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CONTRIBUTION TO STUDIES IN GRINDING MACHINING Ti ALLOYS

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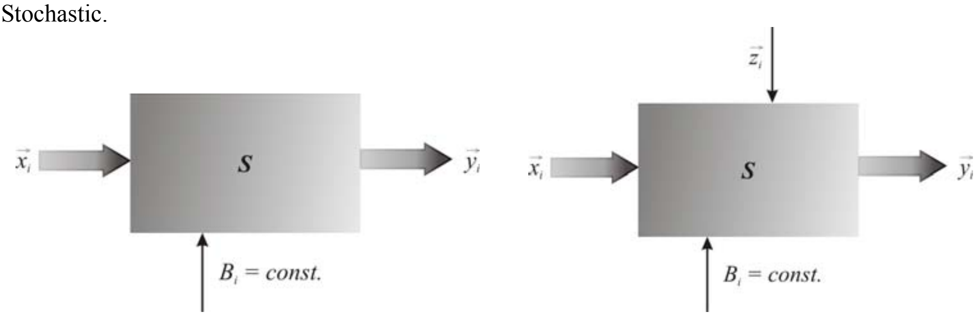
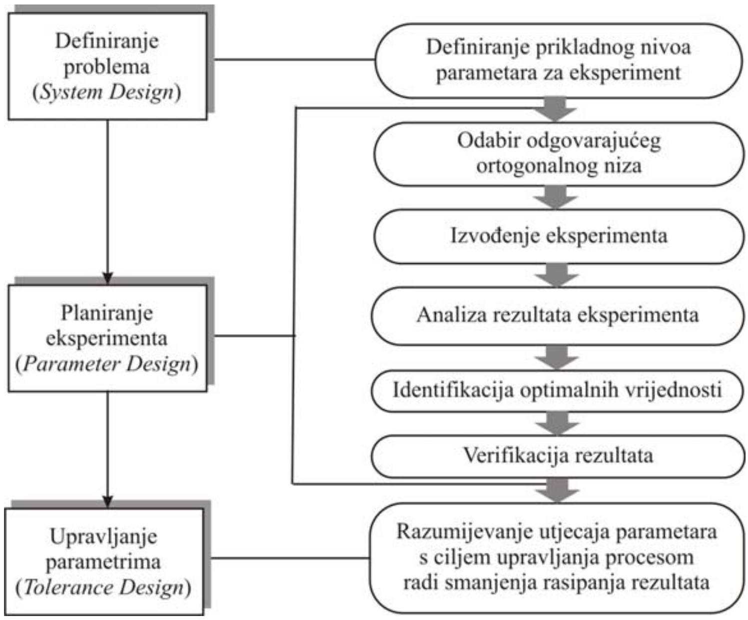
ABSTRACT
The application of new structural materials in aerospace and related to the possibilities of their treatment. By stringent requirements in terms of reduced weight, increased strength, increased corrosion resistance and other mechanical-physical and chemical properties of modern structures necessitate the wide application of titanium and its alloys. Since the application is still limited possibilities of machining and in particular to drilling are investing great efforts and resources for the study of cutting process and to define the parameters of machinability. Based on literature data and experimental results, the paper attempts to demonstrate some specificity in the processing of grinding.
Keywords: machining, grinding, roughness

1. INTRODUCTION
Projecting process should always be preceded by a specific modeling in order to use obtained models in defining multiple solutions from which it is possible to define an optimal process, procedure, load or geometry tools, processing time and so on and so forth.
The results of the modelling process are models that can be analytic, stochastic, numerical, graphical, statistical, etc. That is why modeling represents the description of the law of the changing process parameters in a given time period and place, having in mind a defined set of input parameters, their interactions as well as initial conditions. The models made in that way that in the mathematical may define a relationship between input-output parameters of the process are called athematical models.
Basically, modeling methods can be divided into two general groups as it follows:
- Deterministic and
- Stochastic.



