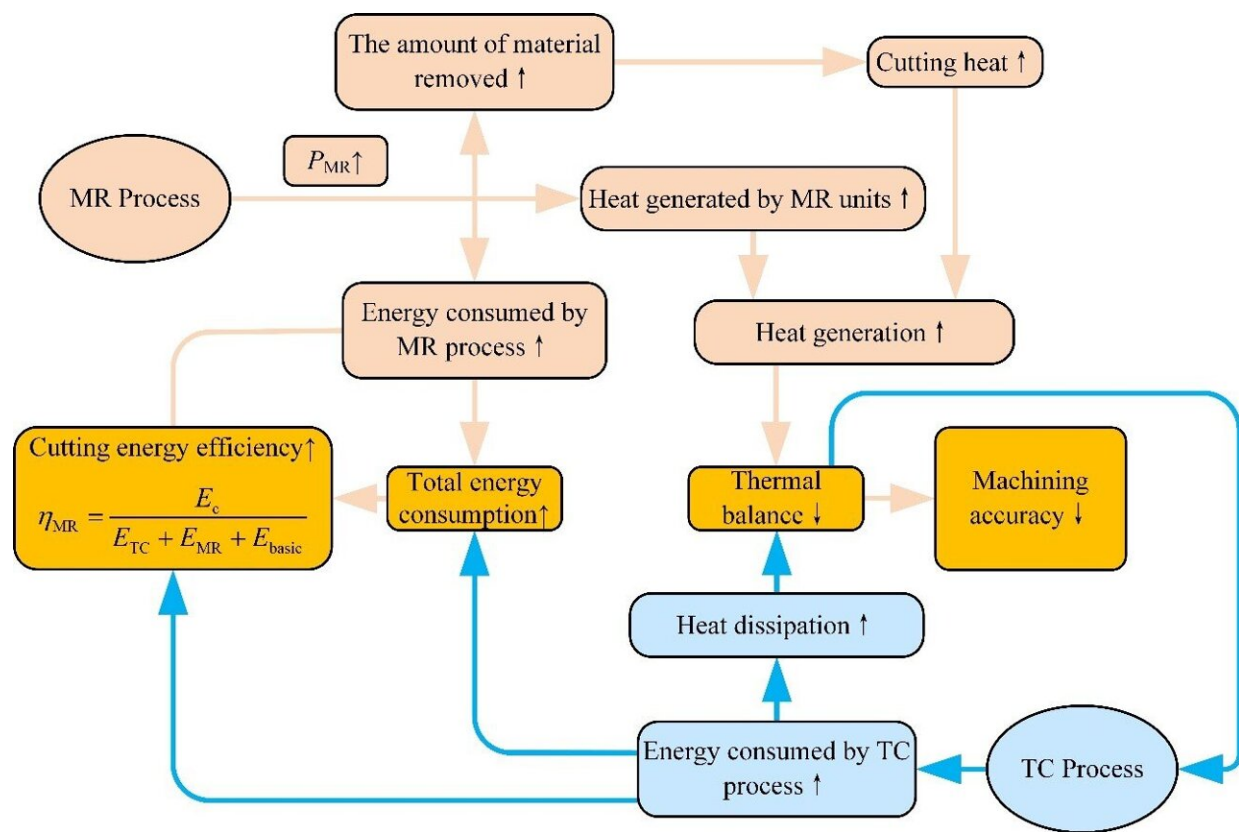


Exploring the the relationship between material removal and thermal control in machine tools

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Coupling relationship between the MR process and TC process of machine tools.
Credit: Kexu Lai , Huajun Cao , Hongcheng Li , Benjie Li , Disheng Huang

Recently, a research team from State Key Laboratory of Mechanical

Transmissions, Chongqing University of China has found the coupling relationship between thermal control (TC) process and material removal (MR) process of precision machine tools. The research team believes that the coupling relationship of the two functional processes can affect the machining accuracy and energy efficiency by influencing the thermal balance characteristics and energy characteristics of machine tools. This study can be found in the journal *Frontiers of Mechanical Engineering* on 29 April, 2022.

With the widespread adoption of [machine tools](#) in manufacturing, the energy consumption of machine tools has been a research hotspot and frontier for green low-carbon manufacturing. However, previous research merely regarded the MR energy as useful energy consumption and ignored the useful energy consumed by TC for maintaining internal thermal stability and machining accuracy. In pursuit of energy-efficient and high-precision machining, more attention should be paid to the energy consumption of TC and the coupling relationship between MR and TC. Therefore, this research team explores the coupling relationship between the two functional processes by using theoretical modeling and experimental analysis. The MR of a precision machine [tool](#) is a value-added process, as the power of MR increases, the energy characteristics will change, and the heat generation caused by MR will increase, synchronously. To ensure the thermal balance state, the TC will consume enormous energy to take away most of the heat generated by MR.

Traditional research is dedicated to improve cutting [energy efficiency](#) which is related to MR. But as machine tools become more sophisticated and machine tool users' increasingly demanding on machining quality, machining accuracy that is closely related to the thermal balance state has become an important index to evaluate the machining performance of machine tools. "There is an obvious mismatch between energy efficiency and machining accuracy, so how to achieve energy-efficient and precision machining collaboratively is a key research project to

improve the machining performance of precision CNC machine tools in the future," said Prof. Huajun Cao, the author of the study.

The research team of Prof. Huajun Cao is one of the pioneer research teams studying green manufacturing in China. This team has carried out extensive researches on green design and energy-saving technology of metal cutting machine tools, dynamic modeling and carbon efficiency evaluation method of manufacturing systems, and thermal balance control and thermal error compensation of precision machine tools.

"Exploring the coupling relationship between material removal and [thermal control](#) is the first step to improve the machining performances of precision machine tools, which is just from a qualitative perspective at present," said Prof. Cao. "In the future, we will continue our research on the coupling mechanism of 'electrical-mechanical-thermal' which is affected by MR and TC. This work can provide theoretical supports for machine tools to achieve high efficiency and precision machining goals, and promote the green and low-carbon development of precision machine tools."

More information: Kexu Lai et al, Coupling evaluation for material removal and thermal control on precision milling machine tools, *Frontiers of Mechanical Engineering* (2022). [DOI: 10.1007/s11465-021-0668-9](#)

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