International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

Vol.6., Issue.4, 2018
July-Aug.

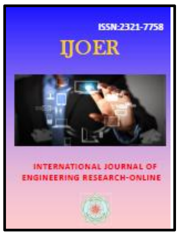
RESEARCH ARTICLE

ISSN: 2321-7758

MODIFICATION IMPACT FOR PRECISE QUALITY CHARACTERISTICS-CASE STUDY

NERINGA TOLIUSIENE

Department of Production Engineering, Faculty of Mechanical Engineering and Design, Kaunas University of Technology, Studentu str. 56, 51424 Kaunas, Lithuania, E. mail: n.toliusiene@gmail.com



ABSTRACT

There are a wide variety of tools at the precise metal working market (holders, cutting discs, turning the cutting edge shafts) which allows to cut work pieces quickly and accurately. However, there is a huge problem for small and medium metal working companies to stay in front of the customers' demands. They have to know how to make their manufacturing faster and more qualified. One of the major problem for precise turning manufacturing is the equipment limits [1]. In order to optimize the agile manufacturing processes research carried out with standard and modified turning tools for quality data monitoring at the precise metal working manufacturing. Small and medium companies faced with an efficiency problem when it comes to processing of larger diameter than the blanks allow unloaded installation options. The standard turning tool was modified (increased processing diameter) according to the elimination of additional operations from manufacturing process. The objective of new modified tool is to check the modified holder working parameters against standard and reveal it worth for precise manufacturing. The tests made experimentally for precise turned mechatronic parts used from stainless steel material AISI 430Fand AISI 1213 steel. The diameters deviations and surface roughness are the main quality properties for precise turned parts, which was exanimated during tests [2]. Working condition for effective cutting diameters and surface roughness for the larger diameters was tested. Testing parameters set according surface roughness values ISO 1302 DIN 4768 standard.

1. Introduction

CNC machine tools and centers using different types of tools made of different hardness of materials. However, the most commonly used materials for precise mechatronic parts are hard metals. High-speed steel CNC machine tools

usually used only for those who can hardly be made of hard metal, or having cutting speeds of up to 30 - 40 m / min according to the specifics of their work [3]. According to the analysis two main types of steels complies with the requirements:AISI 430F **(1.4104) and** AISI 1213 (1.0715). At the market are a wide variety of tools, cutting discs, turning the cutting edge shafts allows material blank to work quickly and accurately [4]. In order to optimize the agile turning process there was modified the standard tool that are used in agile metalworking manufacturing. The research done in the metal processing company has shown main quality problems: difficult to obtain a high quality of the blank;

- difficult to work the product with precise diameters (hard turning of the work piece);
- reduce the time and cost, increasing processing speeds;
- difficult to improve product quality issues resulting from the cutting tool vibration;

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According to the literature review [5, 6, 7, 8, 9] the work piece diameter defines diameter cutting quality and roughness.

Mechanical machining is very important to the installation of technical tools for limited blanks whose dimensions fall within the technical dimensions. Large companies with large variety of equipment can use a lot of equipment adjusting rod dimensions relevant for the installation. Agile manufacturing faced with a problem when it comes to treatment of larger diameter than the blanks are allowed according to equipment installation options. This paper presents tested results of quality properties for increased diameter of modified holder (with turning and threading functions), which allows to cut larger diameter work pieces. Material blanc parameters (and identification) presented in table 1. According to the previous research analysis two main types of steels mostly used in precise turning operations AISI 430F **(1.4104 diameter 40mm) and** AISI 1213 (1.0715 diameter 32mm).

Table 1 :Tested material

Numeration	Blank Diameter	Composition
1.4104DR40/1	0 40	X5CrNiMo17-12-2,
1.4104DR40/3	0 40	
1.4104DR40/5	0 40	
1.4104DR40/7	0 40	
1.0715DR32/1	0 32	9SMn/ 11SMn
1.0715DR32/3	0 32	

The paper divided as follows: firstly presented the main problems faced with at the metal processing manufacturing (small and medium company). Secondly, tools testing description, methodology, equipment and parameters presented in Section 2. Next, the results of the diameters deviation are presented in Section 3, the tests are made for two different steels (according to the raw material analysis at the company). Section 4 show results of roughness testing, of both standard and modified tool; Finally, Section 5 outlines the some of the most important conclusions, and states the advantages and disadvantages of modified tool.