Picture 1. Block diagram: deterministic and stochastic models

The primary purpose of the modeling process or a system is the construction of reliable mathematical models, that they will describe a process or a system adequately with the appropriate degree of accuracy. Products and processes can be designed in that way that they are as less as possible influenced by the environment. Such an approach to designing products and processes is called robust plan (design), and this whole approach is know today by its conceptual creator as the Taguchi method. The underlying idea of the robust design is a minimal variation of the target value of the product or the target process performance. Therefore, the robust design is intended to reduce the potential dependence of the process, or in other words that is to provide such a stability (robustness) of the process that will have limited impact on changes made during the process of designing and manufacturing, in order to reduce potential loss that can be caused by unwanted changes or parameter deviations of the pre-defined values. A number of input parameters as in a full plan of a factor remained three, and the level values of input parameters have been changing.



Picture 2. Taguchi method – procedure

2. RESULTS OF THE EXPERIMENT

The experimental part of the work is performed at the Institute of Mechanical Engineering, Faculty of Engineering and Computer Science, University in Mostar. The aim of this study was to obtain measurement results that will allow the definition of models for the three output parameters of the process of grinding: the temperature of the process of grinding, radial and transversal force grinding, quality of machined surfaces – micro geometry machined surface expressed through the surface roughness (Ra, Rz, Rmax). The experimental data were obtained by using appropriate measurement equipment without the use of coolants and lubrication.

- ✓ Machine

Experiments were made on a universal grinder „Красний Борац 3 71" in the workshop of the Institute of Mechanical Engineering in Mostar. The basic technical characteristics of machines are:

- Drive force of a electric motor – 2,2 kW;
- Number of revolutions of the spindle - 2860 min-1;
- The maximum movement of the table – 200x630 mm;
- Maximum speed of the table – 18 m/min;
- Maximum work piece dimensions – 630x200x320 mm.

- ✓ Tools - grinder

A grinder marked as 2B 46 J 6V was used made by “SWATY" Tovarna umetnih brusov, ISO 525. Dimensions of a grinder are 250x35x26.

- ✓ Specimens

To test the force of grinding were used specimens of titanium alloy T-A6V dimensions ϕ 51 mm, thickness 10 mm.

- ✓ Measuring place

A measuring chain consisted of a dynamometer Kistler 9257 A is used for FXO span> f = 5-10 kN connected to the adapter, that was still sending a signal to SPIDER 8, that is connected to the laptop where we record the values of force and the time interval in which measuring is made for. Recording and processing of measurement results in digital format was done on the computer. Recording force values is obtained on the basis of processing 120 specimens from 2400 measurements per second.

Spider 8

Picture 3. Instruments for Measurement

- ✓ Measurement Results

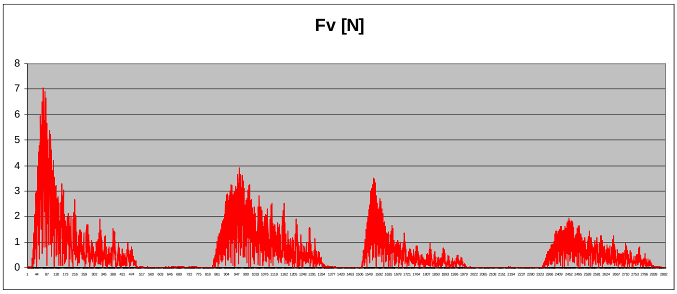
Table 1. The results of measurements of vertical and horizontal components of the grinding resistance

