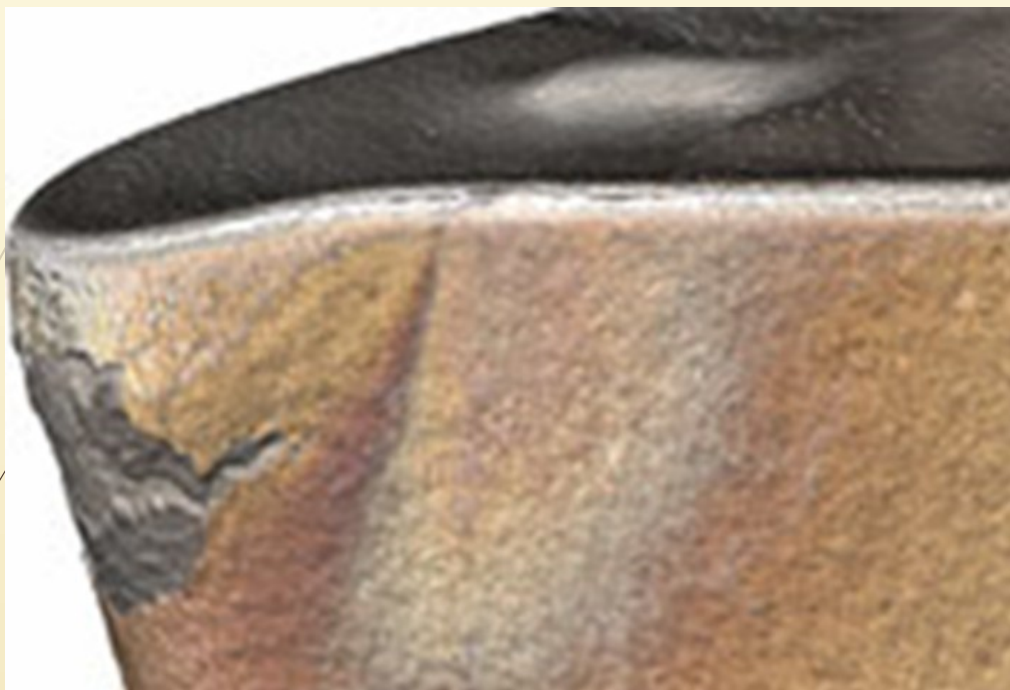


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# Types of wear



# Types of wear



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# Taylor equation

$$VT^n = C$$

| Tool's material           | The exponent $n$ |
|---------------------------|------------------|
| HSS                       | 0,08 – 0,2       |
| Casting alloys            | 0,1 – 0,15       |
| Metal carbides            | 0,2 – 0,05       |
| Mineral-ceramic materials | 0,5 - 0,7        |



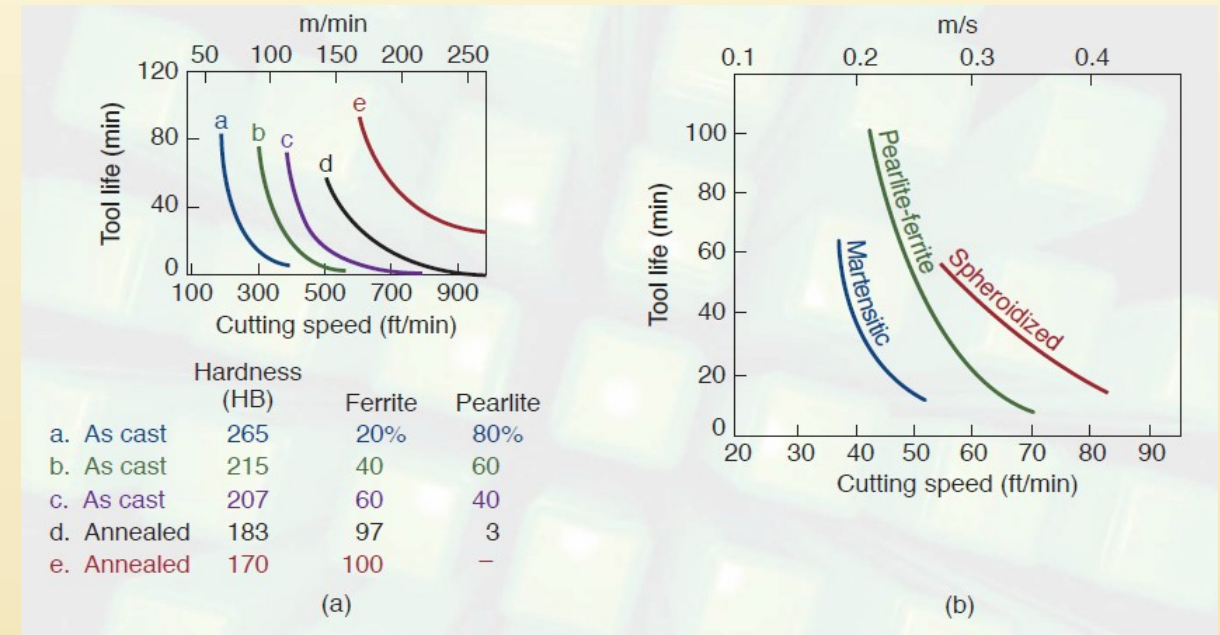


# Effect of blank material on durability

The effect of the microstructure of the blank on the durability of the tool, in turning.

Durability is given as the time (in minutes) required to reach a flank wear of a certain size.

- a). cast iron;
- b). steel.



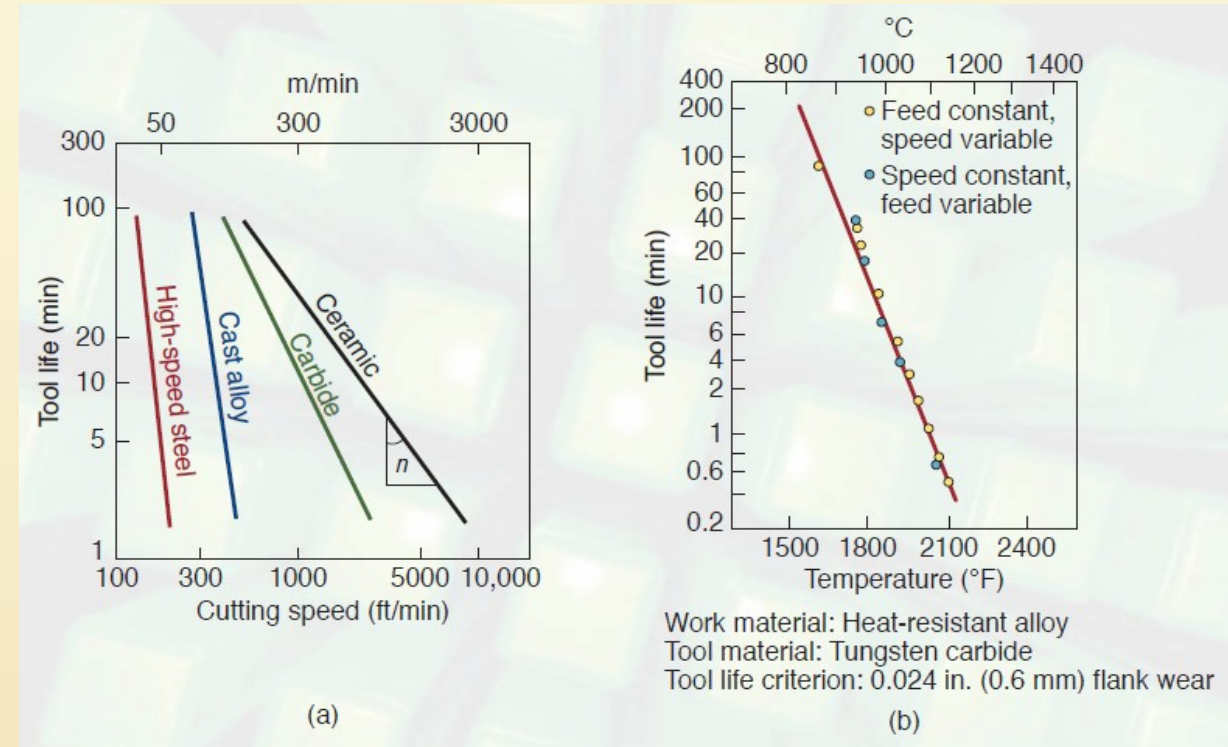
Tool wear monitoring for milling by tracking cutting force model coefficients, Yanjun Cui, 2008, url <https://api.semanticscholar.org/CorpusID:113926195>





# Durability charts

- a). Durability diagrams for various materials. The slope of the curve corresponds to the durability exponent  $n$ .
- b). Relationships between the temperature measured during cutting and the tool durability (for flank wear).



