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Why use Multitasking Machines

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Learning Objectives

- Recognize the benefits of moving to a Multi-Tasking Machine
- Rethink use of current CNC Multi-Tasking
- Understand the complexities of Multi-Axis Machining
- Obtain higher value work for their shops

Description

In today's market, more and more parts are needing faster turnaround times at lower costs. Multi-Tasking Machines allow you to complete a part in a single operation while reducing your setup times. In this class, we will start with the history of Mazak as an organization and how they created the Multi-Tasking Machine market. We will cover the different architectures available in the industry and each of their benefits and shortcomings. From a functionality standpoint, we will discuss different types of synchronization, the reasoning behind each one, and their best case uses. By showcasing some examples through case studies, we aim to highlight the higher value work our customers can obtain by utilizing these types of machine to their full potential. Finally, we will look to the future and the use of Hybrid Multi-Tasking machines.

Speaker(s)

In his 29 years with Mazak Corporation, Rudy has led the Customer Support Team, the Regional Sales and Marketing Team and the Regional Manufacturing Engineering Team. He has worked with hundreds of customers over the years in many countries implementing a variety of Multitasking equipment. He specializes in assisting customers in reducing operating costs. He has successfully implemented large automated multitasking equipment at companies such as Caterpillar Solar Turbines, Senior Aerospace Ketema, Flowserve, Boeing Aircraft Company, Blue Origin, and Callaway Golf to name a few.

History and Current Situation of Multitasking Machine Tools

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Manufacturing industries are in intense global competition, and stricter demands for reduction in cost and total in-process time increase year after year. As a result, a production system that can produce a wide variety of components in small lot sizes in response to fluctuations in demand with small floor space requirements is strongly demanded. Our company has been responding to this challenge by process integration and high-efficiency machining methods using multi-tasking machine tools. In this article, we describe the development and history of such multi-tasking machines as well as examples of workpieces processed by this type of machine tool and examples of recently developed new functions.

Introduction

Manufacturing industries are in intense global competition, and stricter demands for reduction in cost and total in-process time increase year after year. As a result, a production system that can produce a wide variety of components in small lot sizes in response to fluctuations in demand with small floor space requirements is strongly demanded. Our company has been responding to this challenge by process integration and high-efficiency machining methods using multi-tasking machine tools.

Since multi-tasking machine tools have both functions of turning (the same as turning centers) and machining (the same as 5-axis simultaneously controlled machining centers which perform milling, end milling, boring, tapping, etc.), machining processes requiring multiple turning centers and/or machining centers can be integrated and run on a single multi-tasking machine. This article will presents the development and history of such multi-tasking machines as well as examples of workpieces processed by this type of machine tool and examples of recently developed new functions.

History of Multitasking Machine Tools

Multi-tasking machine tools have been developed originally from lathes. That is, normal lathes → CNC lathes → Multi-tasking lathes → Multi-tasking machine tools (lathe-based) → Multi-tasking machine tools (machining center-based). (See Figure 1.) The principaldifference between multi-tasking lathes and multi-tasking machine tools (lathe-based) lies in their milling capacity. During the development of multi-tasking lathes, the diameter of the milling spindle was small, it was thought that multi-tasking capacity limited to small-diameter drilling and tapping was adequate for multi-tasking lathes. But for multi-tasking machine tools (lathe-based), a spindle of 70mm or larger in diameter with sufficient milling capability to perform milling and also end milling was required. Unless multi-tasking machine tools have this milling capacity, machining by a machining center in a following process would be necessary. As a result, process integration was not sufficiently realized in many cases.

On the other hand, multi-tasking machine tools (machining center-based) have recently appeared on the market. These machines allow milling and turning of extremely-large-diameter workpieces which used to be transferred to a machining center for milling after completion of turning. Performing all processes on a single machine results in a significant reduction of in-process time.

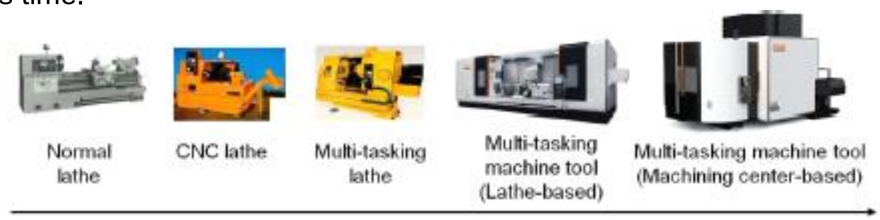


Figure 1

Multitasking Machine Tool structure and applicable parts

The typical structure of multi-tasking machine tools (lathe-based) is shown in Figure 2. It consists basically of 5 axes: 3 linear axes (X,Y and Z), a rotary C axis of the turning spindle, and a rotary B-axis around the Y-axis. In addition, if the machine has a second turning spindle, it consists of three rotary axes, and the Z-axis of the spindle which moves in the Z direction is added. Moreover, if the machine has a second turret, Z- and X-axis movements of the turret are added. A representative example of machining by a multi-tasking machine tool with such a structure is shown in Figure 3.

