

Method Of Shelf Machining On The Milling CNC Machine Tools

Sergey S. Kugayevskii
Ural Federal University,
Ekaterinburg, Russian Federation
cad-cam@mail.ru

Abstract — In this paper the issues of accuracy assurance of part machining at CNC machine tools are considering. The method is proposed for accuracy assurance of the surfaces set not from technological base. Such method is based on preliminary measurement of dimension between “0” point and base surface using special device. At control program is using local coordinate systems which are linking with measured dimensions of constituent links. Local coordinate systems can be effectively used when machining “rotary body” type components at turning CNC machine tools or for machining conditions of box-like parts at milling CNC machine tools. It means that for all technological dimensions tightening of tolerances specified by the drawing will be not necessary. Application of device for adjustment “0” point of control program outside machine tool allows refusing expansive special basing fixture. At the result the preparation time for machine operation is reduced and cost of basing fixture put down.

Keywords — *dimensional analysis, CNC machine tool, coordinate system, preliminary measurement*

I. INTRODUCTION

Modern engineering manufacturing is based on application of CNC machine tools. Incidentally the most effective is application of multiprocessing machine tools of turning and milling machine configuration, which make possible to process large quantity of surfaces using one component locating. For accuracy assurance of location of such surfaces is implementing interoperational dimensional analysis [1].

Various methods of calculation of dimensional chains are applied depending on the required accuracy and seriality of production. The method of a maximum minimum (max-min) [2] and probabilistic method [3] are the most widespread. Means of reducing error in the Machining of Housing Components with Cast Holes are analyzed in [4].

II. DISTINCTIVE FEATURES OF DIMENSIONAL ANALYSIS FOR MACHINING AT CNC MACHINE TOOL

When machining at CNC machine tool in use is one component locating. Increasing of surface location accuracy connects with reducing setting and fixing error due to reduction of component locatings. However the problem is arising when some of the surfaces set by the designer from the base not coincide with technological base selected for current operation.

A. Specifics of dimensional analysis execution for machining conditions of box-like parts at milling CNC machine tools

The simplest example of assignment boss dimensions shown in Fig. 1.

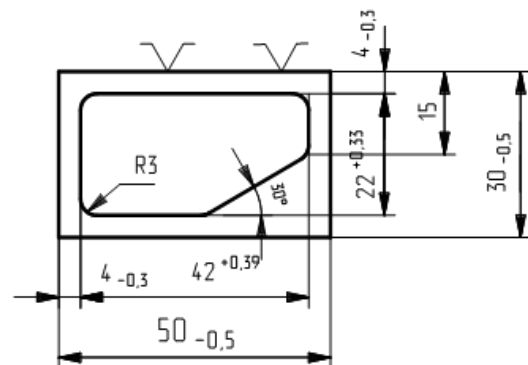


Fig.1: Assignment of dimensions at the drawing according to variant 1

Let assume tolerances of technological dimensions equal to tolerances of design dimensions. Implementation of dimensions during the course of machining at this case does not have any difficulties. But calculation of dimension chain at such case is showing that variation of right shelf width is 1.19 mm (the sum of constituent links' tolerances). It will four times increase the tolerance of left shelf variation and will be 30% of shelf width nominal size.

But in many cases in terms of working conditions of product for designer is necessary provide equal shelf width. Variant 2 dimensioning at the drawing at this occurrence shown in Fig. 2.

When machining at universal machine tools such requirements easy to fulfill by consecutive

implementation of finishing operating steps with changing workpiece locating (Fig. 3).

