

COPUTER AIDED DESIGN OF FIXTURES FOR NC MACHINE TOOLS

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Abstract: *There are shown some tendencies in the increasing of requirement related to the quality and production cost at the manufacturing from view of Jigs and Fixtures Design in this article. New conditions of Europe market causes that the new methods and techniques are needed to develop also in this area and the computer can help at the fixture creation, too.*

Key words: *fixtures and jigs, CAD/CAM systems, coordinate systems*

1. INTRODUCTION

Fixture in machinery is a clamping mechanism for securing a part in a specific orientation. It positions part for machining, welding, or assembly operations, but permit cutting tools to find their own path. Jigs position parts for machining operations such as drilling, milling, reaming and boring, and they physically guide the cutting tools. Then jigs are used in operation without NC control of manufacturing process.

Today's trend in industry is to reduce the required parts inventory for repeat orders by keeping the manufacturing information (NC program, tools setup etc.) in electronic form. This procedure allows companies to operate more efficiently and without tying up substantial portions of their capital in static inventory of slow-moving parts.

To use the fixtures at the creating and simulating of the manufacturing process via computer, it is necessary to define the fixture setup for the manufacturing model. Each fixture setup contains information about the fixtures that are presented in the model when the setup is active. This fixture setup can be used to manipulate fixtures within the manufacturing model. Because the fixture setup contains the fixture assembly information, each fixture setup of manufacturing model has to be explicitly defined, unlike sites or tools. Fixture setups can be defined at the time of setting up an operation or at any time between NC sequences.

2. FIXTURE CREATING IN CAD

From the CAD system view the fixtures are parts or assemblies that help orient and hold the workpiece during a manufacturing operation. Fixtures can be created in Part or Assembly mode of CAD module and saved in CAM module for preparing CAM operations. Generally the creating of the fixture by means of computer has several advantages:

- Fixtures can be created as needed during the intermediate process steps by referencing the workpiece.
- In many causes user can use the library of manufacturing fixtures (clamps, holding plates, chucks and jaws) of generic sizes.
- The fixtures can be redefined, modified or edited during the modelling process.
- Already exist feature can be used as the basic for the creating of new feature.
- New component of the fixture assembly can be created and added.

- Unnecessary component of the fixture assembly can be deleted or removed.
- It can be redefined the placement of fixture component very simply.
- The creating of fixture drawings or individual components, when they were modelled, is very quickly and simply, too.
- All changes in the fixture are automatically transformed into the drawings.
- It is possible to assembly the model of manufacturing part and the model of fixture and so early recognize the mistakes of modelled fixture.
- All data can be saved and stored in electronic form without of the need of paper. Data can be transported via the storage medium and sent by means of mail other electronic ways.
- The simulation of the machining process on the computer is very useful for the fixture designer and for more easily selection of the best variant of suggested fixture.

For use of the fixture in the manufacturing process the fixture setup for manufacturing model must be defined. These setups are depending on the dimension tolerances and dimension chains, which are defined by designer of manufactured piece. Manufacturing process designer must be able to analyse parts and propose types of required locating, supporting and clamping devices, complete economic analysis of a fixture design.

3. COORDINATE SYSTEMS

Coordinate systems are one of the elements of operation and NC sequence in CAM system. They define the orientation of the workpiece on the machine and act as the origin (0,0,0) for CL data generation.

Generally can be find two types of coordinate systems in CAM programs:

- Machine – Acts as the default origin for all CL data. This coordinate system is specified at the time of operation setup using the program zero.
- NC Sequence - Affects all the NC sequence data, such as retract surface and cut feed direction

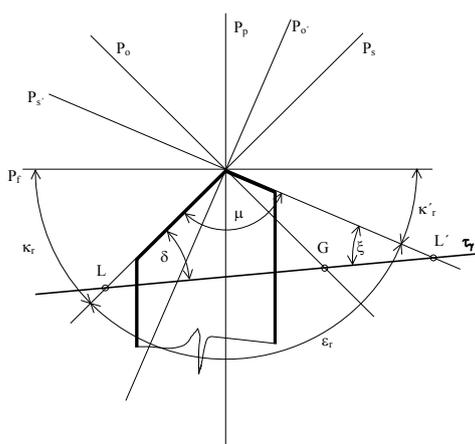


Figure 1 Scheme of relation of tool geometry for calculation of angles for combination 1, 2, 7 and 8 according to table 1