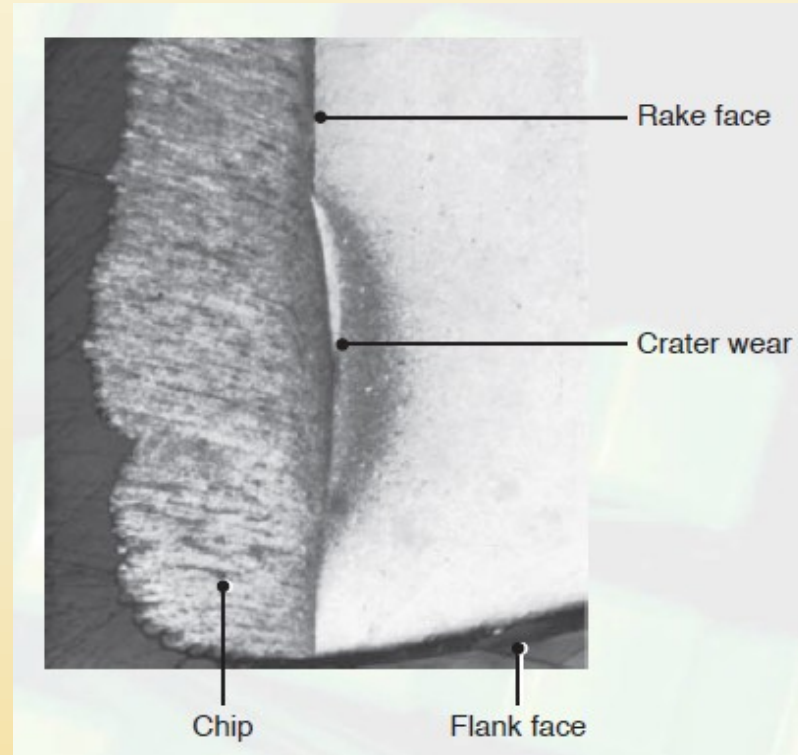
Tool wear monitoring for milling by tracking cutting force model coefficients}, Yanjun Cui, 2008, url <https://api.semanticscholar.org/CorpusID:113926195>





Interfața între așchie (stânga) și fața de degajare a sculei (dreapta), și uzura tip crater la așchiera unui oțel AISI 1040 cu viteza de 3 m/s.

Schimbarea culorii sculei indica temperatura înaltă. De remarcat coincidența între forma craterului și tiparul modificării culorii.

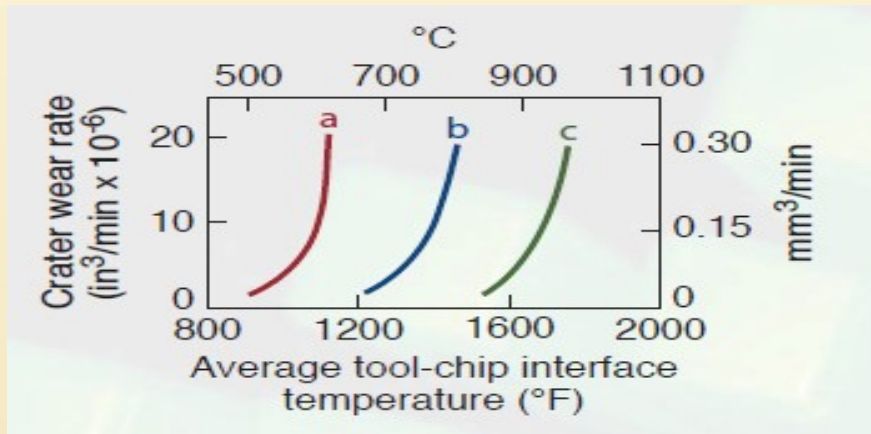




Relationship between crater wear and average temperature at the tool-part interface, in the case of turning:

- a). high-speed steel tool;
- b). C1 carbide;
- c). C5 carbide.

Note the rapid increase in wear in a narrow temperature range.



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Tool wear monitoring for milling by tracking cutting force model coefficients}, Yanjun Cui, 2008, url <https://api.semanticscholar.org/CorpusID:113926195>



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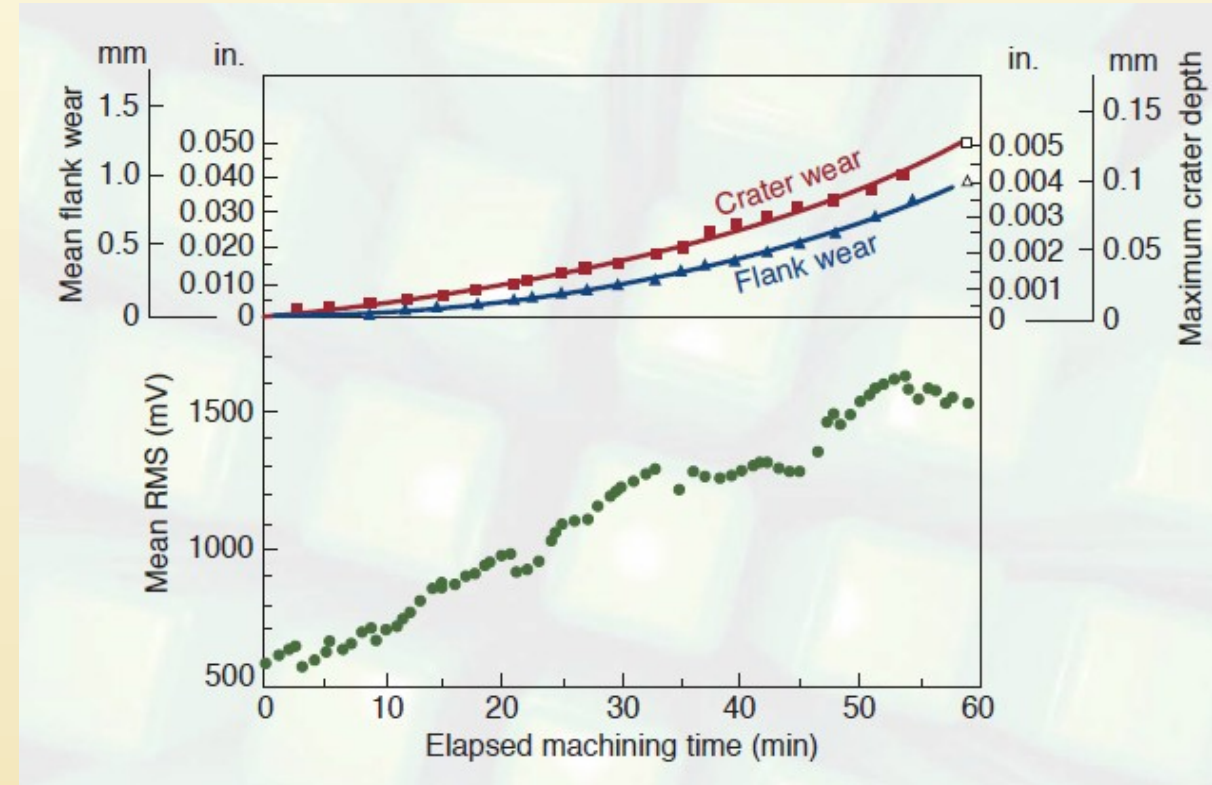
| Permissible wear[mm] |            |         |
|----------------------|------------|---------|
| The process          | Oçel rapid | Carburi |
| Turning              | 1,5        | 0,4     |
| Peripheral milling   | 1,5        | 0,4     |
| Frontal milling      | 0,3        | 0,3     |
| Drilling             | 0,4        | 0,4     |
| Reaming              | 0,15       | 0,15    |



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Relationship between average wear on the seating face, maximum crater wear and acoustic emission, as a function of machining time. The technique is developed as a means of monitoring wear in various cutting processes (continuous and indirect method).



