Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, Volume 22, No. 1, ISSN 1726-9679
ISBN 978-3-901509-83-4, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2011
*Make Harmony between Technology and Nature, and Your Mind will Fly Free as a Bird*
*Annals & Proceedings of DAAAM International 2011*

# RELATIONSHIP OF SURFACE ROUGHNESS AND MACHINING PRODUCTIVITY

**MONKOVA, K[atarina] & MONKA, P[eter]**

***Abstract:*** *The paper contains the results achieved by optimization of a tool angle of the cutting tool with a linear cutting edge not parallel with the axis of the workpiece. The gained results of the measurements show that the investigated cutting tool enables to ensure the same values of surface profile characteristics as a classical cutting tool with the significant increase of the feed per revolution at the finishing. It directly influences the length of the technological operation time which is consequently reduced several times.*
***Key words:*** *surface roughness, cutting tool, geometry, feed*

## 1. INTRODUCTION

The important field of automation is the machining. It is the most common form of manufacturing technologies used in mechanical engineering. One of the parts that significantly influence the manufacturing technology is the cutting tool. It affects achieved qualitative parameters of machined parts and the machining process economy. (Fabian M. et al. 2010).
The improvement of the productivity of the automation of technology is possible to achieve: (Krehel R. et al., 2009)

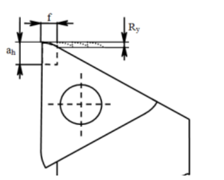
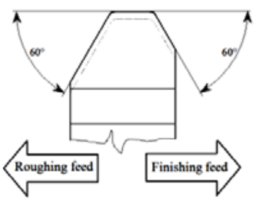
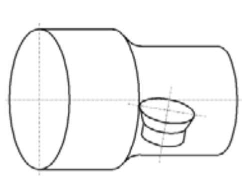
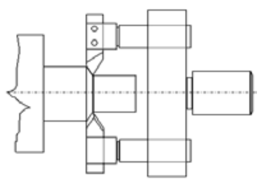
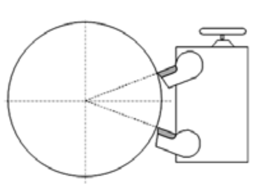
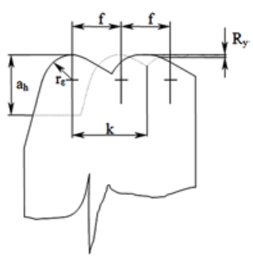
- by increasing the cutting speed, which negatively influences the cutting tool lifetime,
- by increasing the cutting depth, which is counterproductive to the current tendency according to which the semi-product before the machining should have the smallest working allowances possible,
- by increasing the feed values, which is most frequently allowed by the cutting tool geometry modifications.

From above mentioned, it is clear that it is necessary to pay the maximal attention to the right choice of the geometrical parameters, because they considerably influence the labour productivity and the machined surface quality.

The goal of the author's research was to find further possibilities of increasing the machining productivity, especially by using the machining tools with unconventional geometry.

## 2. SURFACE ROUGHNESS AND MACHINING PRODUCTIVITY RELATION

Some current solutions of the problem relates to the observance of necessary surface roughness at the productivity increasing are shown it Tab.1. (Monka & Monkova, 2001; Bilek, & Lukovics, 2008).

