Cyber-Physical Machine Tool

Cyber-Physical Machine Tool (CPMT) is the integration of machine tool, machining processes, computation and networking, where embedded computers and networks can monitor and control the machining processes, with feedback loops in which machining processes can affect computations and vice versa. The proposed CPMT is an application of CPS in the domain of manufacturing. CPMT shares common features with typical Cyber-Physical Systems such as networked, adaptive, predictive, cooperative, intelligent, with real-time feedback loops and with humans in the loop.

Components and functions

- Historical data recorder records the real-time data and provides them to outside applications for further decision-making and optimization activities;
- Machine-to-Machine interfaces allow the Machine Tool Cyber Twin to semantically communicate with other machines, enabling advanced cooperation between field-level production systems.

CPMT consists of four main components: CNC machine tool, data acquisition devices, Machine Tool Cyber Twin and Smart Human-Machine Interfaces (HMIs). The most significant difference between a CPMT and a traditional CNC machine tool lies in the Machine Tool Cyber Twin.

The Machine Tool Cyber Twin has three main functions:
- Information model and embedded algorithms and analytics tools take full advantage of the real-time data, endowing the machine tool with various autonomous functions by providing real-time feedback to the physical world;
- Visualization, Simulation, Optimization, PHM
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CPMT functions as a key enabler for the Cyber-Physical Production System (CPPS). The CPMT-centred CPPS enables not only the vertical integration of various smart systems at different hierarchical levels of a manufacturing system, but also the horizontal integration of machine tools with other field-level manufacturing facilities and resources. The realization of the CPMT-centred CPPS will lead to improved product quality, increased productivity and reduced production cost.