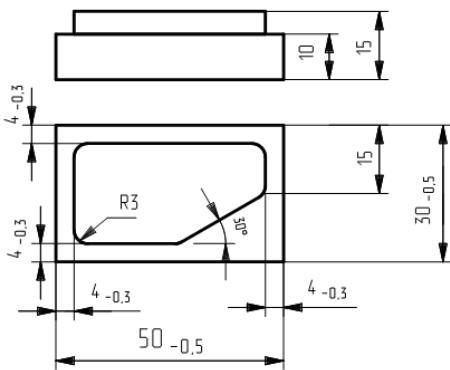


Fig. 2: Dimensioning at the drawing figure according to variant 2

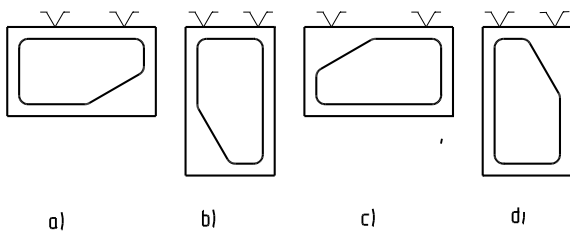


Fig. 3: Cut-map of the workpiece at universal machine tools with repositioning

Machining at CNC machine tool is doing using one locating. For checking of implementation of right shelf width accuracy assurance at CNC machine tool necessary to fulfill dimensional analysis design diagram of which is showing in Fig. 4.

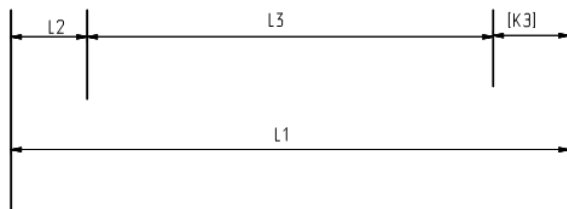


Fig. 4: Dimensional diagram when using traditional coordinate system according to variant 2

Let assume the economically feasible values of tolerances for overall size L1 and for setting size L2 from locating device base. Precision of the dimension L3 of internal boss circuit depends of control program calculation validity and technological system's errors (machine tool, locating device, cutting tool, machining component). In such cases is saying that dimension L3 is internal for given operation.

Set: $T_{L1} = 0.1$; $T_{L2} = 0.15$; и $T_{L3} = 0.3$.

Dimension K3 (fig. 4) is closing dimension spreading of which equal the sum of component links' tolerances. Spreading of dimension K3 (0.3) equate to tolerance T_{K3} .

Then: $T_{K3} = T_{L1} + T_{L2} + T_{L3} = 0.1 + 0.3 + 0.15 = 0.55$ (mm).

Consequently for given dimension system required tolerance of dimension K3 (0.3) cannot be provided. The result of dimensional analysis at this case is the conclusion that tolerances of constituent links (technological dimensions) including overall size is necessary to tighten up.

B. Using special probe system

Toughening of tolerances on the technological sizes are not always possible therefore now the method of the automated measurement of overall dimension by means of the special probe system [5] is widely applied (Fig. 5).

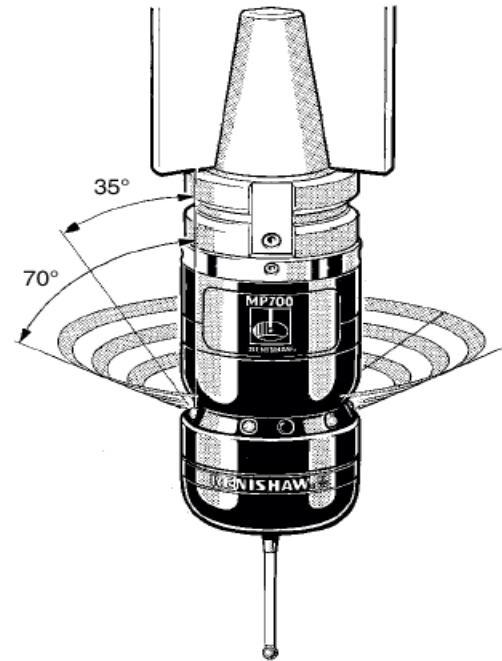


Fig. 5: The MP700 Probe System (Optical Machine Interface Variant)

In this case, the auxiliary time of operation connected with control process raises.

III. USING LOCAL COORDINATES FOR MILLING OPERATION

Let review a concrete example of processing of ledges on the milling NC machine (Fig. 6). In the reviewed example the shelf for installation of the cutting plate into the turning cutter is processed.

