ABSTRACT
At present when still increase requirements for the higher production when machining materials with high strength and hardness, it is necessary to look for new ways how to increase cutting tool life and reduce production cost. One way how to do so is to use the thin coatings which are very progressive and a lot of producers use them. This is the first step. The next one how to increase tool life is focused on the functional shape of the cutting edge and tool micro-geometry. This is why this article will be focused on the problematic of the tool shape before the deposition of the thin coating and the possibilities of modifying cutting edge and micro-geometry. This article will be divided into two parts. The first one is dealing with different methods of the modifying the tool shape and micro-geometry and in the second part are presented the real results from the practical tests. For the test the face end milling cutter was used with the nanocristalic coating. During the tests the cutting edge shape and tool micro-geometry were changed and the tool life and cutting forces were monitored. The machined material was tool steel according to ČSN 19 462 (ISO C210Cr12) with hardness 60 HRC.

Keywords: end milling cutter, tool shape, tool micro-geometry, tool life, hard machine material

1 INTRODUCTION
For the cutting tool efficiency and tool life has fluencies a lot of factors which suggest machining and production costs. Today cutting tools are designed in terms of the machining materials. With it are linked selection of the cutting tool materials, tool shape, tool geometry, selection of the thin coatings and cutting tool chuck system. For current cutting tools the mentioned factors are maximum optimized and the tool life and cutting power are really high. On the other side the producers requirements still grow and press tool producers to search the new applications for the other increasing cutting tool efficiency and machining power. Today trends are focused on cutting tool micro-geometry its mean focused on the cutting tool wedge and their quality which has important influence for the increasing of the tool life. So tools producers makes different modifications of the tool wedge but not all methods are acceptable. If is used the optimal wedge modification it can causes increasing cutting tool efficiency more then 25%.

2 MAIN WEDGE MODIFICATION TECHNOLOGIES
In standard we can say that if is used some wedge modification is obtain the higher edge quality then has cutting edge after the grinding. The cutting tool edge quality is very important value which summarized a lot of factors. Some main factor which influence quality are:
- tool edge geometry form
- shape of the edge, tool rake and tool clearance
- cutting tool materials properties
- physical-chemical cutting edge changes

This contribution is focused on the first two events. The main factors are cutting tool edge quality and the shape after the grinding and their influences to the cutting process. The deposited tools are regulated before deposition by the pre-deposition processes. It causes higher substrate whiteness, morphology and chemical properties. Pre-deposition processes are substrate chemical cleaning, substrate ion cleaning and when the re-deposition is made is use before all processes the stripping. If we want to increase the cutting tool efficiency with thin coating more time we have to use before all these processes cutting tool edge technological modification.

The edge which incurred on the point of intersection tool rake shape and clearance shape has the small asperity after the grinding. It causes imaginary sharp edge reduction to the edge with the small radius marked r (figure No. 1).
These modification methods are used:
- send blasting
- brushing
- lapping
- tumbling
- laser modification

All these methods causes edge reduction roughness, clean edge and causes small radius which is depend on used modification methods (Figure No. 2).

3 CUTTING TOOL EFFICIENCY TESTS
For the tests the tumbling modification edge methods and long term tests were used. The use tumbling substrate and the modification time has main influence for the cutting tool wedge quality and shape. For the tests the same tool geometry, sharpening method, thin coating and cutting conditions were used.
3.1 Used conditions

3.1.1 Used cutting tools
For the tests the moonlit sintered carbide face and mills were used. The tool diameter was 10 mm. The used tumbling variants (V): V1 – V5 – from the shortest to the longest edge modification time. Like ethalon the cutting tool without modification was used (WM).

![Figure 3: Edge before and after modification [2]](image)

3.1.2 Machined material
For the machining the tool steel according to ČSN 19 462 (ISO C210Cr12) with hardness 60 HRC was used. The grade machining is 6b.

3.1.3 Used machine equipment
Machine:
drilling machine MCV 750 A with HEIDENHAIN TNC 426/430 ME system
Optical microscope Carl Zeiss with digital CCD camera

3.1.4 Cutting condition
For all tests the same cutting conditions were used.
cutting speed: \( vc = 100 \text{ m·min}^{-1} \)
feed: \( fz = 0.08 \text{ mm/zub} \)
axial depth cut: \( ap = 3 \text{ mm} \)
radial depth cut: \( ae = 0.5 \text{ mm} \)
Cutting environment:
dry

4 EXPERIMENT RESULTS
The main experiments output were specifying optimal tool wedge contact time with the tumbling substrate. For this specifying, tool wear on the tool rake shape (value VB) was monitoring during the machining. The analyses were made on the total machining cutting tool time. The maximum tool wear value was \( V_{B_{\text{max}}} = 0.15 \text{ mm} \). Because 2 edges face end mills were used the tool wear value was average value of both edges (Graph 1).
Graph 1: Process of tool wear

Graph 2: Total cutting tool machining time
The graphs show the influence of the cutting edge modification time to the cutting tool efficiency which increases. On the second side, if is selected the bad modification time it can cause decrease cutting tool efficiency very sizable. If is compare etalon tool and the best variant of the modification (V5) the increase of the cutting tool efficiency is visible about 28%. If it convert to the cutting length the machined line is 3.55 m longer then etalon line.

5 CONCLUSION
The results show that at this time the possibility of the increasing cutting tool efficiency still doesn’t run out. It is cause by the all time unfolding automotive and all time more using NC a CNC machines with still increasing requirements to the increase the cutting power and reliability.

References
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