| **The solutions based on the modification of geometrical characteristics of cutting wedge** | |
|---|---|
|  | Designed cutting tip has instead of linear cutting edge the secondary one which is created in an arc shape with big radius. The optimal radius is R=0.15÷0.5L, where L is the width of the cutting tip. This solution can be used for bigger cutting depth. |
|  | The cutting tool with linear cutting edge parallel with the workpiece axis. This tool is used for high feed values (also 3mm per revolution) at 1,5 mm cutting depth. This concrete presented tool enables to work in one direction as a rougher and in reverse direction as a finishing tool. |
|  | The cutting tool with circle cutting tip with big radius (about 10 mm) This solution markedly decreases the roughness of machined surface at the turning (about ten times). If the location of the tool is fulcrumed, it is possible to work with double cutting speed compared to using a normal cutting tool. The feed can be higher by 50% and the cutting life increases ten times. |
| **The solutions based on the rise of cutting wedge number in contact** | |
|  | Two cutting tools which are held radially opposite each other. The position of the tools considerably eliminates radial component of cutting force. One of the tool is rougher, the second one machines finely. Both tools have to be set so that the corner of the smoothing tool is set to half of the feed compared with the tool mark of a rougher tool. That enables double increase feed while maintaining the required roughness. |
|  | Two cutting tools which are held one after another in a clamping head of a turning carriage. Using this solution, it is possible to work with double feed value at the same surface roughness and considerable vibration decrease. The tools are set up so that the suitable effective angles of the cutting wedge for both tools are achieved and so that the tip of the smoothing tool is set up at half revolution of feed compared with the tool mark of a rougher tool by the workpiece. |
|  | Cutting tool with two corners. The corners are moved apart from each other in the direction of feed always by the odd multiple of half of feed. The requirement is to set up both corners in the same plane, parallel with the workpiece axis. The additional corner equalizes irregularities formed by the first corner. This tool can be used for the roughing. |

Tab. 1. Productivity increasing by variations of cutting tools

## 3. SUGGESTED SOLUTION TO INCREASING THE MACHINE PRODUCTIVITY

The new possibility of the production efficiency increasing is provided by the tool with linear cutting edge not parallel with workpiece axis, which was verified at FMT TUKE with seat in Presov. This solution represents very good relationship between feed and surface roughness, however the disadvantage is the necessity of major run-in and run-out of cutting tool. It enables to machine only bottomless cylindrical surfaces without the shoulders. Because of the disadvantages of this tool, other variants were sought, in order to preserve the advantages and eliminate the disadvantages of the tool.

The dependency of the surface roughness characteristics on the cutting edge angle of this tool was also examined, as shown on the Fig.1. (Valicek J.; Mullerova, J. & Hloch S., 2008).

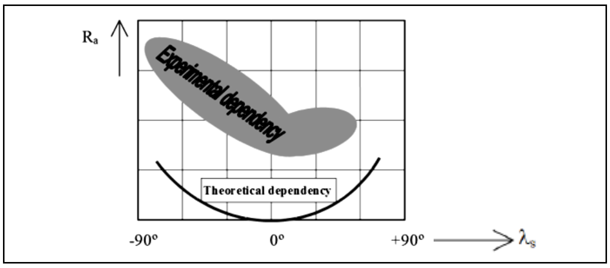



Fig. 1. The dependency of $R_a$ on the cutting edge angle

Based on the results, the value 45º for cutting the edge angle was used in next verification.

During experiments it was observed that cutting tool achieves better work results if active length of cutting edge is not too long; the tool is unprofitable in term of low brittle rupture resistance. The tool corner which is set up a little bit above the workpiece axis, plays a part in the cutting process, therefore the modification of primary geometry by zero face hardening was suggested. The values 1, 2 and 3 mm were suggested for the zero face width. Various combinations of values were verified for cutting depth during experiments, such as setting up the corner above workpiece axis and zero face depth. The best results of surface roughness values were achieved at the following combination of values:

–tool setting up 1mm above workpiece axis and

–hardening zero face depth 1 mm.

The important factor in creating the unsuitable surfaces roughness, or too high vibration, was caused by great length of active cutting edge and too great shift of tool angles by setting up the tool too high above workpiece axis. It is evident from the Fig. 2 that point of cutting edge that generates the maximal radius ($R_{max}$) has very unfavourable geometrical parameters.

