Problems of using tool assemblies in CAM system

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Abstract.
This article is devoted to the main problems of using tool assemblies in the CAM system when developing control programs for CNC machines using the example of Siemens NX9 CAM system. One of the main difficulties in developing control programs is the likelihood of mismatching tools in the CAM project and in the cell of the machine shop, and therefore this requires the use of measures to reduce the risk of errors. Using libraries of tool assemblies automates the work of a programmer-technologist due to the availability of ready-made tool models and ensures consistency of cutting conditions between different CAM projects. NX9 has two options for creating an instrumental assembly and their libraries: by manually entering information and using automatic data import. When automatically importing information about a tool, it is necessary to standardize the description of the tool and its components in accordance with certain standards, such as ISO 13399, therefore, without the use of a single standard, creating a tool library is impossible. The example of creating a parametric instrumental assembly by manually entering information demonstrates an increased risk in the event of an error, as well as the need for a complete description of the tool.

1. Introduction
Tool assembly is an assembly consisting of a cutting tool, plates (in the case of using a collection tool) and an auxiliary tool for fixing the cutting tool on a CNC machine tool. At the development stage of the control program (CP), there are several problems associated with Tool assemblies. The first problem is the possible error of a programmer-technologist or a CNC machine operator when using the tool assembly. The mismatch of the tool number in the CAM project and the tool number in the cell that was laid with this number can lead to defects, tool breakage, cause damage to the machine and production downtime. The second problem is the high probability of an error in the CP due to an incorrectly described tool in the CAM system. The error can be made when manually entering information, transferring incorrect data, as well as the necessary information from the tool manufacturer is absent. The third problem is ensuring the same cutting conditions when machining different parts made of the same material.

2. Accounting for instrument assemblies
A large number of tool assemblies can be used in a technological operation. The tool used in the CAM project is installed on the machine. To prevent errors of mismatch of tool assemblies in the CAM project, additional accounting of tool assemblies performed by programmers-technologists is necessary, for example, in the form of a table (an example is given in Table 1) with an indication of the tool and its T-
number. The main graphic data in the accounting table of tool assemblies should be: assigned tool number, tool designation, interchangeable polyhedral plates, in the case of using a replaceable tool, mandrel or tool holder, designation of parts where the tool is used, the tool value from holder, for example, when using a collet chuck. This information is used simultaneously by means of a machine for collecting tool assemblies and programmers-technologists. Thus, the maintenance of standard tables excludes the possibility of unauthorized access to the cutting tool. The table for tool assemblies should be based on the principles of universal applicability for the less number using the less nomenclature tool [1-3]. However, the selection of a universal tool should not lead to a decrease in processing performance. To calculate the number of duplicate tool assemblies on the machine with knowledge of the tool life.

| № | Name of the cutting tool, mm | Name of the cutting part | Manufacturer | Name of the cutting tool | Recognition of the cutting tool | Manufacturer |
|---|-------------------------------|--------------------------|--------------|--------------------------|-------------------------------|--------------|
| 1 | T1                           | insert                   | XNKT06405PN  | KORLOY                   | Cutter body                  | RM3PCM3020   |
| 2 | T2                           |                          |              | SR-MM PC3600             | Centering drill              | A1115-12     |
| 3. Creating libraries of instrumental assemblies

Modeling tool assemblies is a crucial process, since all coordinates are the use of tools for precision, milling, drilling and other processes using the CAM system with interrelated assembly parameters and their movement in the CAM project relative to the tool trace points. To develop and use simulation checks, an electronic library of tools imported into the CAM system for 3D models or created by technologically programmable tools for systems with manual input of values from catalogs is required [4].

3.1. Problems of creating MRL libraries

Many industrial CAM-systems cooperate with production-controlling tools and equipment in order to create a library of technological resources - a library of production resources (hereinafter - the MRL library). These compatible solutions of manufacturers of tools and CAM systems simplify writing and improve the reliability of CP. The work of the MRL libraries, by the example of Siemens NX9, is carried out with the help of special algorithm in the Teamcenter library of the above-mentioned component system from supplier catalogs. Recording according to the tools is described in special tools in NX. Thus, automatically populated data for parametric assemblies appear.

For an optimal transfer and translation of information about the instrument, standards of description are necessary. Currently, there are several standards for the description of the cutting tool, for example, ISO 13399, developed by large tools and tooling SANDVIK COROMANT together with the Royal Institute of Technology in Stockholm [5]. This standard establishes terms in which the components constituting
the cutting tool are indicated with the exception of the elements for machining and connection the tool for the machine tool. This standard does not support a direct classification of geometry forms, which limits its use. It should be noted that the ISO 13399 standard has a comprehensive classification that makes this standard difficult to use without a specially configured XML template. Another limited representation is GD & T (geometrical dimensions and tolerances) with accuracy checks and rules that do not correspond to high semantic accuracy. Currently, CAM system developers need to establish and maintain data integration based on many standards and develop convenient data transfer methods, for example, using the ISO 13399 tool, which is output in file using STEP AP214 (ISO 10303-214 their integration). [6-13]. Currently, there are problems with creating a single MRL library, which can lead to laboriousness and translation errors. To facilitate the work on creating the MRL library, there is such special systems search, as tools used to export data in DIN4000 and ISO13399 / GTC formats, as well as in exporting 2D and 3D geometry to DIN4003 and DIN SPEC 69874 formats, but due to the lack of a set of manufacturer’s required values, obtaining information in the electronic library can be impossible.

