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OPTIMIZING TOOLS DIAMETERS AND TOOL PATH STYLE TO IMPROVE TIME MACHINING

BY

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Abstract. In the global market, the time to deliver parts according to the technical requirements in the shortest time with minimal cost became imperative. This paper present the experimental study to optimize the time machining necessary to work a die cast made from H 13 material.

For optimization is used a software that allow to the operators to employ a data base of tools with associated speeds and feed rates. Also the software has a range of tool paths that can be used for machining.

This allow to the operators to increase the productivity and decrease the time machining.

Key words: time machining, optimize tools diameter, optimize tool path.

1. Introduction

The mechanical production in the manufacturing industries represents a key element that influences the economical performances of the companies.

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Preparing the fabrication, means to involve machines, tools and procedures to generate the designed product with the specified tolerances and relating to delivery time.

The software and hardware evolutions, allow to engineers to propose the special object representations that helps to simulate the processes.

Machining process is a very complex mechanism that involves many changing parameters.

Optimizing cutting conditions using an appropriate software that has the ability to calculate time machining, helps significantly the engineers on their actions.

The researchers (Tamizharasan & Senthilkumar, 2014), (Tamizharasan & Senthilkumar, 2012), had analyzed the effects of variation in cutting tools geometries, both experimentally and by simulations, and the best tool that can be used has an alternating tool geometry (Senthilkumar, Tamizharasan & Anandakrishnan, 2014), (Senthilkumar & Tamizharasan, 2014), (Senthilkumar & Tamizharasan, 2014)

In the case of the complex surface conventional machining, the feed rate will be set as a constant value for the all the tool paths. This will increase the machining time and also will increase the wear of the tools.

Some studies on that direction are carried out by (Wang, 1988), (Takata, Tsai, Inui & Sata, 1989), (Altan, Shatla & Yen, 1998), (Jerard, Fussell & Ercan, 2001) that had developed different process planner to modify the feed-rate and the spindle speeds.

2. Method Explanation

In order to avoid the premature tool breakage and the premature wear of it and to create a smooth surface for the mold, the surface finishing is critical.

Also, is very important to use the machine to the full capacity and to extend the tool life time to the maximum to obtain the desired surfaces qualities and to improve the time machining.

The operators should optimize the selection of the tool diameter and tool paths for the best configuration regarding the part machining.

Using all of those parameters and a software tool for simulations, we should be able to optimize the machining time.

Table 1
Chemical Composition of H 13

Composition	C	Si	Mn	Ni	V	Cr	S	P	Cu	Mo
%	0.32-0.45	0.8-1.2	0.2-0.5	0.3	0.8-1.2	4.75-5.5	0.03	0.03	0.25	1.1-1.75

The material used is H 13, is an air hardening chromium die steel. The higher vanadium content ensures increased resistance to heat checking and all round improvement to properties at elevated temperatures. Tools may be water cooled without risk of cracking. After normal heat treatment has been carried out it is suitable for nitrating 0.30mm deep.

The chemical composition of the H 13 is presented in table 1.

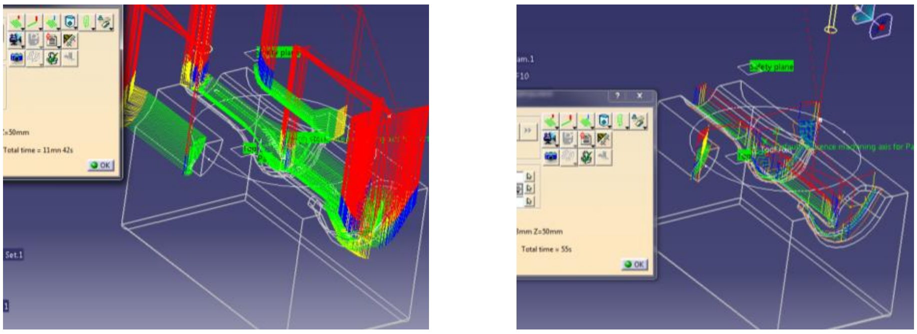
The experiments were carried out on a CNC vertical center machine OKUMA MB 46 VAE. The machining is wet using mineral emulation Blasocut from BLASER.

3. Selecting of Cutting Tools and Tool Paths

In our simulation we will use WALTER end mill Prototyp Qmax HNR with different tools diameter (6, 8, 10) for roughing. The spindle speed proposed by tool producer is 200 m/min for 4 tooth and the feed per tooth is presented in the following table 2. The machining time is also presented in Table 2.

Table 2
Feed per tooth

a_p	Diameter	f_z mm/tooth	Time machining			Additional time machining
			Helical	Zig-zag	One way next	
0.5	6	0.07	11’42’’	12’57’’	14’11’’	0
0.5	8	0.12	8’01’’	9’43’’	10’25’’	48’’
0.5	10	0.15	6’35’’	6’52’’	7’52’’	55’’



(a) (b)

Fig. 1 – Time machining for the tool with diameter of 10 mm (*a*) ; Time machining for the reworking areas (*b*).