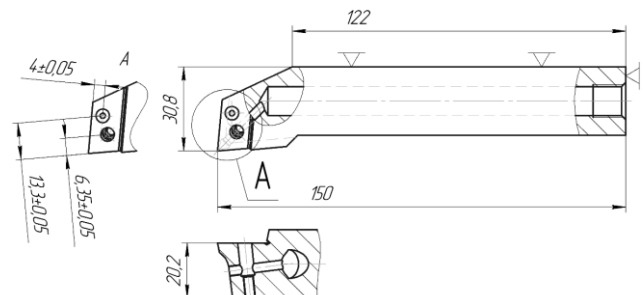


Fig. 6: Example of a task of shelf borders from adjusting base

Technological bases are longitudinal and cross cutter faces and the width of a shelf is set from the opposite side. In this case, the accuracy of shelf borders arrangement will be influenced by errors of overall dimensions of a cutter. At absence probe system in this case it is possible to use shuttle pallet and local coordinate system for ensuring accuracy of shelf borders arrangement according to the drawing.

Tightening technological dimensions' tolerances is not always possible. That is why will be introduced another variant of machining.

Known that when designing the control program (CP) for CNC machine tools there is the possibility for assignment of reference point coordinates from several local "zeros" using preparatory G-functions G54, G55, . G59 [6,7].

Under study example (Fig. 6) is possible to specify at NC code coordinates from different local "zeros" as shown in Fig. 7.

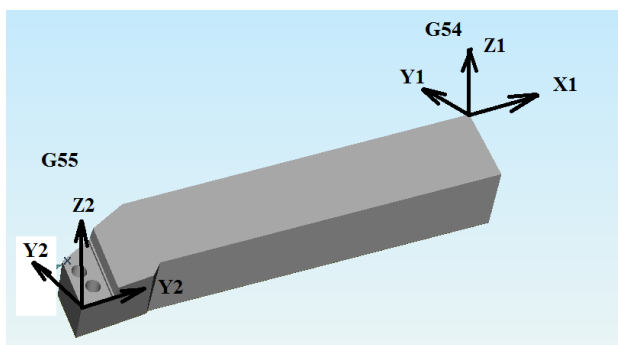


Fig. 7: Using local coordinate when design control program.

At this case is not necessary to tighten tolerances of overall sizes and other chain constituent links (technological dimensions). But another task is arising – point "O₂" (fig.7) will have different values of coordinates X₂ and Y₂ for each component at coordinate system X₁O₁Y₁ (G54). It means that before machining of each component necessary to measure it overall dimensions and input to NC unit additional coordinate system X₂O₂Y₂ (G55). For example it is possible to measure values X₂, Y₂ at coordinate inspection station before locating component at CNC machine tool. Special device for adjustment "0" point outside machine tool (Fig.8) was designed in Ural Federal University [8].

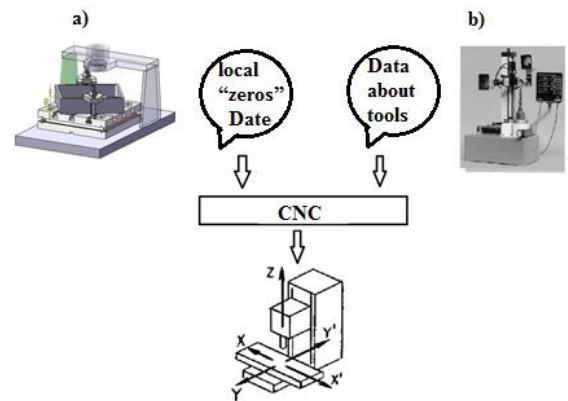


Fig.8: Measurement of local "zeros" coordinates on shuttle pallet (a) and measurement data about overhangs and diameters of tools outside machine tool (b).

Shuttle pallet is placing on device plate and information about coordinates X₁O₁Y₁ (G54) and X₂O₂Y₂ (G55) is reading after this by measurement unit and input to NC unit of machine tool. Using similar device also possible to receive data about overhangs and diameters of tools in tooling setup. The possibility of refusing work piece locating at special arrangement also seems as advantage of such method because simultaneously with coordinate measurements of zero points O₁ и O₂ possible determine a swivel of corresponding coordinate systems relative to the base of shuttle pallet.

IV. SUMMARY

- 1 Introduced method allows providing location accuracy of which are specified not from technological base when machining at CNC machine.
- 2 Method may be used for programmed milling and turning machining operations.
- 3 Application of device for adjustment "0" point of control program outside machine tool allows refusing expansive special basing fixture.

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