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IMPROVEMENTS ON CNC MULTITASKING LATHES TO MACHINE COMPLEX PARTS

CURTA, R[azvan] T[raian]; BALC, N[icolae]; CAREAN, A[lexandru] & POPAN, A[lexandru]

Abstract: *The paper presents a comparative study about the complete machining of complex parts in one setup on CNC multitasking lathes, towards complete machining of the same parts on CNC turning centers and CNC machining centers, where are needful more setups of the machines. Increased productivity and precision of the machining can be attained in the simplest way, by decreasing the number of the part clamps and the number of the employed machine-tools. This paper recommends the use of the CNC multitasking lathes, a modern technology that creates the possibility to machine the parts completely on a single machine tool, in one setup.*
Key words: *CNC machining, turn-mill, CAD/CAM, driven tools, productivity.*

1. INTRODUCTION

One of the CNC machine tools greatest benefits, is the fact that they are highly productive. In order to increase the productivity and the quality of the machining on CNC machine tools, one of the greatest but difficult to accomplish desire of the CNC programmers is to machine the whole part in a single setup (Curta & Cărean, 2009). Therefore, the CNC lathe manufacturers have added to the standard lathe with turning capabilities several new capabilities specific to CNC machining centers, such as milling and drilling capabilities. Thus, they have saved at least one machine setup and related handling. With technology advancing at a very rapid rate, it became possible to provide not only some rather simple milling capabilities, but also many very complex machining processes as well.

The turret of such a multitasking lathe, having usually 12 stations, contains not only stationary turning tools, but also driven tools which rotate due to their own power source. This used modern technology is known as the turn-mill operation with driven tools, rotary tools or live tools (Kriangkrai & Bohez 2008).

The term “turn-mill” reflects the actual cutting activities more accurately – turning machine with milling capabilities. The provision of driven tools on CNC turning centers is the first step towards multi-process machining, that incorporates various turning and many milling applications, multiple turrets and chucks, subspindles, automated part reversal and part transfer and many other features.

Any major change in machine design will influence the programming methods. New features and design changes (as significant as milling on CNC turning centers) will bring different programming methods and the inevitable challenges associated with it (Hiroyuki, 2007; Yildiz, 2005).

The main design features of any multi-process machine are focused on reducing setup time. Once the initial setup has been made, complete parts can be machined without operator’s interference. As expected, the main benefits include single setup for multiple operations. Turning and milling operations of some of the parts, previously undertaken separately, have now been combined into just one setup.

2. CASE STUDY AND RESULTS

In order to highlight the advantages of the machining on CNC turning centers with milling capabilities, we consider the machining of the test part presented in figure 1 and figure 2.

Fig.1. Reprezentative part

The test part material is Aluminum and the 3D model was designed in SolidWorks 2008 software. The final dimensions of this test part are: Φ100 mm the maximum diameter, and 120 mm the final length. The process planning presumes a laminated workpiece of Φ102 mm diameter and 122 mm length and involves only CNC machine tools. The CNC programs and technical documentation were designed with SolidCAM 2008 software.

Two technological variants are considered in order to optimize the process planning. The first variant analyses the machining on 3 types of CNC machine tools, namely a 2 axes standard CNC turning center, a 3-axes CNC milling machine and a 4-axes CNC vertical machining centre. The second variant analyses the complete machining of the part on a single CNC machine tool, namely a 3-axes CNC multitasking lathe, using driven tools.

Accordingly to the first technological variant, the process is composed by 6 operations and 6 setups. The first operation, the complete turning of end 1 of the part and the second operation, the complete turning of end 2 of the part were performed on a 2-axes CNC turning center LYNX 220 type, with FANUC 0i-TB control, from the Technical University of Cluj-Napoca, TUCN.

The operation 3, the milling of the triangular pockets of end one (figure 2) and operation 4, the complete milling, respectively drilling and of end 2 of the part were performed on a 3-axes milling machine TM-1 HAAS Toolrom Mill type (TUCN).

The 5-th and 6-th operation, the milling of the radial surfaces can be performed only on at least 4-axes CNC machine center.

The machining strategies corresponding to the five operations (external turning, internal turning, profile milling, pocket milling, drilling, threading etc.), were analyzed in SolidCAM software, in order to obtain the minimum time. The selected tools were Sandvik Coromant type.