The unsuitable combination of parameters such as part radius $R_{max}$, cutting depth and the setting up of the tool corner above workpiece axis, results in such a change of tool flank angles (angle η), that makes the cutting process considerably worse, or rather completely impossible. The increasing of flank angles also can´t take big values, because it greatly decreases the hardness of cutting wedge.

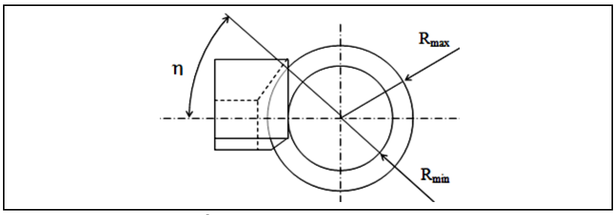



Fig. 2. The scheme of the tool geometry change due to machining parameters

The increasing of flank angles also cannot take big values, because it greatly decreases the hardness of cutting wedge.

The other experiments were related to the surface roughness and feed per revolution at the machining by tool with linear cutting edge. The dependency of the characteristics listed above is shown in the Fig. 3.

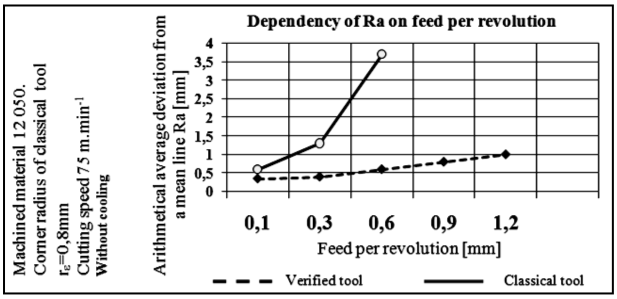



Fig. 3. The dependency of $R_a$ on the feed per revolution

## 4. CONCLUSION

Based on results demonstrated in this article, it has been established, that experimentally verified tool with linear cutting edge not parallel with workpiece axis achieved better results of surface roughness characteristics at the machining using several times higher feed values as compared to standard tool. Therefore, the tool can be used for machining process intensification in production, due to the fact that it enables to shorten the machine time. This tool connects roughing and finishing operations with required surface quality assurance, which would enable to reduce the number of technological operations, too.

Next experiments will focus on:

- the shortening of tool run–off area,
- the using of more complex characteristics of surface roughness for cutting process evaluation,
- tool features designing for chip forming or breaking.

## 5. ACKNOWLEDGEMENTS

This article originates with the direct support of Ministry of Education of Slovak republic by grants VEGA 1/0885/10 and KEGA 270-014TUKE-4/2010 & KEGA 035TUKE-4/2011.

## 6. REFERENCES

Bilek, O. & Lukovics, I. (2008). Experimental simulation of heat and stress formation for surface grinding, *International DAAAM Scientific Book*, Katalinic B. (Ed.), p. 35-42, Published by DAAAM International, ISBN 978-3-901509-69-0, ISSN 1726-9687, Vienna, Austria

Fabian M., et al. (2010). CAM parameters settings and NC milled surface quality, *Annals of DAAAM*, 20-23.10.2010, Zadar, Croatia, ISSN 1726-9679, ISBN 978-3-901509-73-5, Katalinic, B. (Ed.), p. 0391-0392, , Vienna, Austria,

Krehel R., et al. (2009). Mathematical model of technological processes with prediction of operating determining value, *Acta Technica Corviniensis: Bulletin of Engineering*, Vol. 2, No. 4, p.39-42, ISSN 1584-2673

Monka P. & Monkova K. (2001). Cutting tool geometry and machined surface quality, *Proceedings of ICPM*, 17.-18.6.2001, Usti nad Labem, CZ, ISBN 8070443588, p. 181-186, UJEP, Usti nad Labem

Valíček J.; Mullerova, J. & Hloch S. (2008). Interpretation of the roughness measurement spectra of the surface profiles, *Machines, technologies, materials*. Vol 2, No. 10-11, p. 22-24, ISSN 1313-0226