ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XV, NR. 1, 2008, ISSN 1453 - 7397

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Statistical Modeling of a Considering Work-Piece

In this article are presented the stochastic predictive models for controlling properly the independent variables of the drilling operation a combined approach of statistical design and Response Surface Methodology (RSM).

***Keywords**: work-piece, modeling, statistical model*

1. Introduction

The stochastic predictive models for controlling properly the independent variables of the drilling operation a combined approach of statistical design and **R**esponse **S**urface **M**ethodology (RSM) are followed.

Statistical design of experiments refers to the process of planning the experiment so that the appropriate data can be analyzed by statistical methods, resulting in valid and objective conclusions.

RSM is a collection of mathematical and statistical techniques for the modeling and analysis of problems in which a response of interest is influenced by several variables along with visual representation of this effect at different levels of these variables.

2. Experimental

The model factors (independent variables) are quoted in Table1 and the response variables are given in Table2.

For better manipulation of the equations, the independent variables will become dimensionless and the factors are given coded values that correspond to low level (-1), medium (0) and high (1) (Table3).

Table 1. Drilling model factors (Physical values)

Model factors			
Work-piece material Maximum strength (daN/mm^2)	**Drill diameter D (mm)**	**Feed s (mm/rev)**	**Rotational frequency n (rev/min)**
X_1	**X_2**	**X_3**	**X_4**
Al 5005 (~15)	8	0.1	81
St 37 (~40)	12.5	0.2	226
		0.3	637

Table 2. Model response (dependent) variables

Model response variables			
Axial force F (N)	**Torque M (N cm)**	**Average roughness R_a (μm)**	**Dimensional error ε_D (mm)**
Y_1	**Y_2**	**Y_3**	**Y_4**

Table 3. Assignment of coded values to the model factors

Coded values			
Work piece material	**Drill diameter D**	**Feed s**	**Rotational frequency n**
X_1	**X_2**	**X_3**	**X_4**
-1	-1	-1	-1
1	1	0	0
		1	1

3. Results

The factor exhibiting the highest influence on the axial force is feed, followed by work-piece material and drill diameter; cutting speed has a lower influence, whilst the Diameter*Feed, Material*Feed and Material*Diameter appear also significant.

The most significant factor of the torque model is the drill diameter; feed and the work-piece material follow in influence. Cutting speed has a negligible effect and the Diameter*Feed interaction is significant.

Work-piece material has by far the dominant effect on average surface roughness variance; follow in influence the cutting speed square, the Material*Diameter interaction and the drill diameter.

Considering the hole oversize model, feed is found to be the most significant factor; the Material*Diameter interaction and the workpiece material are less significant.

In Table4 comparative results are shown regarding the statistical validity and the most significant factors of the developed models.

Table4. Validity assumptions and statistically most significant factors of the stochastic models

	F (N)	M (N cm)	R_a (μm)	ε_D (mm)
R^2	0.959	0.979	0.412	0.403
Conformity to hypotheses	full	full	partial	partial
Statistically more significant factor	Feed	Drill diameter	Work-piece material	Feed
Statistically most significant interaction	Diameter*Feed	Diameter*Feed	Material*Diameter	Material*Diameter

From the above table it can be observed that the conclusions drawn via the primary tests converge to those arrived at by the modeling; feed has the dominant influence. Also, an important role is played by the work-piece material and the drill diameter.

Once the statistical significance and predictive power of the models for torque and axial force have been accepted, there is a need of experimental control and verification. This was enabled by considering data from the primary tests corresponded to levels of factor values not employed in the models.

4. Conclusions

The models developed for surface roughness and dimensional error have fair correlation with the control drilling factors; thus, these models are just indicative and not reliably predictable.

References

[1]. Alauddin M., M.A. El Baradie, M.S.J. Hashmi, "Computer-aided analysis of a surface-roughness model for end milling", Elsevier, *Journal of Materials Processing Technology* 55, 1995, pg. 123-127.
[2]. Anghel C.V., Petropoulos G. – "*Multi-parameter analysis of surface finish in electro-discharge machining of tool steels* ", Analele UEM Reşiţa, Fascicola de Inginerie, Anul XIII, ISSN 1453-7394, Ed. "Eftimie Murgu", Resita, 2006
[3]. Svilen Rachev, Spirov D.– "*Dynamic study of synchronous machine electric drive",* Analele UEM Resita, Fascicola De Inginerie, Anul XII, nr.1, ISSN 1453-7394, Ed. "Eftimie Murgu" Resita, 2005

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