This machining time isn’t the real one because the machined volume isn’t the same for all tools due to the part configuration. The solution is a reworking of the machining areas with a smaller tool (Fig. 1).

Also in table 2 is presented is presented different tool path solutions with the time machining necessary to perform the machining.

For finishing, in our simulation software we will use 2 operations. One for semi finishing to smoothing the scallop heights (Fig. 2) and a second one for real finishing to obtain the desired surface quality.

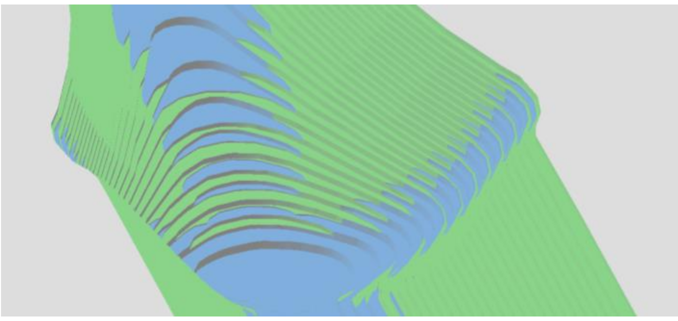


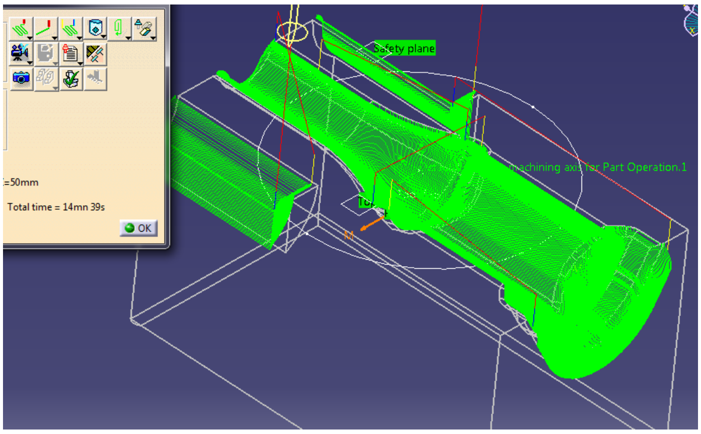
Fig. 2 – Surface quality after roughing

For semi finishing, the tools used during the simulations are WALTER ball-nose end mill Protostar 30 with different tools diameters (4, 6, 8). The spindle speed proposed by tool producer is 220 m/min for 2 tooth and the feed per tooth is presented in the following table 3.

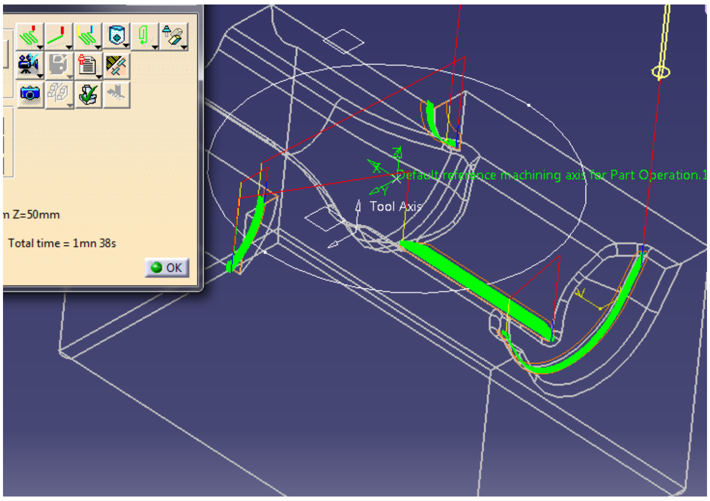
Table 3
Feed per tooth

a_p	Diameter	f_z mm/tooth	Time machining/tool path		Additional time machining
			Sweeping perpendicular to part profile	Sweeping parallel to part profile	
0.2	4	0.06	20’58’’	25’52’’	0
0.2	6	0.08	19’03’’	23’05’’	49’’
0.2	8	0.15	14’39’’	17’47’’	1’38’’

Also in table 3 is presented different tool path solutions with the time machining necessary to perform the sweeping operations with the selected tool path.



(a)



(b)

Fig. 3 – Time machining for the tool with diameter of 8 mm (*a*) ; Time machining for the reworking areas with the tool with diameter of 4 mm (*b*).

In Fig.3 is presented the tool path for the ball-nose end mill with diameter of 8 mm for semi finishing and the reworking areas left from the sweeping operation machined with the ball-nose end mill with diameter of 4 mm.

For smoothing the escallop heights after roughing operation, the surfaces are machined with a sweeping operation like presented in the Fig. 4. The yellow is surface machined by the 8 mm ball-nose end mill and the magenta surface is the 4 mm ball-nose end mill.