2 Turning tool testing

The most common materials for CNC machine tools are hard metals. Usually vibration during cutting have a negative impact on the quality of the work piece and the maintenance for desired quality dimensions. By adjusting the tool that vibrate at the desired frequency of 20-40 Hz vibrations can be used to optimize the cutting regime. The respective frequency vibration can reduce the cutting area, friction and temperature, to extend the service life of the tool, reduce the cutting edges and machined surfaces micro burst.

Table 2 presents the testing parameters. The blank of 1.0715 (9SMn / 11 SMn) steel was cut 2 specimens 0 32mm. There was tested stainless steel 1.4104 (X5CrNiMo17-12-2,) 0 40mm blank. In total has been obtained, 4 samples of 1.4104 and 2 samples of 1.0715 steels. During testing all cutting processes cooled by emulsion. Operating mode selected by the recommended tool parameters (spindle revolutions, the feed rate, cutting depth).

Table 2 :Testing properties

No. work piece	Speed (ipm)	Feed (mm/rev)	Depth of cut (mm)
1.4104DR40/1	1800	0.18	2
1.4104DR40/3	1800	0.18	2
1.4104DR40/5	1800	0.18	2
1.4104DR40/7	1800	0.18	2
1.0715DR32/1	4000	0.25	2
1.0715DR32/3	4000	0.25	2

In order to verify the modification accuracy of the tool and operating parameters tool checked at the prototype-testing stand. Fig. 1 presents testing methodology and inspection methods.

Firstly, the tool is assembled and verified for testing. According to the quality data analyzation, checked two main quality requirements for mechanical parts. Verification of the results carried out using coordinate measuring machine and roughness measuring equipment. Cutting force depends on the selected mode, these parameters depends on holder overall dimensions. Cutting insert attachment point performs an important function of tool modification. Also, cutting insert and screws are under pressure to the special slot. Socket position and rotation angles of the planes to be exact, as they determine the positioning accuracy and machining quality characteristics. Main plane tilted at an angle, the angle between the wedge in the front surface and perpendicular to the cutting surface would be optimal. It depends on the cutting angle formation conditions and fulfillment of quality characteristics [10]. Front angle y- is the angle measured between a front surface insert and a line parallel to the supporting plane of the cutting edge. This angle is very important for cutting. Modified holder can be used for CM inserts. In order to verify the modification accuracy of the tool and operating parameters tool checked at the prototype-testing stand. Figure 1 presents testing methodology and inspection methods. Firstly, the tool is assembled and verified for testing. According to the quality data analyzation, checked two main quality requirements for mechanical parts. Verification of the results carried out using coordinate measuring machine and roughness measuring equipment.

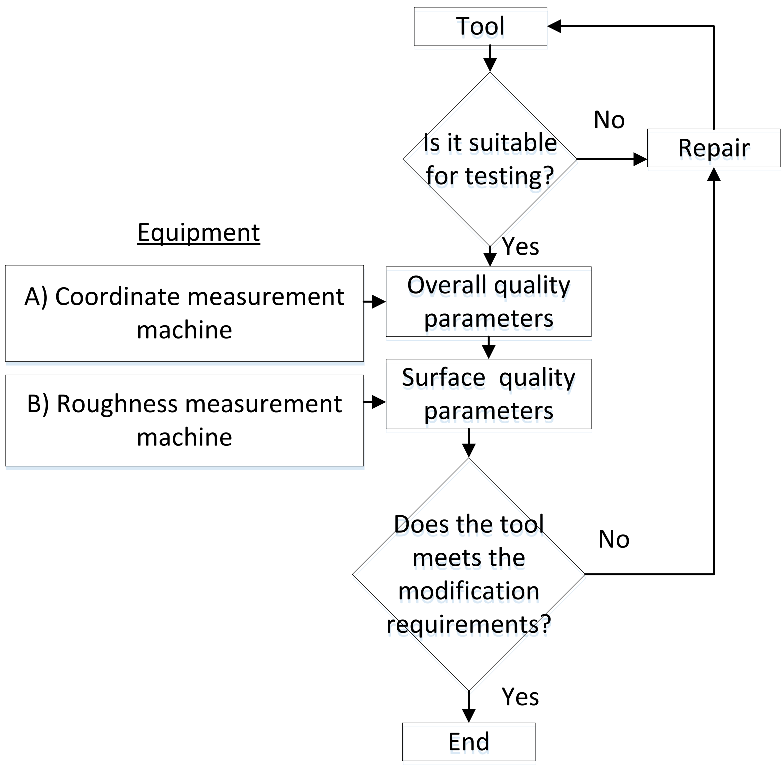

Figure 1: Testing methodology

3. Diameters deviations testing

The aim of the test for diameters deviations was to carry out the influence of modified tool against the standard for precision metal cutting. Tested tools presented in Table 3. The table also contains samples. All tools tested with the same original and modified holders. Table 3 presents testing results according cutting tools and blank diameters. Two major diameters were selected based on the analyzed data requirements.