Tool wear monitoring for milling by tracking cutting force model coefficients}, Yanjun Cui, 2008, url <https://api.semanticscholar.org/CorpusID:113926195>





# Wear mechanisms

## Abrasive wear

It occurs in the contact areas between the chip and the tool clearance face, respectively between the chipped surface and the tool seating face and is caused by hard abrasive particles (cementite or carbides of some alloying elements).

It mainly manifests itself in the form of wear on the seating face or in the form of a crater, when machining with carbon steel tools.





# Wear mechanisms

## Adhesive wear

It is caused by the molecular adhesion of some constituents of the chip material to the tool material (for example, adhesion between ferrite in the workpiece material and cobalt in the tool material).

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# Wear mechanisms

## Diffusion wear

It occurs as a result of the diffusion of some elements from the tool material into the solid solution of the material to be processed.

For example, when machining with carbide tools, the carbon from the tool material, under the action of high temperatures and pressures, migrates into the chip material.

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# Wear mechanisms

## Ion transport wear

The material of the tool and the workpiece form a galvanic couple. In this couple, an ionic current is formed, with the direction from the tool to the workpiece. Through this current, the tool loses ions and wears out.

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# Wear mechanisms

## Chipping wear

Occurs as a result of stress on tools made of brittle materials (e.g. carbides).

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# Wear criteria

The moment of unacceptable wear of the cutting tool can be detected by various signs:

- appearance of shiny streaks on the chipped surface.
- increase in cutting force;
- change in the shape and color of the chip (appearance of recovery colors on the chip surface);
- increase in the roughness of the chipped surface;
- appearance of vibrations in the technological system.

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# Wear criteria

The wear of various elements of the active part of the tool is established in a conventional manner. For example:  $V_B=0.2$  mm,  $K=0.1$ .

In this way, the following machinability indicators can be defined:

$V_{60\ B\ 0.2}$  – cutting speed for which, after 60 minutes of continuous cutting, a wear of  $V_B$  of 0.2 mm appears on the tool seating surface, under normal cutting conditions.

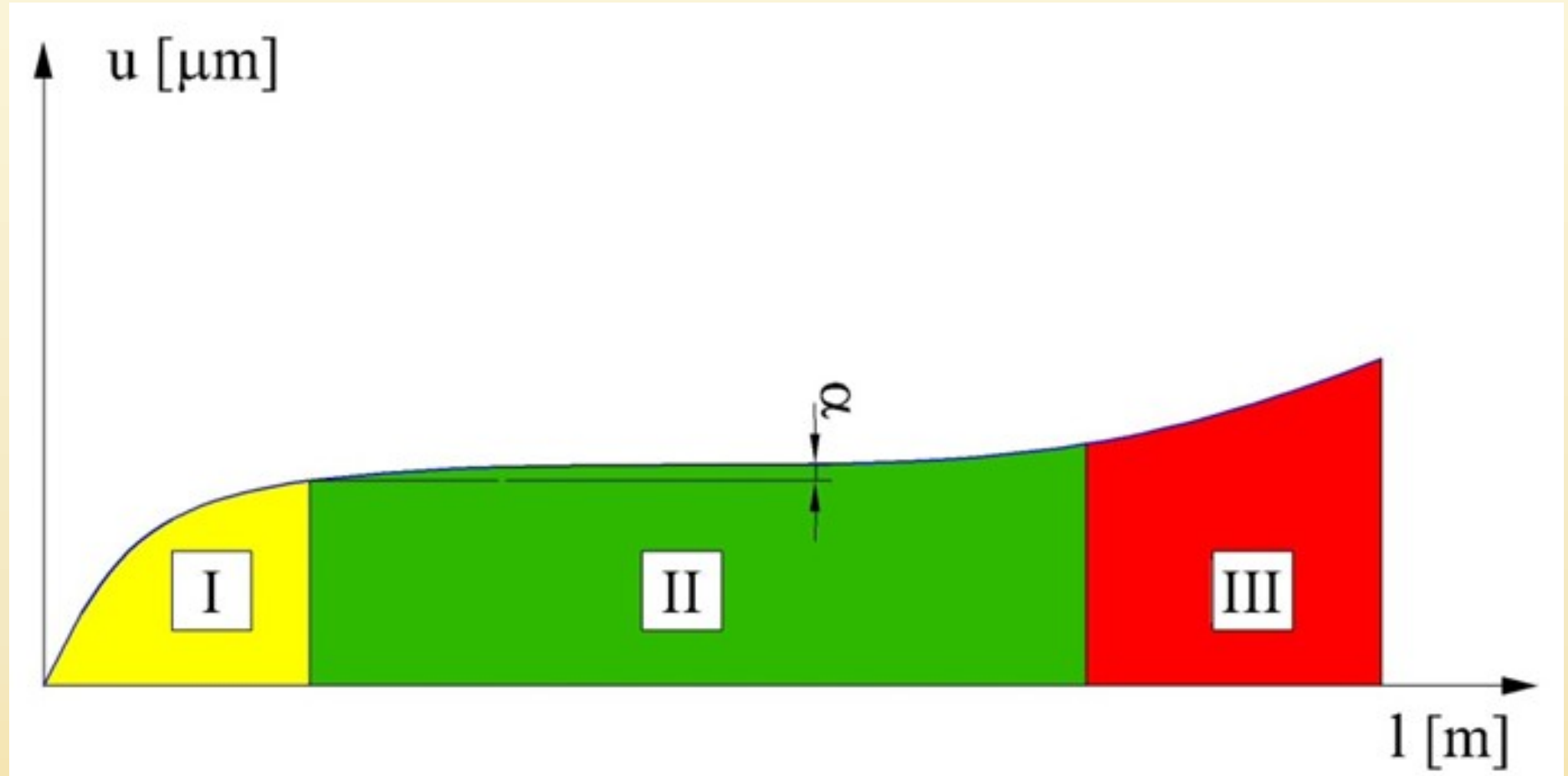
$V_{60\ K\ 0.1}$  – cutting speed for which, after 60 minutes of cutting, a crater is produced on the clearance surface, characterized by the ratio  $K=0.1$ , under normal cutting conditions.

$V_{60}$  – cutting speed for which, after 60 minutes of continuous cutting, under normal working conditions, catastrophic wear occurs.