3.2. Creating a library of tool assemblies by manually entering information

Creating a library of tool assemblies is a manual entry of the values of parametric assemblies in the CAM system. To create a library by manual input, it is necessary to analyze information from different catalogs, recorded according to different internal standards of description, and there may be a lack of certain values, such as the depth of the hole in the collet chuck or the distance from the clamping screw to the end of the Weldon cartridge. With a lack of information about the instrumental assembly required measurement of the missing parameters of the measuring tool. Most of the tool manufacturers will introduce in the catalogs their designations that are different from a single standard, therefore, for each individual standard, it is necessary to create algorithms for converting tool values from a paper catalog to model parameters in the CAM system.

CAM systems have limited capabilities for entering the parameters of an existing tool, for example, the parameters are used to describe the drill in the CAM NX9: D (diameter), PA (apex), PL (tool length to the point of tracing), CR (angle radius), L (length), FL (cutting edge length), number of teeth, material. In the value set for drill description there are no additional parameters for a detailed description of a body drill with an FCP type insert (Iscar). Since the CP coordinates in the drilling cycle are calculated relative to the tool tip, then as a result, the Z coordinates in the drilling cycle will be displayed incorrectly, without taking into account the tip on the flat plate.

Figure 1. A simulated parametric model of the drill in the CAM system

To drill a hole with a depth of 22 mm in the cylindrical part, it is necessary to write a CP using a parametric model of an instrumental assembly consisting of a 460.1-1450-044A1-XM GC34 SANDVIK COROMANT carbide drill, collet cartridge A111414 32 070-SANDVIK and ER32x16 KFH collet. With all the parameters entered, we obtain the following program. For the experiment, we change the angle at the apex of 140º to 120º for a parametric tool; we get another CP that is different from the real instrument.
Table 2. Comparison of the effect of the value of the angle at the tip of the drill to get the CP through NX9

| Drill point angle is 140° | Drill point angle is 120°  |
|-------------------------|---------------------------|
| %                       | %                         |
| N0010 G40 G17 G90 G71   | N0010 G40 G17 G90 G71    |
| N0020 G91 G28 Z0.0      | N0020 G91 G28 Z0.0       |
| N0030 T01 M06          | N0030 T02 M06            |
| N0040 G00 G90 X0.0 Y24.5 S0 M03 | N0040 G00 G90 X0.0 Y24.5 S0 M03 |
| N0050 G43 Z3. H01      | N0050 G43 Z3. H02       |
| N0060 G81 Z-24.6388 R3. F250. | N0060 G81 Z-26.1858 R3. F250. |
| N0070 G80             | N0070 G80               |
| N0080 M02            | N0080 M02              |
| %                     | %                        |

As can be seen from the comparison of the coordinates of the tool movement along the z axis in Table 2, the difference in depth in the drilling cycle G81 (block No. N0060) is about 1.5 mm. With an increase in the diameter of the drill, the difference in the depth of drilling increases, which can lead to a spoilage in production.

To determine the exact number of duplicates necessary, it is necessary to ensure the unity of processing conditions. In the library, created by manual input, NX CAM implemented the function of automatically setting cutting modes for a specific tool in the library of tool assemblies, when specifying the material of the cutting tool and processing method, thus ensuring consistency of tool wear [14]. Between CAM projects, the processing conditions will be ensured, and, therefore, the same tool consumption will be provided, which will be useful when analyzing production resources.

4. Conclusion

When developing a CAM project, it is necessary to take into account tool assemblies in order to eliminate possible inconsistencies both in other projects and in the machine shop cell. The risk of receiving a defective product when the parametric and real cutting tools do not match is great in all other machining operations, when milling, turning, boring, threading, etc. in the same way as an auxiliary tool. When using sets of tool assemblies from different manufacturers, it is necessary to take into account that many manufacturers work by their standards, which is especially evident when analyzing an auxiliary tool. Thus, manual input of information reduces the performance and accuracy of the development of CP. To avoid errors of manual input of information, as well as the absence of physical values, the coordinated work of the developers of CAM systems and manufacturers of cutting tools in the form of MRL libraries is necessary. At the same time, a single standard is needed for the description of tool assemblies, to which all tool manufacturers must adhere.

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