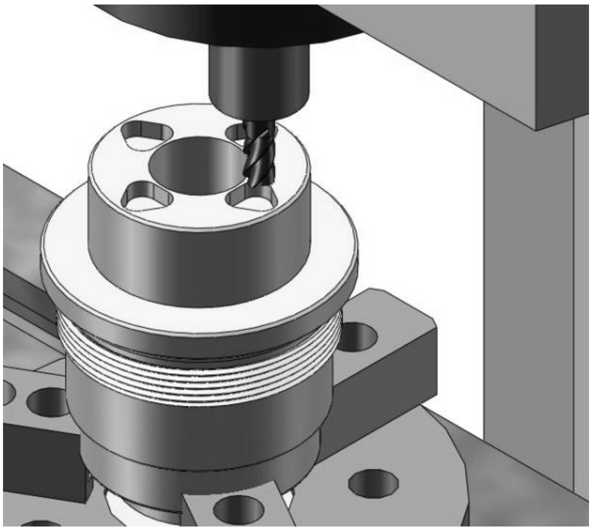

Fig. 2. The shape of the part after operation 3(first technological variant)

The cycle times corresponding to the six operations (6 setups of the part on 3 types of machines) of the first variant, depending on the tools and selected cutting conditions are the following: 3.27 min for the complete turning of end 1; 6.52 min for the complete turning of end 2; 2 min for the complete milling of end 1; 6.67 min for the complete milling of end 2; 3.2 min for the radial milling 1; 9.68 for the radial milling 2. The total cycle time is 31.34 min.

The total machining time per part (Cărean, 2006), considering a batch of 800 parts per month is 32.18min/part.

The second technological variant presumes the complete machining of the part on a single machine tool in two operations. This CNC machine tool is a 3-axes CNC turning center with driven tools, Topper TS-1000 type.

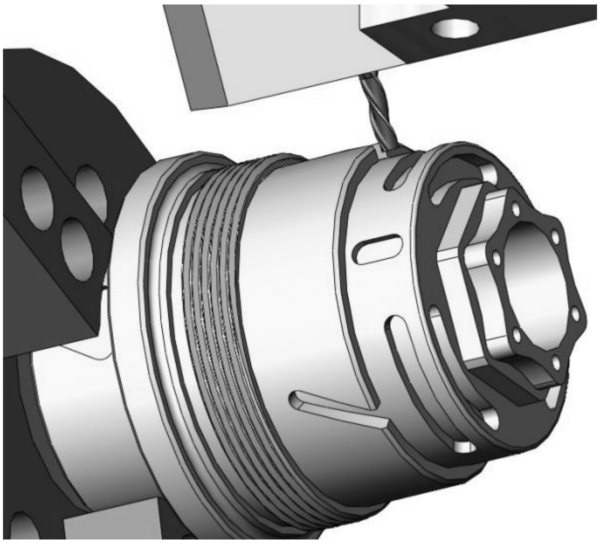

Fig.3 The shape of the part after the last operation(second technological variant)

The first operation is the complete machining of end 1 (face turning, exterior rough and finish turning, drilling and internal turning, face milling and radial milling). This operation gathers all the machining phases from the operations 1, 3 and 5 of the first technological variant, thus we save two machine tools and two setups.

The cycle times obtained after optimizing the turn-mill process in SolidCAM software, when machining on CNC multitasking lathe according to the first operation belonging to the second variant are the following: 0.18 min for the face turning; 0.91 min for the rough turning; 0.23 min for the finish turning; 0.88 min for the drilling; 0.81 min for internal turning; 1.7 min for the face milling; 2.81 min for the radial milling.

The cycle times obtained after optimizing the turn-mill process according to the second operation (complete machining of end 2) are the following: 0.18 min for the face turning; 1.7 min for the rough turning; 0.5 min for the grooving; 0.85 min for the finish turning; 1.58 min for the threading; 0.88 min for the drilling; 0.73 min for internal turning; 0.51 min for the profiled milling 1; 1.68 min for the profiled milling 2; 1.91 min for the slot milling; 1.56 min for the drilling of 6 holes; 5.68 min for the radial milling 1; 3.11 min for the radial milling 2 (figure 3).

The total cycle time for the both operations (complete machining of end 1 and complete machining of end 2) is 28.39 min.

The total machining time per part, considering a batch of 800 parts per month is 28.72 min/part (Cărean & Cărean, 2006).

The analysis of the two technological variants reveals that the total machining time of the part in the second variant is reduced with 3.46 min/part. That means that the productivity is increased with 12.07%. In the same time, the number of the machines employed in the process was reduced from 3 to 1 machine tool and the number of setups from 6 to 2.

3. CONCLUSIONS

The comparison between the two technological variants of machining described in this paper, brings into light that the machining of cylindrical parts with complex surfaces (plane surfaces, profiled surfaces, different type of linear/circular slots or holes on a diameter or on the face) on CNC turning centers with driven tools is preferable and completely justified, instead of useing three machine tools, such as a CNC standard lathe, a 3-axes CNC milling machine and a CNC vertical machining center.

The main advantages of machining the complex parts on CNC turning centers with milling capabilities are:

- Decreasing the number of the CNC machine tools by concentrating several operation in just one operation, performed on a single machine;
- Increasing the machining precision by machining the part in just one setup;
- Increasing the productivity by decreasing the time related to setups.

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