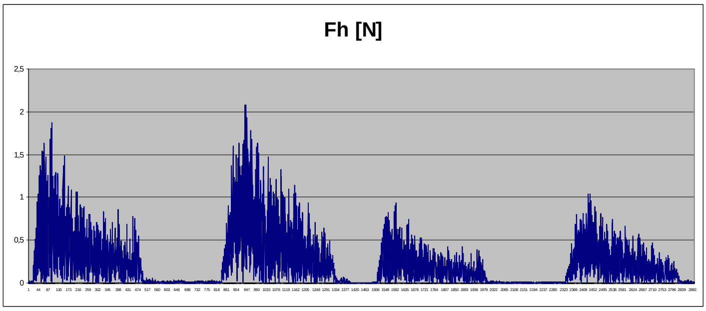
	Feed rate of a table s [mm/o]	Debth of Cutting t [µm]	Speed of a table v [m/min]	X0	X1	X2	X3	Fv [N]	ln Fv	Fh [N]	ln Fh
10	4	0,015	7	1	1	1	1	8,26	2,11	2,79	1,03
2	1	0,015	7	1	-1	1	1	8,17	2,10	3,38	1,22
14	4	0,005	7	1	1	-1	1	7,52	2,02	1,99	0,69
17	1	0,005	7	1	-1	-1	1	8,68	2,16	2,66	0,98
29	4	0,015	3	1	1	1	-1	8,79	2,17	3,59	1,28
6	1	0,015	3	1	-1	1	-1	7,20	1,97	1,87	0,63
7	4	0,005	3	1	1	-1	-1	6,59	1,89	2,52	0,92
4	2	0,0087	4,5826	1	0	0	0	6,61	1,89	2,63	0,97
16	1	0,005	3	1	-1	-1	-1	6,59	1,89	2,01	0,70
22	2	0,0087	4,5826	1	0	0	0	6,50	1,87	2,48	0,91
23	2	0,0087	4,5826	1	0	0	0	6,48	1,87	2,53	0,93
25	2	0,0087	4,5826	1	0	0	0	6,28	1,84	2,76	1,02

Mathematical processing of the data obtained, we come to the following conclusions:

$$F_v = 8{,}65 \cdot s^{0{,}01206} \cdot t^{0{,}08304} \cdot v^{0{,}13899} \left[N\right]$$

$$F_h = 4{,}68 \cdot s^{0{,}07111} \cdot t^{0{,}17419} \cdot v^{0{,}11386} \left[N\right]$$





Picture 4. The clip strip format forces Fv and Fh

3. CONCLUSION

1. Processing of titanium alloys is very difficult and it must be paid a special attention on the problems that occur at that time more than on the treatment of conventional materials. Manufacturing systems with increased rigidity are especially needed.
2. Processing of titanium alloys by grinding is difficult because of poor thermal conductivity as well as it is caused relatively high ductility (titanium is soft, it lutes on the desktop grinding), and then because of the hard oxide layer (800-900 HV) occurring long standing in air,
3. In grinding of titanium greater depths, and relatively low speed of processing objects, they have been noticed torched places (that explains the poor thermal conductivity of titanium). Use of grinding wheel softer than these that have been used would probably give better results.
4. It is possible to achieve quality of IT6 and IT7 by processing methods that have been applied, and in some cases IT5, too (choose a larger grain grinders compared to conventional materials).

4. REFERENCES

[1] Ekinović S.: Postupci obrade rezanjem, Univerzitet u Sarajevu, Mašinski fakultet u Zenici, Zenica, 2003.
[2] Cebalo R.: Duboko brušenje, Školska knjiga, Zagreb, 1990.
[3] Jurković Z.: Modeliranje i optimizacija parametara obrade primjenom evolucijskih algoritama kod inteligentnih obradnih sustava, Doktorska disertacija, Tehnički fakultet Rijeka, Rijeka, 2007.
[4] Taguchi G., Sayed M., El. M., Hsaing C.: Quality Engineering and Quality Systems, McGraw-Hill, NY, 1989.
[5] Ekinović S.: Metode statističke analize u Microsoft EXCEL-u, Mašinski fakultet u Zenici Univerziteta u Sarajevu, Zenica, 1997.
[6] Haznadarević L., Mišković A.: „Appendix to the study of thermal condition by process of grinding", Naučni skup "MATRIB '05", Vela Luka, 2005.
[7] Haznadarević L., Kevelj J.: „Optimalno područje brušenja titanovih legura", 3rd International Conference on Computer Aided Design and Manufacturing CADAM 2005, September 27th – October 1st 2005, Supetar – Brač, Croatia.