Chapter 16

Technological Assurance of Manufacturing Effectiveness on CNC Machining Centers

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**ABSTRACT**

The chapter is devoted to the solving of the problem of increasing the efficiency of lever-type parts machining due to the introduction of flexible fixtures ensuring multi-axis machining. The relationship between the design and technological parameters of the parts were discovered, which is the fundamentals for the analysis of parts and the search for the fixture layout for the given production conditions. An innovative approach to the design of technological processes for lever-type parts machining is proposed, which is based on the principle of intensification of machining processes, design and technological features of the parts, functional and technological capabilities of modern metal-cutting machine tools. A mathematical model of machining accuracy of parts depending on the level of fixture flexibility is obtained. It is analytically and experimentally proved the feasibility of using flexible fixtures for multi-axis machining of lever-type parts in multiproduct manufacturing.

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INTRODUCTION

In a globally competitive environment of the rapid development and use of up-to-date technologies, the machine-building industry is permanently searching for the introduction of new and more efficient technological processes at manufacturing enterprises.

Modern approaches in manufacturing engineering are based on the delimitation of single units’ production and parts manufactured at contracting enterprises. Nowadays, in actively developing enterprises, the use of CNC machine tools is the predominant trend. The efficiency of their applications is substantiated by both the multi-nomenclature of parts and medium-size production. Increase of product nomenclature requires complication of design works on manufacturing technological equipment, especially fixtures. Multiproduct manufacturing causes frequent readjustments to the machining of parts from another type. This doubts the economic feasibility of designing and manufacturing dedicated fixtures. Consequently, the development of flexible fixtures is an urgent manufacturing problem. The fixtures should have the ability to readjust themselves into another size in a range determined by their technical characteristics. Additionally, the fixtures should have the ability to setting similar parts.

Intensification of technological processes and increase of the efficiency of technological equipment in the machine-building industry is one of the priority directions in the field of manufacturing engineering. This is especially important in the face of relatively fierce global competition. This is additionally confirmed by the fact that after the rapid development of advanced technologies, the machine-building industry is constantly introducing new and more efficient technological processes at enterprises all over the world involving modern equipment. Considering the simultaneous increase in the product nomenclature, the seriality factor, and the specific impact of multiproduct manufacturing, the development of flexible fixtures is the fundamental factor for ensuring high-quality production, for increasing productivity, and for reducing the complexity of the technological process.

Fixtures play an important role in ensuring the production of competitive products. This is confirmed by the fact that the ratio in the total amount of technological equipment is 70–80% (Karpus, Ivanov, Kotliar, Minenko, & Ivanova, 2012). The costs of technological preparation of production, design, and manufacturing of fixtures reach 90% (Karpus & Ivanov, 2012). The cost of fixtures is about 10–20% of the total cost of production systems (Bi & Zhang, 2001). Furthermore, up to 40% of defective parts in manufacturing engineering are due to poor fixture design (Ivanov & Pavlenko, 2018; Nixon, 1971).

Thus, due to the rapid development of technological capabilities of modern metal-cutting machines, as well as trends in the ability to perform multiaxis machining in a minimal number of setups, flexible fixtures can be successfully applied for machining complex parts on drilling-milling-boring machine tools. Particularly, based on data of the International Organization of Motor Vehicle Manufacturers in 2018 (World Motor Vehicle Production by Country and Type, 2019), the annual output of the automotive industry in the world reaches 95.7 million pieces.

Consequently, the focus of this research is the development and implementation of flexible fixtures as a topical scientific and practical problem. Solving this problem will allow manufacturers to reduce the time for readjustment.

The main aim of the research is to improve the machining of parts (i.e., levers) in terms of batch manufacturing by the systematization of machining objects with respect to design and technological features, as well as by development and implementation of flexible fixtures for multiaxis machining on CNC machine tools.
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