Study of Reconfigurable Machine Tool-Design and Manufacturing

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ABSTRACT

The demand for efficiency and precession of CNC grows with advancing technology. From 3-axis to 4 or 5-axis machines are built to meet industrial demands, so does the number of studies and literatures regarding reconfigurable machine tools. The application of configurable units is between dedicated units and multifunctional CNCs. Dedicated units are selected for pieces to be machine for single products of mass production. If the pieces are in small quantity and large variety, highly priced multifunctional CNCs are a good choice. For other types of machining, the configurable machine tools may be considered. They have the potential of development and worth in-depth investigation and study in this regard. This paper is intended to focus on the development of reconfigurable modules of machine tool. First the modular categories of machine tool parts and components are established based on functions, kinetics and assembly needs. Then, introduction is given on how to separate the unit into primary and secondary modules from the point of view of direction from which the flow of force is directed, and unfit modules are eliminated from a selection of modules. Modules that meet the criteria are identified using this series of selection steps, and finally a limitation equation is brought in to identify machine tool modules that fit the cost function the most. By employing this sequence, designers will be able to come up with the best-fit module combination from a module library based on various needs, thus eliminating the need to redesign and redevelop a unit of the same specifications. It requires the replacement of necessary modules to modify the entire unit and no need for redesign, saving both time and cost. A modular method was introduced to simulate the establishment of a configurable unit. Preliminary structure design was performed after confirmation of specifications. Calculations were made to determine suitable key components, such as threaded rods and linear guideways, that meet precision requirements. For the selection of machining process, suppliers are sought out to satisfy the demands for costs and delivery deadlines. Parts and components to be machined are scrutinized for tolerance based on design drawings. After measurement, parts and components are placed in warehouse by categories. Standard assembly procedures and machine checklists are established to facilitate the assembly based on standard procedures and ensure the errors accumulated from allowable tolerance within control. The unit is energized and laser interferometer is used for positioning compensation. Circular tester is used for roundness test in order to meet the requirement of co-action interpolation error. Finally D-H modified notation is introduced for coordinate conversion program. CC path is converted to CL path to produce NC Code of machining. NC Code is imported into the control for machining and the precision of finished products is measured to make sure that the requirements of dimension in the design are met.

Keywords : modular、five-axis、D-H modified notation

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