Table 3 :Diameters deviations

Material/Diameter/No.	Cutting tool	Ø 12 mm		Ø30/26 mm	
		max	min	max	min
1.4104/DR40/2	A	12.0112	12.0024	30.0042	29.994
1.4104/DR40/4	B	12.0112	12.0024	29.994	29.9984
1.0715DR32/2	C	12.0365	12.0252	26.037	26.0283
1.0715/DR32/4	D	12.1426	12.1327	26.315	26.1382
1.4104/DR40/6	E	11.9724	11.9611	29.9647	29.9601
1.4104/DR40/8	F	12.029	12.0196	30.0233	30.018

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Figure 2 presents the difference between standard tool (A and B) and modified tool (E and F) according the processed material. Accurate results for processing Ø12 diameter showed incoming A tool. Standard and modified tools had the lowest difference of 0.02 mm. However, this modification presents better treatment results, meaning 12.068 mm closer to required diameter (constant = Ø 12).Figure 3 presents the results of 1.4104 steel blank just for diameter Ø30 mm (constant) . Precise results were received with the same A (modified) tool. The values differ from the constant diameter of 0,02 mm.

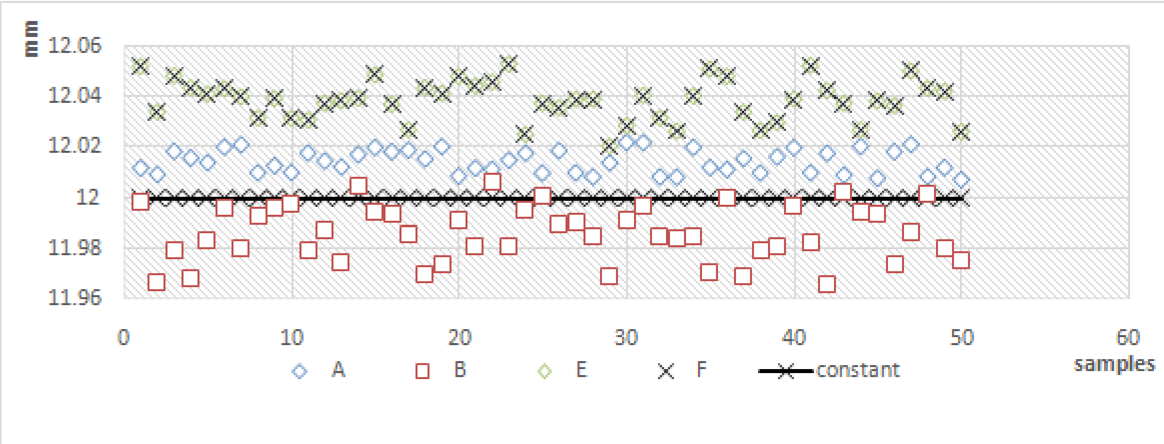

Figure 2 : A, B, E and F tool processing deviation of Ø 12

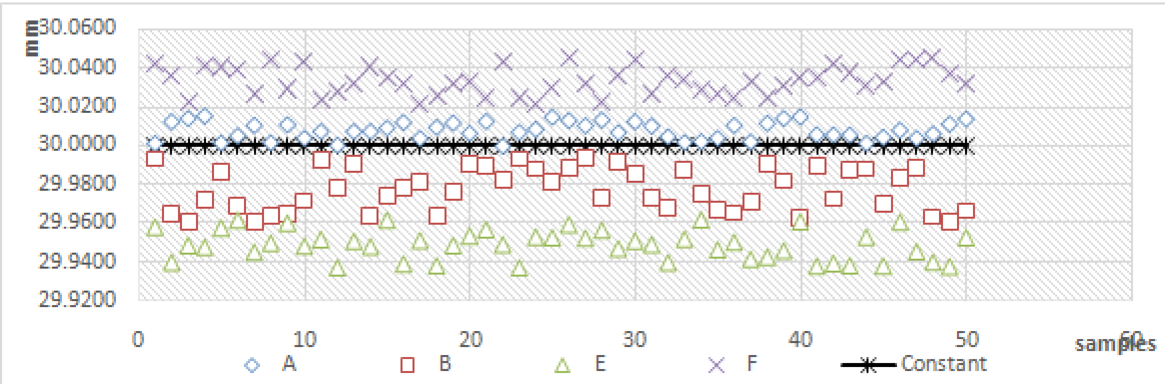

Figure 3 : A, B, E and F tool processing deviation of Ø 30

Second stage of the testing performed with the material 1.0715. Also performed Ø 12 and Ø 26 blanks.Figure4 Ø 12 mm diameter processing deviations C and D tools. Figure provides the results of testing. Ø12 mm testing showed precise cutting of D tool Ø 12,030 mm . The results are the closest to the constant diameter of modified C tool, deviation is better than standard tool of 0,02 mm.