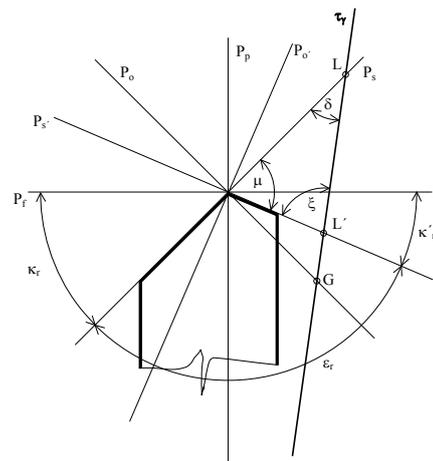


Figure 2 Scheme of relation of tool geometry for calculation of angles for combination 3 - 6 according to table 1

Coordinate systems can belong to the design model, to the workpiece, or to any other component of the manufacturing assembly. Some problems with defining of coordinate systems can be obtained in case use of cutting tool definitions according to tool-in-hand or

tool-in-use system. Possible combinations of geometry characteristics for cutting tools are show in table 1 and schemes of tool geometry relations for calculations of angles are in figures 1 and 2.

Table 1 Combinations of angles ε_r , γ_o and λ_s for tool-in-hand system

Combination	Cutting edges shape from view to corner of tool	ε_r	γ_o	λ_s	μ	
1		$> 90^\circ$	$\geq 0^\circ$	$\geq 0^\circ$	ε_r	
2		$\leq 90^\circ$	$\geq 0^\circ$	$\geq 0^\circ$		
3		$> 90^\circ$	$\geq 0^\circ$	$< 0^\circ$	$180 - \varepsilon_r$ or $(\kappa_r + \kappa'_r)$	
4		$\leq 90^\circ$	$\geq 0^\circ$	$< 0^\circ$		
5		$> 90^\circ$	$< 0^\circ$	$\geq 0^\circ$		
6		$\leq 90^\circ$	$< 0^\circ$	$\geq 0^\circ$		
7		$> 90^\circ$	$< 0^\circ$	$< 0^\circ$		ε_r
8		$\leq 90^\circ$	$< 0^\circ$	$< 0^\circ$		

The differences in definitions of coordinate systems for cutting tools and other features of CAM model must be solved by unification of coordinate systems principles for all components of this model.

To design and to make the good fixture is very difficult task, because the fixture must verify several requests at the same time (the request for accuracy, toughness...) and the fixture designer must know not only conditions of the fixture suggestion, but he must be good constructor and he must know the CAD/CAM system for the computer designing.

On these principles and with the use of computer (CAD/CAM system ProEngineer) it was suggested the fixture on the figure 3 for the positioning of the workpiece as show figure 4.

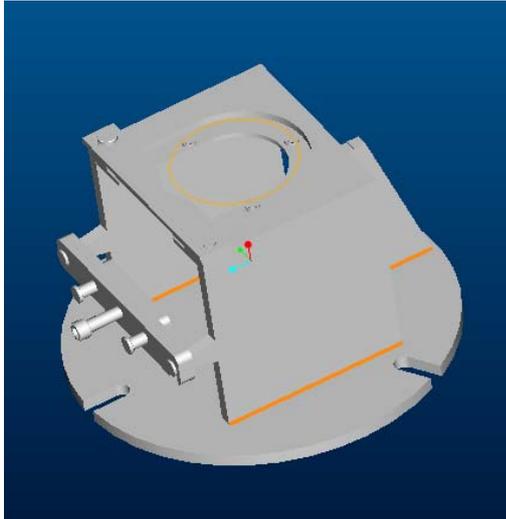


Figure 3 The modelled fixture



Figure 4 The positioned workpiece

4. CONCLUSION

Fixture design is the process of designing and developing the tools, methods, and techniques, which are necessary for the improving of manufacturing efficiency and productivity. It gives industry the machines and special tooling needed for today's high speed, high-volume production.

The main objective of tool design is to low the manufacturing costs while the quality and production are increased. To accomplish this, the tool designer must satisfy the more objectives – providing simple, easy-to-operate tools for maximum efficiency – reduce manufacturing expenses by producing parts at the lower possible costs – design tools that consistently produce parts of high quality – increase the rate of production with existing machine tools – design the tool to make it foolproof and to prevent improver use – select materials will give adequate tool life – provide protection in the design of the tools for maximum safety of the operator.

By help of modern design tools – computers and CAD / CAM programs – on this very hard way the manufacturers can work more quickly and more safety.

5. REFERENCES

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