Development of e500H Horizontal Machining Center

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We have developed the e500H Horizontal Machining Center to be a base machine for cell manufacturing systems and as a machine tool that leads its class in simplicity and cost performance. Based on the technology cultivated through our manufacturing know-how, the e500H, which features high cutting performance and productivity, comprises multiple cell-lines for customers' manufacturing.

***Key Words**: horizontal machining center, high speed, minimum floor space, roller guide*

1. Introduction

It has been a long time since the process-integration type flexible cell-line system configured by lining up multiple machining centers was adopted in the manufacturing of automotive components and so forth. In recent years, in line with the globalization of the market, requirements from customers have grown even more diversified, making it difficult to predict production volume, and creating a need for equipment that can respond more flexibly to multi-product variable-volume production.

In addition, while process-separate type transfer lines suited to mass production are adopted in the markets of newly emerging countries where capital investment is strong, a preference for process-integration type machining center cell-lines which require only a short time for production preparation and allow for early startup of production and profits is also beginning to emerge.

2. Development Aims

JTEKT markets the FH-J series as machining centers suited to cell-production and has been highly reputed. The e500H horizontal machining center introduced in this paper has been newly developed based on a machining center as a simpler and higher cost-performance machine for cell production. It inherits features of the FH-J series such as high productivity and easy adaptation with hydraulic jigs.

The e500H is able to form more diverse cell-lines by selecting specifications with or without a pallet changer depending on the customer's specific line configuration or by selecting from the two choices of a #40 or #50 spindle to match the process, etc.

Fig. 1 e500H Horizontal Machining Center

3. Features

Table 1 shows the specifications of the e500H while **Fig. 2** shows its overall configuration.

3. 1 High-Speed Performance

In order to achieve high productivity, the e500H has reduced cutting time and non-cutting time by adopting a high rigidity machine configuration able to withstand high-efficiency cutting and a greater feed speed.

The rapid feed rate and rapid feed rate acceleration are set to the highest levels in the class at 60 m/min and 9.8 m/s^2 respectively (X, Y and Z axes) and the B axis rapid feed rate rotating speed is set to 40 min^{-1} to shorten the positioning time. In order to achieve high-speed performance, sufficient rigidity is provided for the bed and the column that support moving body, the moving body table, etc., by using CAE analysis, and a roller guide is used on the feed unit to increase rigidity. In addition, as with the FH-J series, a high-speed cam type ATC unit is adopted to enable a tool change time as short as 2.5 seconds (C-C time, #40 spindle specifications).

Table 1 Main specifications

Specifications			#40 spindle	#50 spindle
Feed unit	X-axis stroke	mm	730	
	Y-axis stroke	mm	630	
	Z-axis stroke	mm	850	
	Rapid feed rate	m/min	60	
	Rapid feed acceleration	m/s^2	9.8	
Table	Size of working surface	mm	500×500	
	Max. workpiece envelope × height	mm	ϕ800×900	
	Workpiece allowable weight	kg	500	
Spindle	Spindle taper size	–	BT No. 40	BT No. 50
	Spindle rotation speed	min^{-1}	12 000	6 000
	Spindle output	kW	22/18.5	30/25
ATC	Tool capacity	Tools	20 (40)	20 (40)
	Tool change time	s	2.5 (C－C)	3.6 (C－C)
	Max. tool diameter	mm	ϕ140	ϕ285
	Max. tool length	mm	560	560
	Max. tool weight	kg	8	27
Control	CNC	–	MC50 (JTEKT) +TOYOPUC	
Floor space	Width × length	mm	2 200×3 650 2 330×4 570 (with APC)	2 745×3 650 2 875×4 570 (with APC)