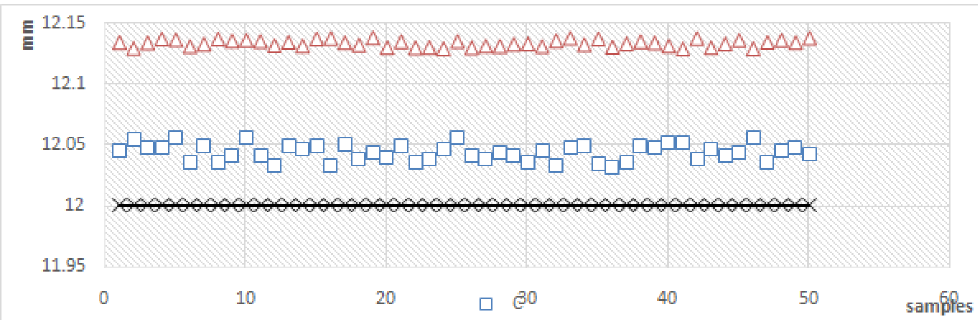

Figure 4 : C and D tool processing deviation of Ø 12

Figure5 Ø 26 diameter deviations C and D tools. Constant diameter is Ø 26 mm, testing steel 1.0715. Accurate result for this kind of diameter is using modified tool C, the diameter average Ø 12,030 mm. D tool performed the worst results with the same parameters: modified tool Ø 26,230 mm, standard tool Ø 26,135 mm.

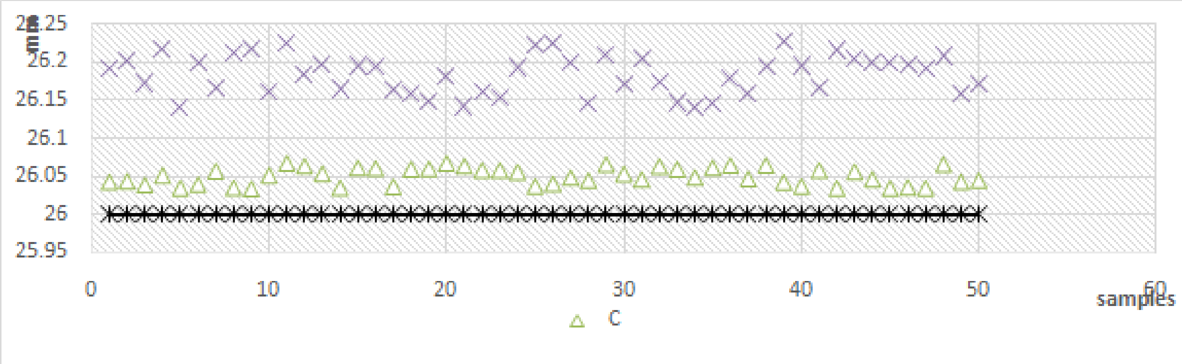

Figure 5 : C and D tool processing deviation of Ø 26

4. Roughness testing

According to the literature review (Jangra, et al., 2016; D'Mello, Srinivasa and Puneet, 2016; A'Addona and Raykar, 2016) there was made a lot of tests for turning process optimization. Another important requirement for mechatronic components is surface roughness. It effects surface corrosion and surface friction. For modified tool we have made the roughness evaluation tests according to the standard tool and main quality requirements for precise metal processing.

Roughness testing was done with roughness measuring device SURFTEST SJ 500th. As a standard tool case, the surface roughness of the sample measured in two places. In order to avoid large errors in measurements used the same settings as the standard testing tool. Testing parameters was set according surface roughness values ISO 1302 DIN 4768 standard.

