Rzeszow University of Technology Rzeszów, 2023
Faculty of Mechanical Engineering and Aeronautics
Department of Manufacturing Processes and Production Engineering

ABSTRACT OF DOCTORAL THESIS

Title: Minimization of the influence of temperature on the repeatability of the final characteristics of machined parts in numerical centers using real-time compensation
Author: mgr inż. Damian Basara
Supervisor: dr hab. inż. Leszek Skoczylas, prof. PRz

The doctoral thesis concerns the development and implementation of a method for compensating machining errors on a numerically controlled machine tool, resulting from changes in the temperature of machine elements and operating fluids. The developed method does not go beyond the technical means constituting the factory equipment of the machine tool. This approach is in line with the requirements set by the company where the research work is carried out. The dissertation contains a description of issues concerning the variety of sources of machining errors and methods of their compensation. The principle of operation of the CNC control system was characterized, taking into account the individual modules of the CNC controller. An analysis of the possibility of adapting the temperature compensation system in the Sinumerik 840D SL control system was carried out.

As part of the work, an original method was developed for quick control of the basic geometrical and setting parameters of the machine tool for periodic quick control of the technical condition. The method was based on measurements of the reference artifact using a measuring touch probe and measurement cycles. The developed method has been implemented for use within a flexible production line within which the machine tool being the object of research is installed. Tests were conducted to determine the measurement uncertainty with the touch probe in the system of the tested machine tool. In order to develop mathematical models of thermal displacements of the TCP, statistical data was collected during the actual machining processes of the AGB gearbox cover. An analysis of the significance of the influence of thermal factors on TCP drift was carried out by robust regression analysis. The final mathematical model was verified in terms of predictive capabilities on independent data from experiments simulating machining. The developed method of thermal error compensation using a series of IDS synchronous actions was tested in the Sinutrain environment. The solutions were implemented on the machine tool being the object of the research. Finally, the effectiveness of the developed solution was verified in production conditions during the processing of test parts.

The doctoral thesis showed that it is possible to effectively compensate for machining errors resulting from changes in the temperature of machine tool components and technical fluids, based on the factory equipment of the machine tool.