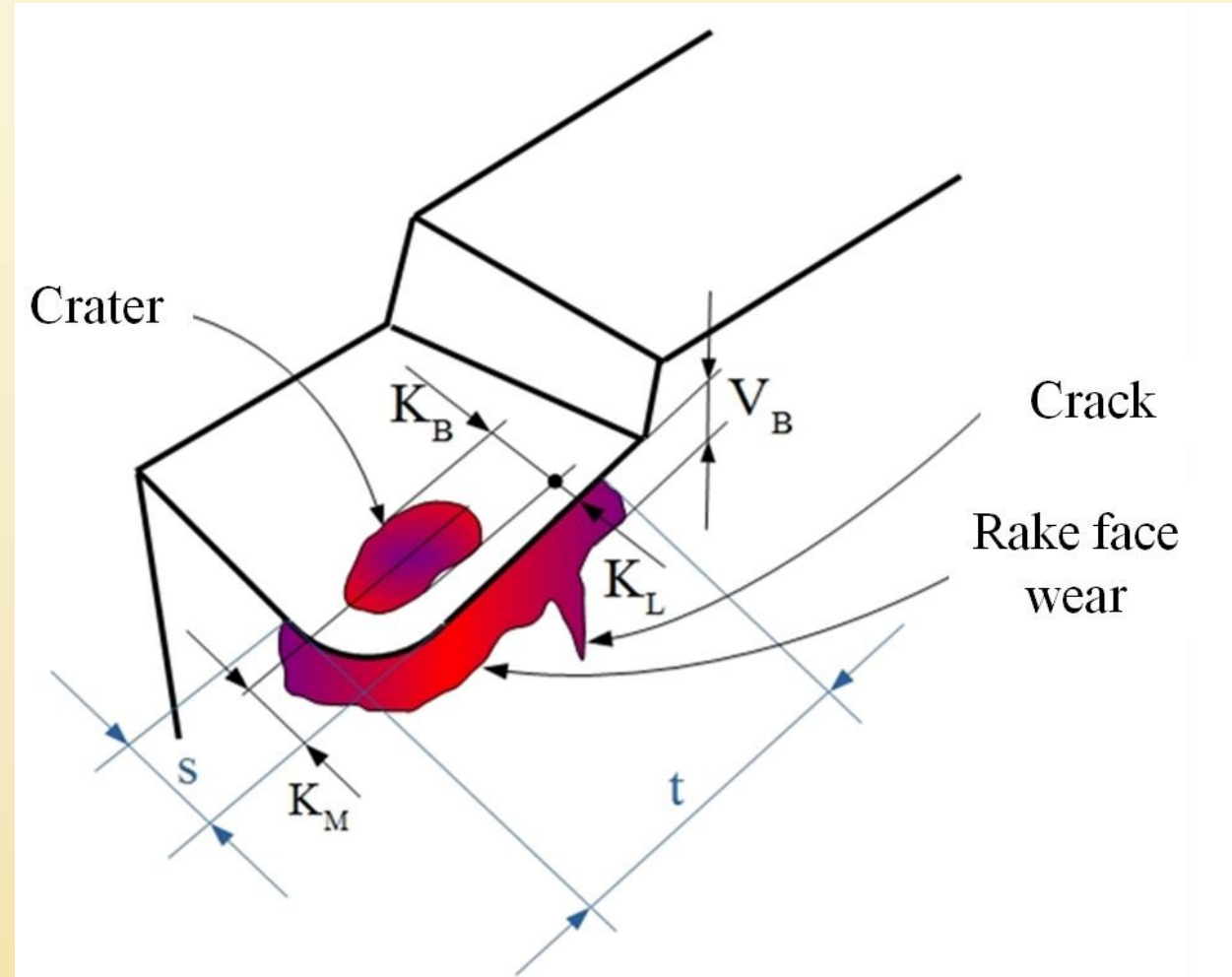


Analyzing cutting tool wear over time, three main areas can be distinguished on the wear diagram.





# Permissible values for wear criteria parameters



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# Types of wear



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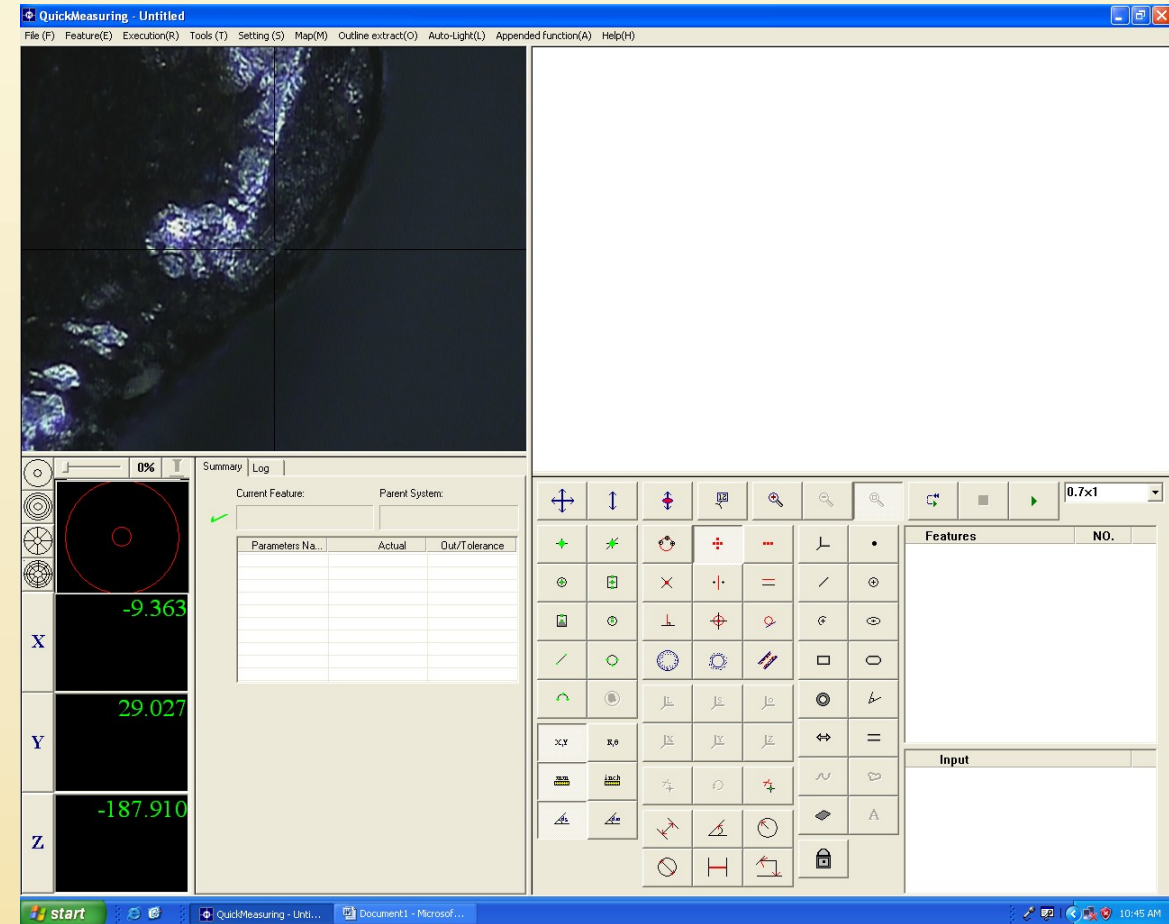
# Types of wear