Experiment parameters (table 5):

- Because of the uneven surface of the perform, basing the sample, the measurement used by Mean line compensation;
- Le = 0.8;
- Nle = 2

Table 4 : Roughness measuring parameters

Ra, µm	Rz, µm	Length, λc ,mm	Quantity	Scan length
0,006<Ra<0,020	0,025<Rz	0,08	5	0,4
0,020<Ra<0,1	0,1<Rz	0,25	5	1,25
0,1<Ra<2	0,5<Rz	0,8	5	4
2<Ra<10	10<Rz	2,5	5	12,5

Figure 6 Surface roughness measurement. Presented sample of the Ø12 mm blank. Test performed in two separate places of the diameter using calibrated roughness measuring equipment Surf test SJ500. Figure 7 presents the surface roughnes deviations of ABEF tools forØ12.

Figure 6: Surface roughness measurement

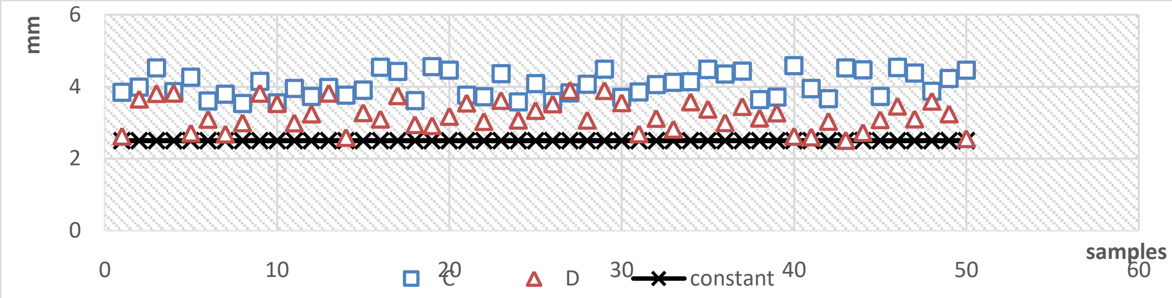

Figure 7: A, B, E, F tools Surface roughness Ø12

Figure 8 Roughness of Ø 30 for 1.4104 steel. Figure presents the results obtained with diameters Ø 30 of material 1.4104. The worst results showed tool E average of roughness found Ra=2.54µm. The best results revealed standard B tool average of surface roughness Ra=1,56 µm.

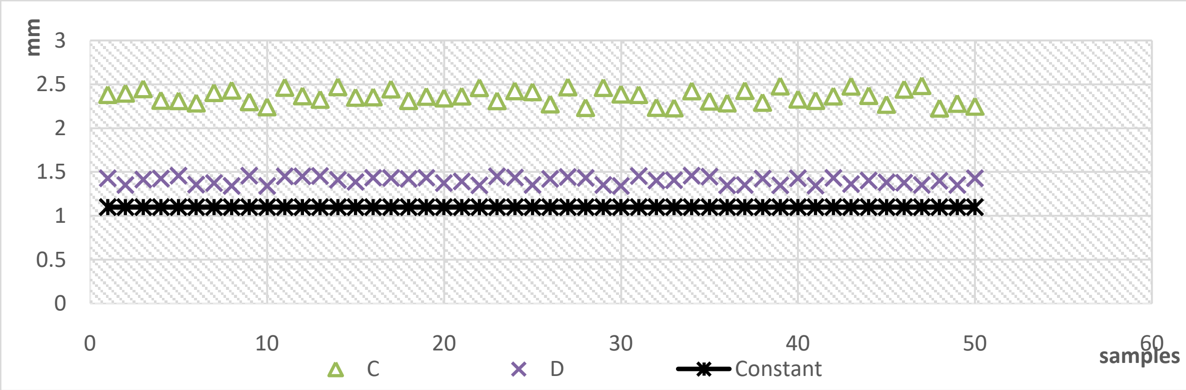

Figure 8:A, B, E, F tools Surface roughness Ø30

Figure 9 Roughness of Ø12 for 1.4104 steel. Fig. 9 shows the roughness of the differences between standard and modified tool measured values on the diameter of Ø12. The best value shown tool A, the value Ra =1.177 µm. Meanwhile, the standard tool Ra = 1,263 µm.