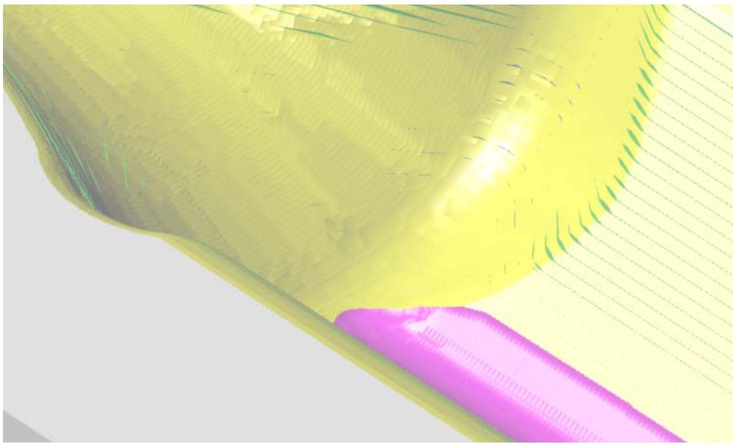


Fig. 4 – Surface quality after sweeping for semi finishing

For finishing, the tools used during the simulations are WALTER ball-nose end mill Protostar 30 with different tools diameters (4, 6, 8). The spindle speed proposed by tool producer is 220 m/min for 2 tooth and the feed per tooth is presented in the following table 4.

Table 4

Feed per tooth

a_p	Diameter	f_z mm/tooth	Time machining/tool path		Additional time machining
			Sweeping perpendicular to part profile	Sweeping parallel to part profile	
0.2	4	0.06	29’58’’	34’52’’	0
0.2	6	0.08	26’03’’	30’05’’	2’15’’
0.2	8	0.15	18’54’’	25’06’’	3’24’’

Also in table 4 is presented 2 different tool path solutions, sweeping perpendicular to part profile, sweeping parallel to part profile and additional sweeping path, with the time machining necessary to perform the sweeping operations with the selected tool path.

In Fig.5 is presented the quality surface left by the tool path for the ball-nose end mill with diameter of 8 mm for finishing and the reworking areas left from the sweeping operation machined with the ball-nose end mill with diameter of 4 mm.

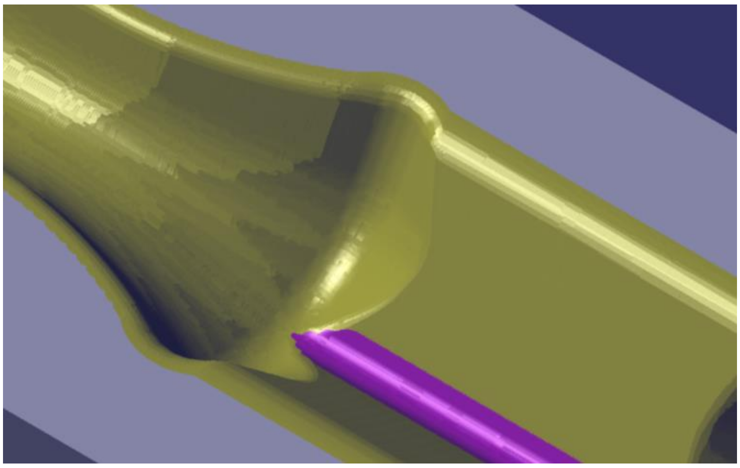


Fig. 5 – Surface quality after sweeping for finishing

5. Conclusions

In this article we have been interested by tool paths based on tools diameter and its parameters, calculating the machining time based on that chosen strategy.

The surface quality is one of the important aspects of the customer's needs for machined parts.

The optimization is essential for time machining. On one hand is the time gained and on the other hand is employing on the right way the tools.

The optimum time machining is obtained for roughing for the 10 mm end mill tool diameter, for semi finishing is sweeping perpendicular to part profile for the 8 mm ball-nose end mill with additional machining with 4 mm ball-nose end mill and for finishing is sweeping perpendicular to part profile for the 8 mm ball-nose end mill with additional machining with 4 mm ball-nose end mill.

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OPTIMIZAREA DIAMETRELOR DE ASCHIERE ALE SCULELOR ASCHIETOARE UTILIZATE SI A TRAIECTORIILOR ASOCIATE PENTRU IMBUNATATIREA TIMPULUI DE PRELUCRARE

(Rezumat)

Pe piața mondială, livrarea pieselor respectând cerințele tehnice, în cel mai scurt timp cu un cost minim a devenit imperativ.

Această lucrare prezintă un studiul experimental pentru a optimiza timpul de prelucrare necesar prelucrării unei matrițe de forjare la cald realizata din materialul H 13.

Pentru optimizare, este utilizat un software care permite operatorilor să utilizeze o baza de date cu scule aşchietoare cărora le sunt asociate viteze de aşchiere si avansuri.

De asemenea, software-ul are o serie de traiectorii pentru sculele aşchietoare care pot fi utilizate pentru prelucrare. Acest lucru permite operatorilor creșterea productivității și reducerea timpului de prelucrare.