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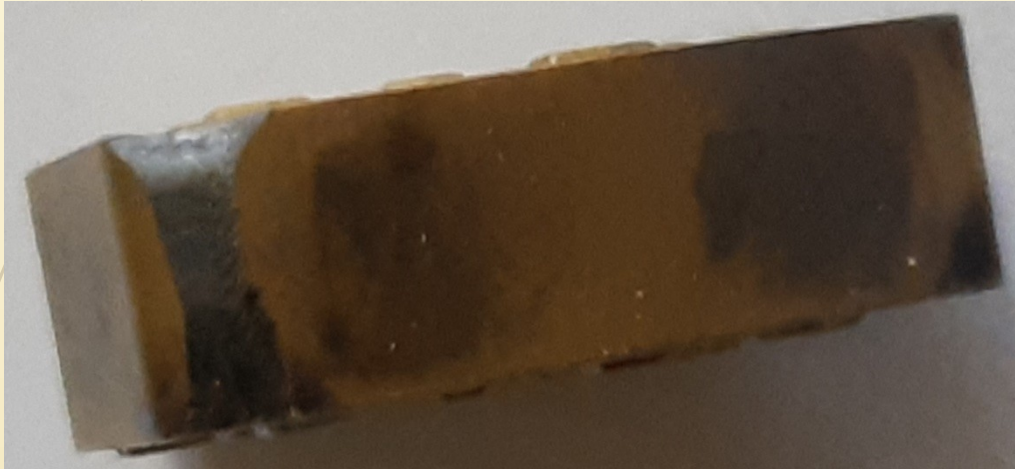
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# Types of wear



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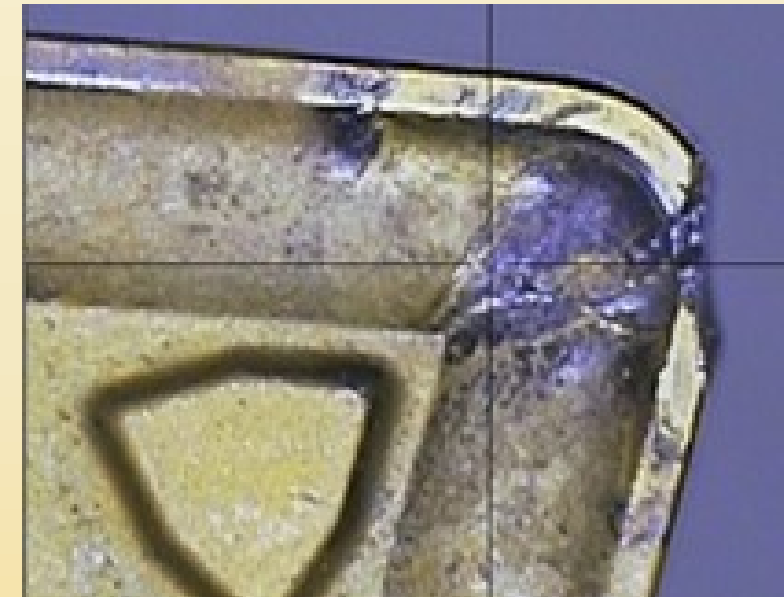
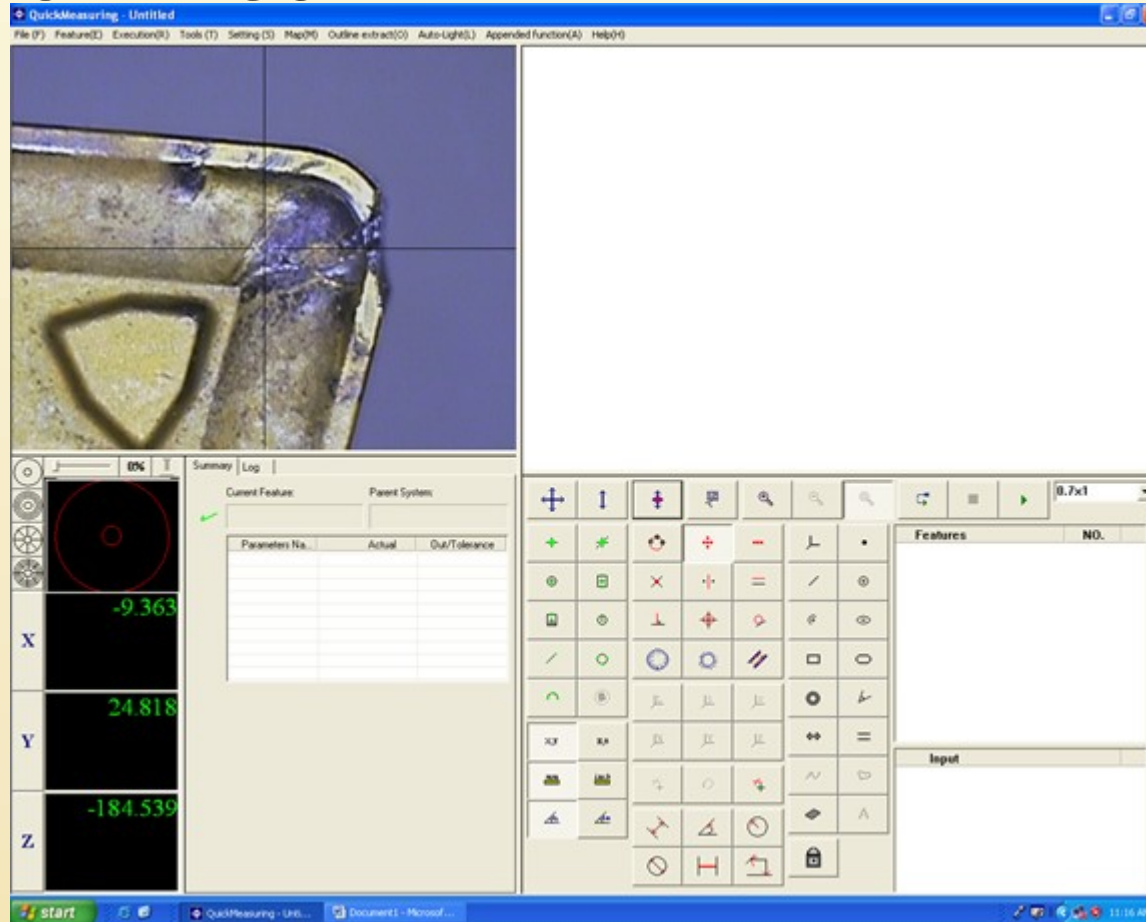
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# Types of wear