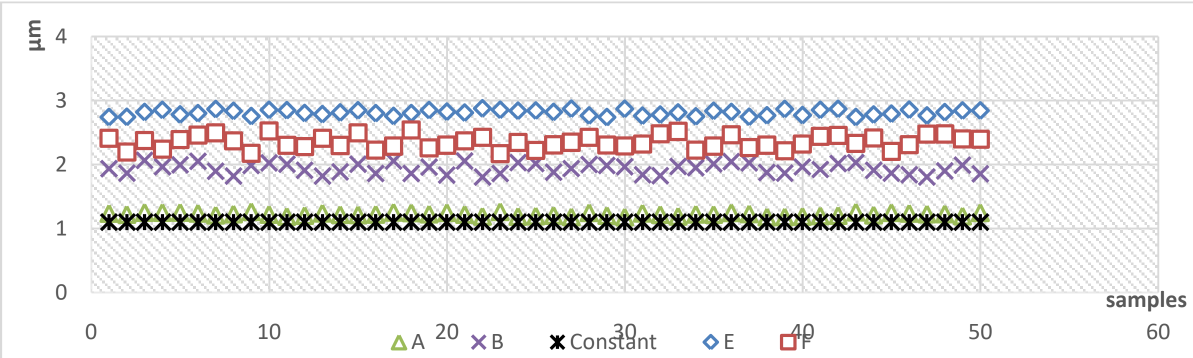

Figure 9: C and D tools Surface roughness Ø12

Figure 10 Roughness of Ø 26 mm for 1.0715 steel . Figure presents the surface roughness for 1.0715 steel. The best result presented D modified tool Ra = 1.30 µm. Standard tool D performed the accurate result for Ø 26 mm Ra = 1,20 µm.

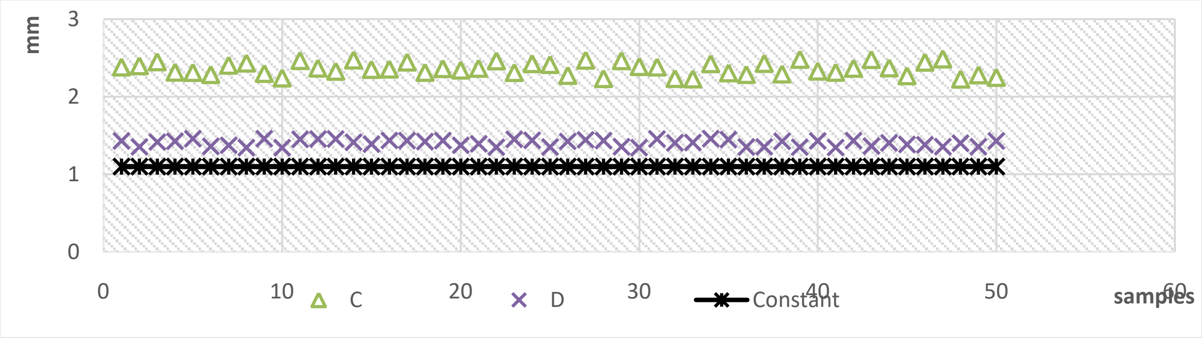

Figure 10: C and D tools Surface roughness Ø26

5 Results

The modified tool tested for diameters and surface roughness cutting accuracy. The tests were made for two main steels used for mechatronic components 1.0715 and 1.4104.

Processing of material 1.4104 the best results with the tools presented in table 4. Tests presents that the A and B tools meets closest results to the constant diameters.

Modified holder tested by Ø40 and Ø32 steel blank. Tools A and B presented (table 3) best results according to the standard holders. The best diameter deviation results showed A and B tools average >0.02 mm. However, the surface roughness was using A tool Ra = 1.177 µm with the same tool.

Tests of modified holder revealed that it can be used with the larger blank diameters without turning leathers modifications. It also approved to have cutting accuracy and surface roughness similar or in some cases better results, especially using for larger diameters (table 6).

However, the main problems of the tool revealed also. Firstly, the modification of the tool was not very accurate according to the given quality properties. The distances between planes do not fit into modification tolerances.

Finally, the tool could be using with the blanks for bigger diameters neither using standard tools (aprox.10 cm). Therefore, this tool must to be modified in a better way, especially the cutting insert place.

Table 5: Testing results

Material	Tool	Ø12 mm	Ø30/Ø26 mm	Roughness
1.4104	A	+	+	+
1.4104	B	+	+	
1.4104	E	+	+	
1.4104	F		+	+
1.0715	C	+		
1.0715	D			+

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