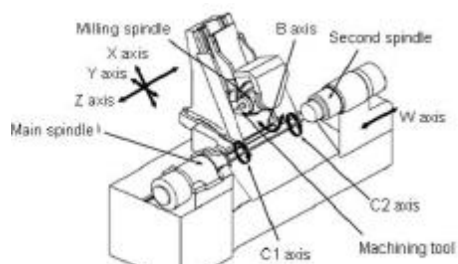


Figure 2

A typical structure of multi-tasking machine tools (Machining center-based) is shown in Figure 4. This is a machine with a horizontal machining center table whose rotational speed is increased to about 600rpm. Various machining processes such as turning can be performed by various tools mounted in the milling spindle which can swing in the B-axis direction. Having a ram spindle which corresponds to the second turret of multi-tasking machine tools (lathe-based) allows workpiece I.D. machining. A representative example of a workpiece machined by a multi-tasking machine tool with such a structure is shown in Figure 5.

Figure 3

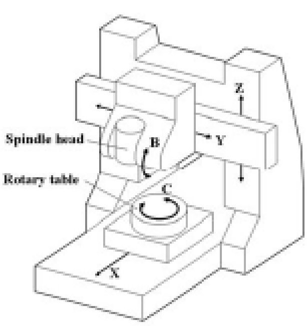


Figure 4

Figure 5

Additional Functions

Multi-tasking machine tools have been developed to integrate lathe and machining center processes. With the recent development of machines having advanced functions, multi-tasking machines are now capable of special machining which was previously considered as processes that were difficult to integrate. (See Figure 6). On the other hand, workpieces of difficult to machine materials increased, and there has been a challenge to reduce their machining time. Examples of process integration and highly-efficient machining methods in which the advantages of multi-tasking machine tools with advanced functions are utilized are shown below:

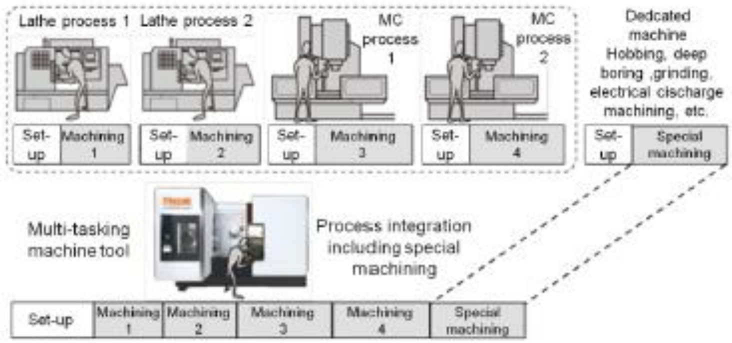


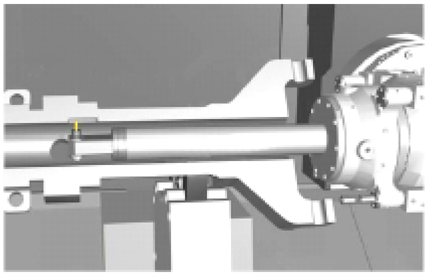
Figure 6

Deep boring

For aircraft landing gear (landing wheel struts) components, deep boring is required. For many deep boring applications, dedicated machines have previously been used because it is difficult to machine them by general-purpose machines.
A long boring bar system for such deep boring processes for multi-tasking machine tools is introduced here. This long boring bar is hydraulically clamped to the Y-axis lower saddle with a construction that ensures sufficient rigidity. Three long boring bars that can bore a 1000mm deep can be stored in a dedicated stocker. The inserts of some boring bars can be automatically replaced.

Deep Hole Milling

Keyway milling in deep-bores is difficult to be performed by a normal angle tool. For such deep-hole milling, a special high-rigidity tool holder for process integration by multi-tasking machine tools was developed. This special high-rigidity tool holder is clamped at four locations on the tool spindle surface and has a high-rigidity structure to withstand deep-hole milling. This special high-rigidity tool holder is stored in a dedicated stocker and automatically loaded/unloaded to/from the tool spindle.



Taper Boring

In tapered bore (conically shaped hole) machining of valve-related components, a fine finished surface is normally required for the purpose of high sealing property. Normally, tapered-hole boring cannot be performed by the milling spindle; however, it can be performed using a special U-axis tool. The U-axis tool has a control axis (U axis) in the radial direction of the tool spindle, and the tip of the tool can be controlled in the radial direction while the milling spindle is rotating. Complex inner taper or curved surfaces can be finished with high accuracy by the U-axis tool.

Hobbing

Components found in many industries – such as jet engines, energy, construction machinery and others, have gears integrated on shafts. Gear teeth are normally machined by dedicated machine tools such as gear hobbing machines. Gear hobbing can be performed by multi-tasking machines by synchronizing the spindle rotation with that of the milling spindle.

Mill Turning

Mill-Turning is performed by using a rotating milling cutter instead of a normal turning tool. The cutter rotates during cutting, then as with rotary cutting, the tool tip can be cooled while air cutting as well as reducing tool wear. High-efficiency machining can be realized by rotating the tool at high speed even if the workpiece is not rotated at a high speed, which is extremely beneficial for heavy-duty cutting of unbalanced workpieces as well as intermittent cutting. Additionally, this ensures the breaking of the machined chip for difficult to machine materials.

Closing

In this article, the history and structure of multi-tasking machine tools and how they are used recently have been introduced. A review of the history shows that a reduction of the total production lead time – from supply of raw material to the finished product, has been realized. Therefore, as long as there continues to be strong customer demands for higher efficiency, the evolution of multi-tasking machines will continue in the future resulting in further improvements in productivity.

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