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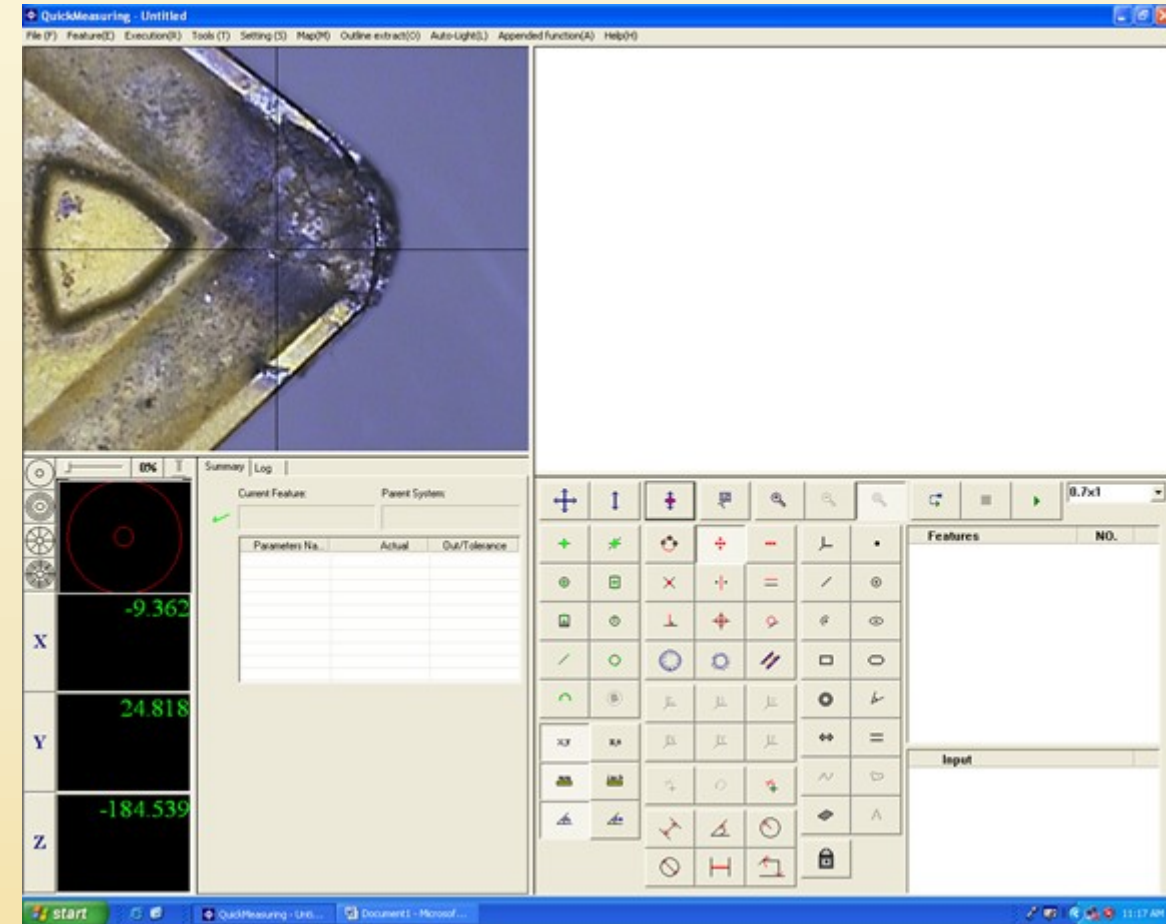
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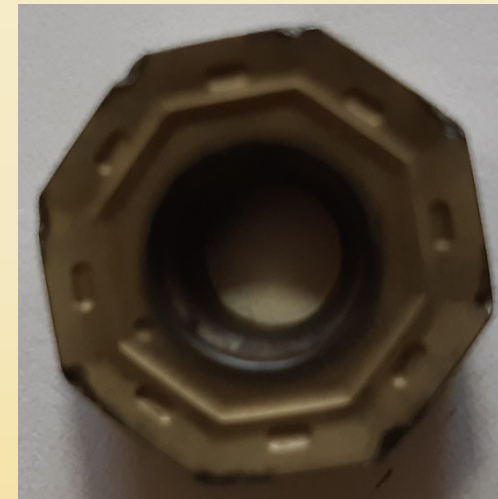
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# Types of wear



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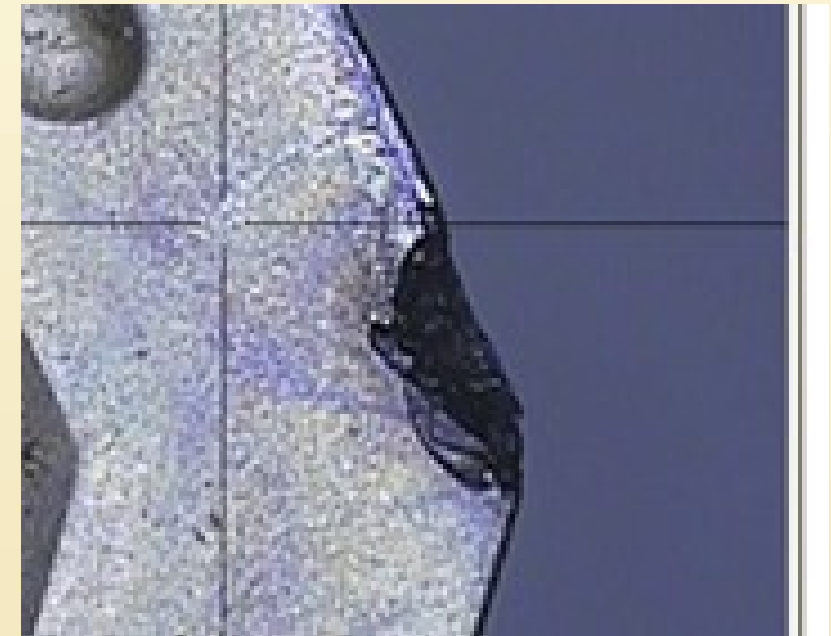
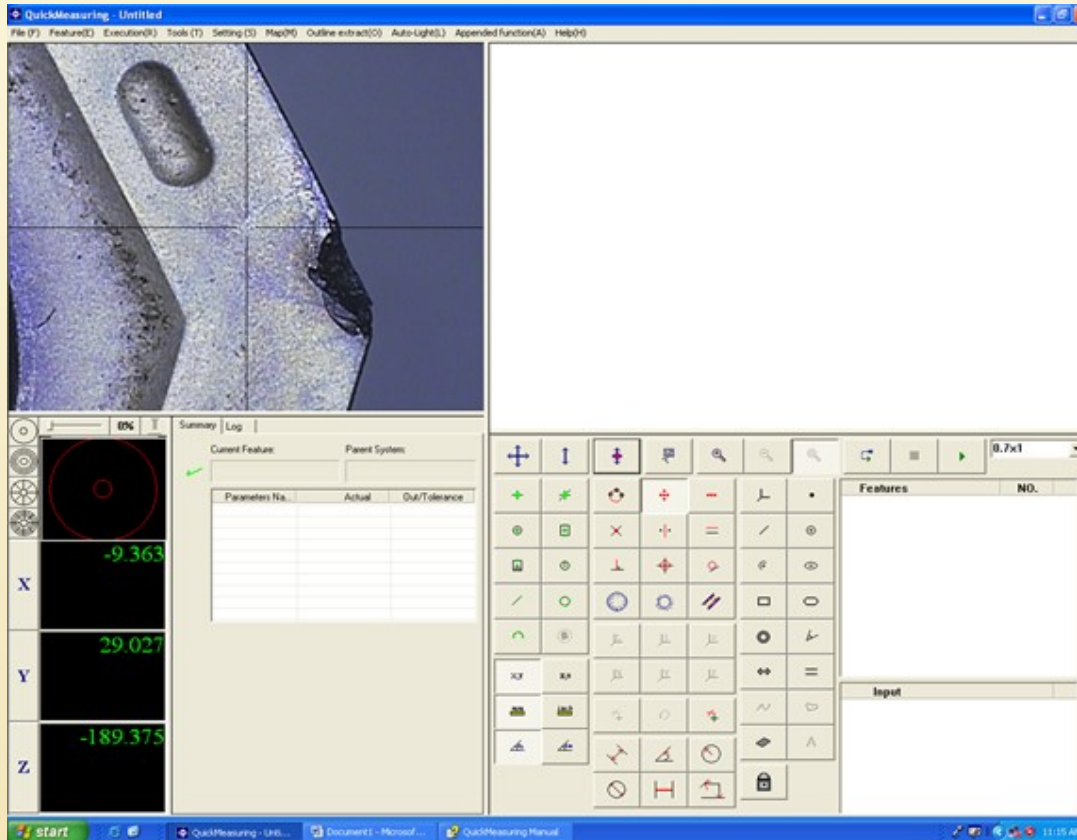
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# Types of wear



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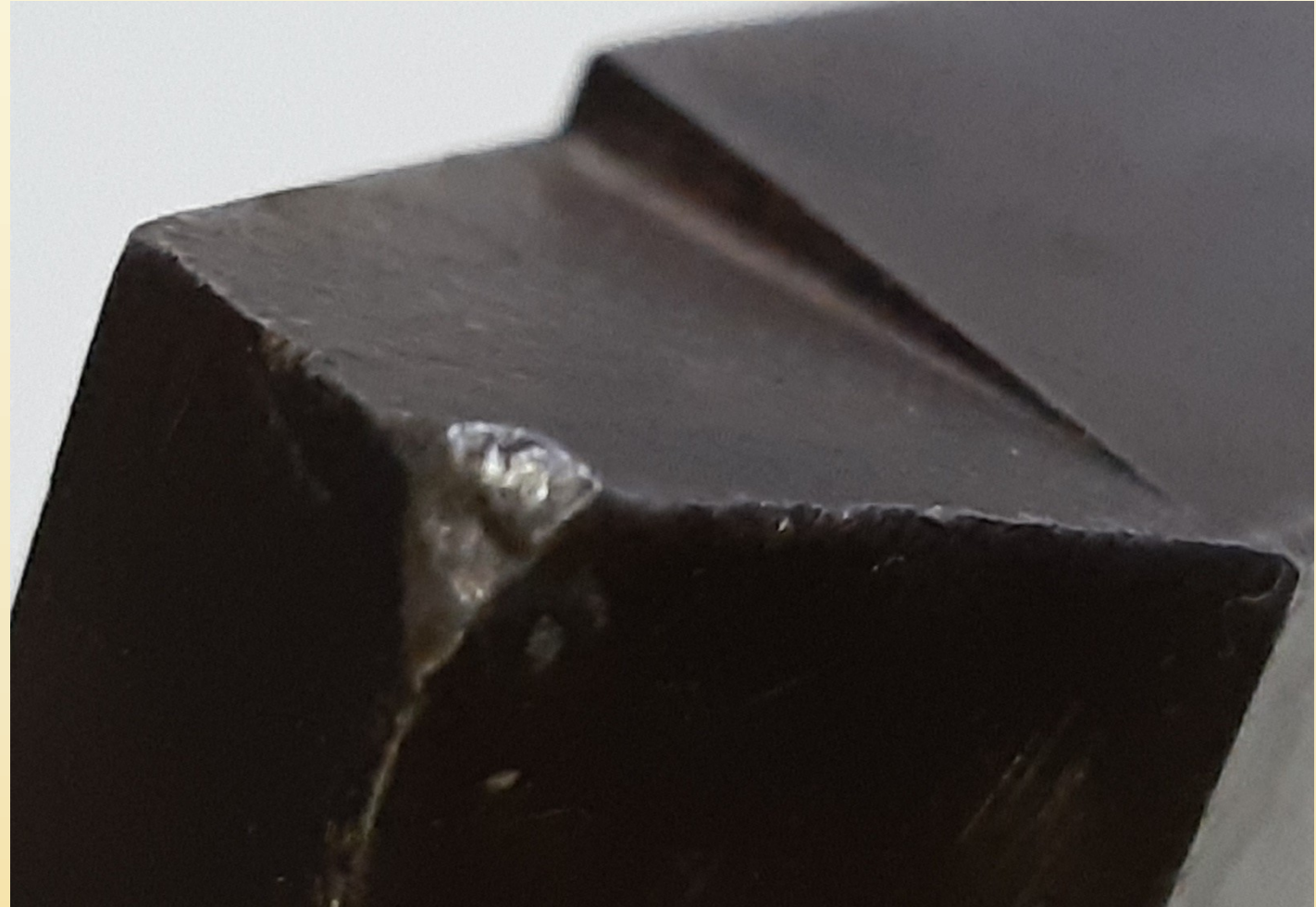
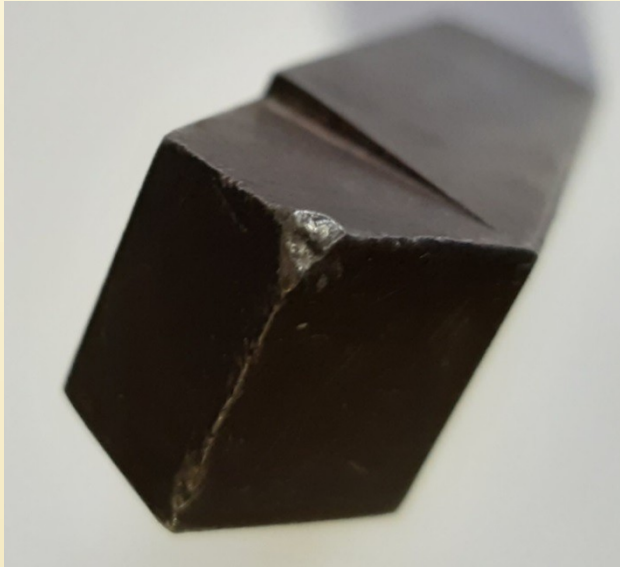
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# Types of wear



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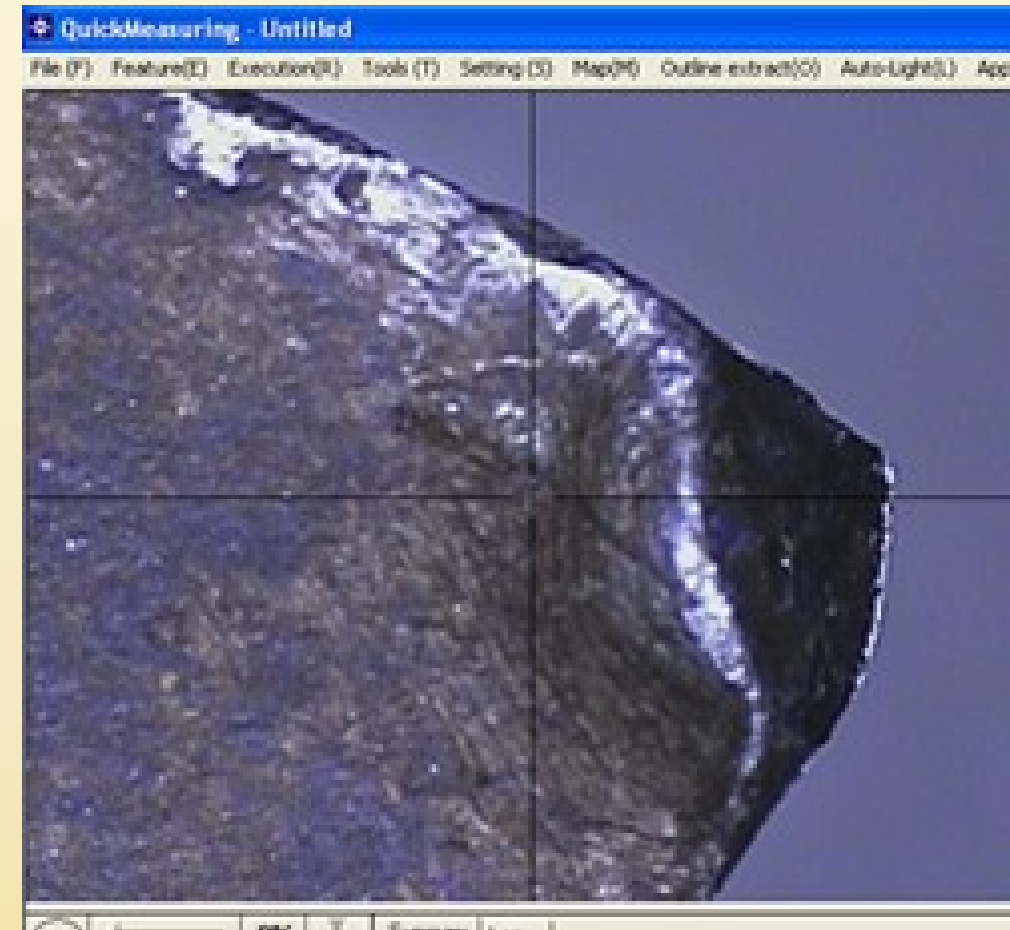
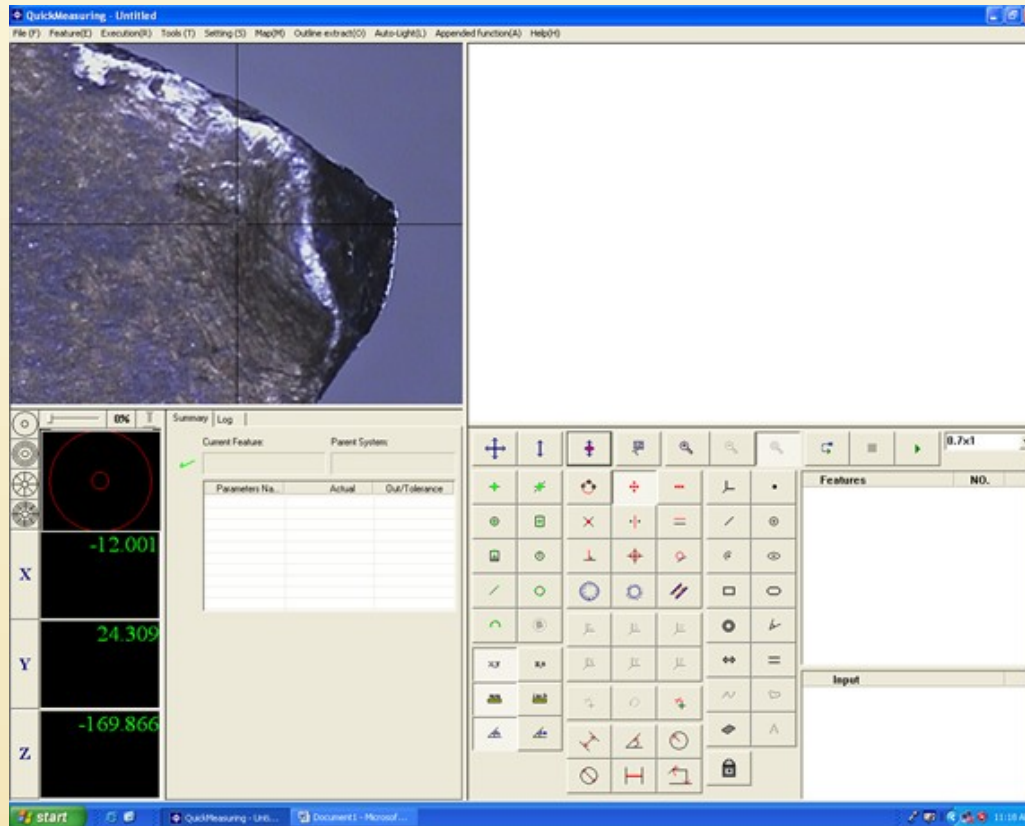
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# Types of wear



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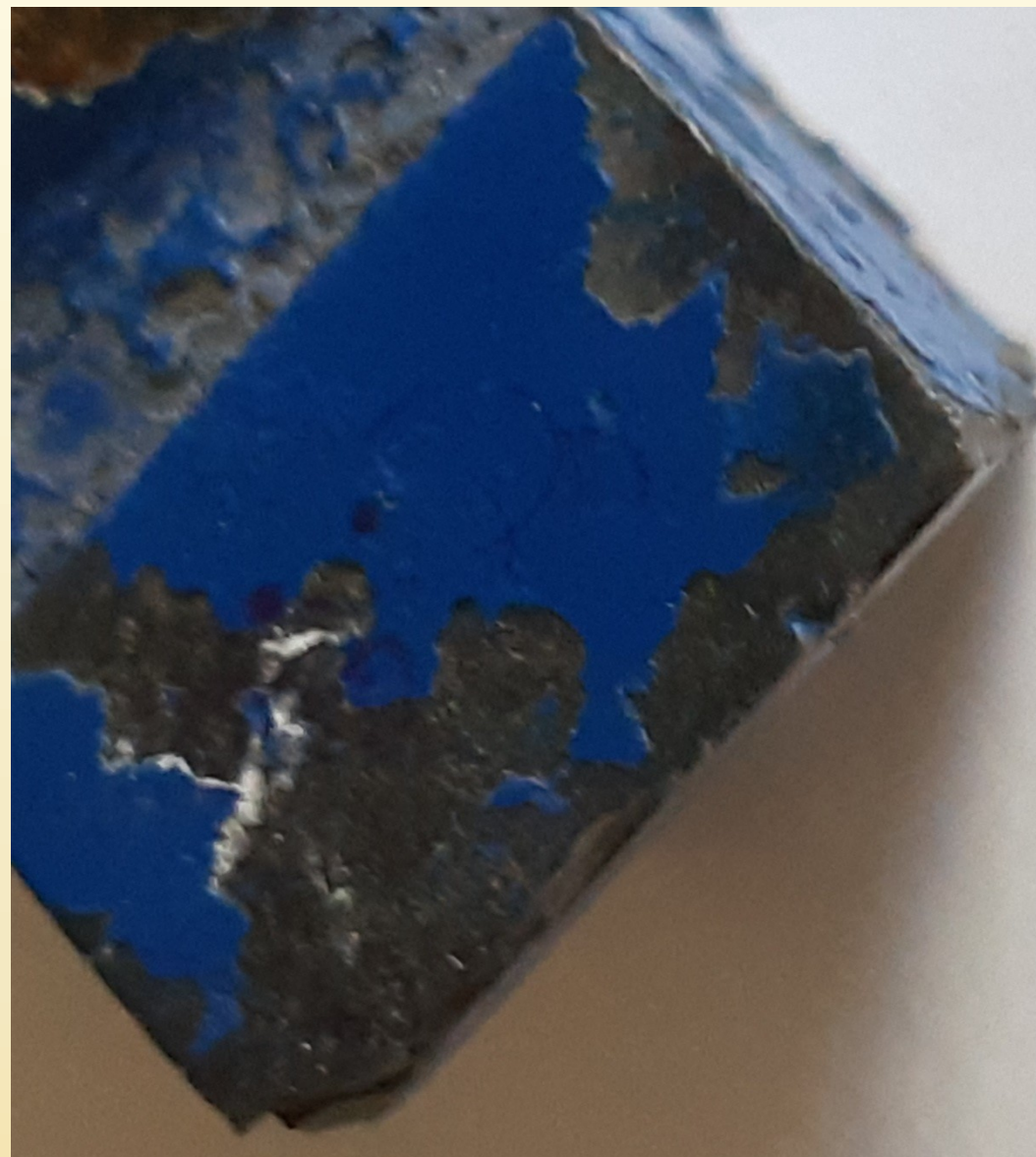


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# Types of wear



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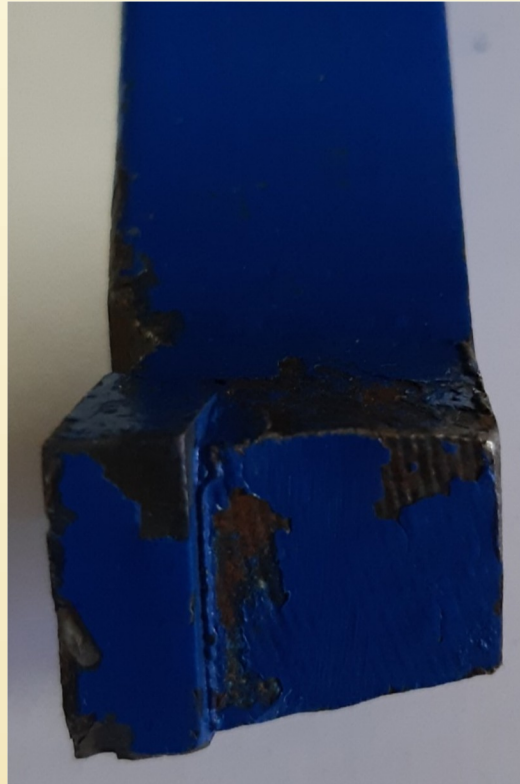


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# Types of wear



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