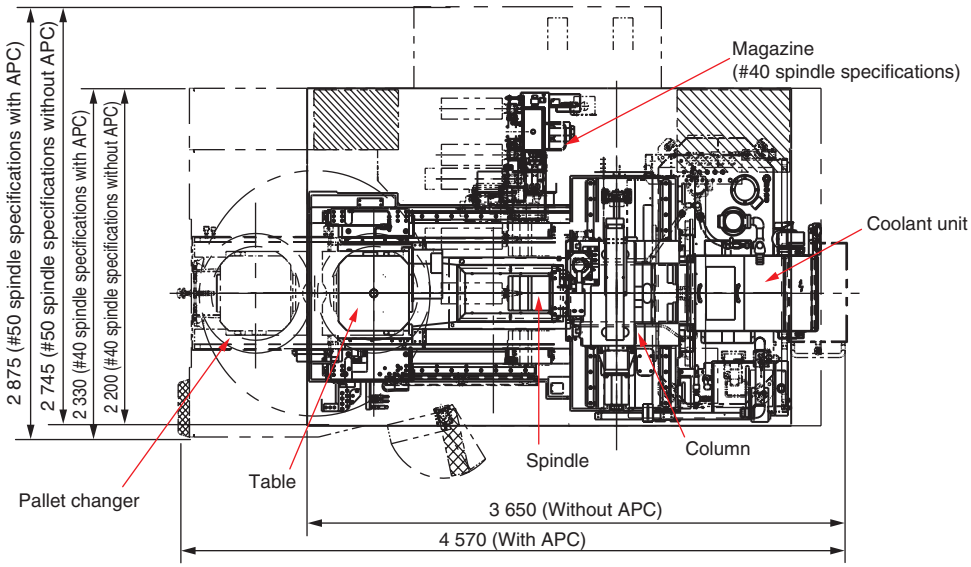

Fig. 2 Machine layout

3. 2 Space-Saving

Building a production line with smaller machines is important in terms of increasing space-production efficiency. On this machine, by adopting small devices and reviewing machine layout, the smallest floor space in the 500-square pallet class has been achieved, resulting in a reduction of 38% compared to the conventional machine. Furthermore, in spite of having the smallest floor space, the e500H has a wide workpiece area and, particularly due to a Z axis travel of 850 mm, workpiece runout and interference with long tools can be avoided, meaning that jigs can be designed with ease.

3. 3 High Accuracy

In order to stabilize positioning repeatability accuracy in component machining, a machine configuration with well-balanced heat distortion caused by ambient temperature change is important. On the e500H, rib configuration of the bed, the column, etc., is arranged thermally well-balanced by repeated heat capacity analysis using CAE.

In addition, the e500H offers the options of a spindle thermal displacement compensation function **(Fig. 3)** that corrects spindle elongation, a scale feedback function and a touch sensor function, making it possible for the e500H to handle machining with even higher accuracy.

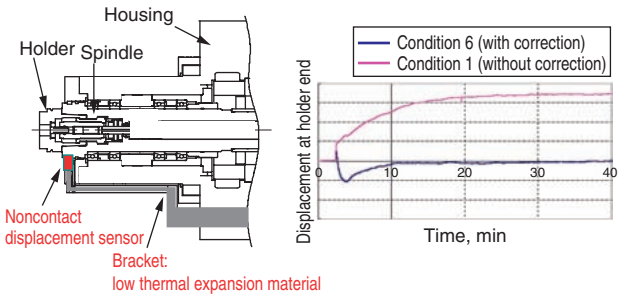

Fig. 3 Spindle thermal displacement compensation

3. 4 Easy Accommodation of Hydraulic Jigs

In today's production lines, where automation is becoming more and more prevalent, workpieces are often retained hydraulically. Generally in such cases, to supply hydraulic or air pressure to hydraulic jigs, either a hose suspended from the overhead cover must be connected to a distributor installed on jigs, or a large coupler device must be externally installed. Both of these methods sometimes either place limitations on jig design or generate high costs.

In the case of the e500H, 5 hydraulic ports and 3 air ports via distributors inside the table are standardly installed on the top of the pallet **(Fig. 4)** so that hydraulic oil and air can be supplied from the underside of the jigs. In this system, there is no hydraulic or air pressure supply element within the cutting area, therefore jigs can be configured simply and tooling can be designed with ease. Furthermore, hydraulic or air pressure ports can be switched using M codes as opposed to the conventional method which involved machine manufacturers' designing sequence circuits to suit each customer. This means customers are now able to program the jig operation cycle themselves to suit production preparation, jig change and so on. If a pallet changer is equipped, hydraulic pressure is constantly supplied by 2 ports on the table side.

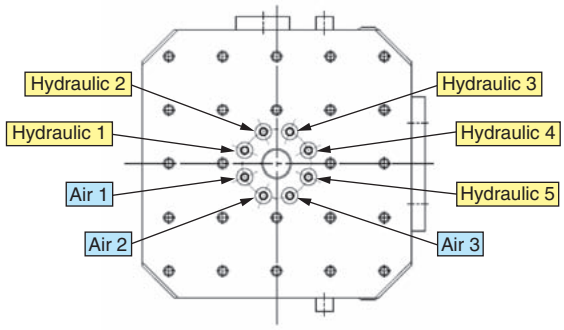

Fig. 4 Hydraulic pressure supply with pallet-through method

3. 5 Accessibility and Operability

Based on an assumption that workpieces will be set and removed manually, the e500H is designed to have a short distance from the pallet center to the front door. In addition, the front of the machine is open to the ceiling in order to allow the smooth loading and unloading of jigs and workpieces by cranes and other means, as well as to prevent cutting oil dripping from the cover ceiling onto the operator, etc. In the same manner, the side door for debugging work is also open to the ceiling, providing ample space and letting in light **(Fig. 5)**.

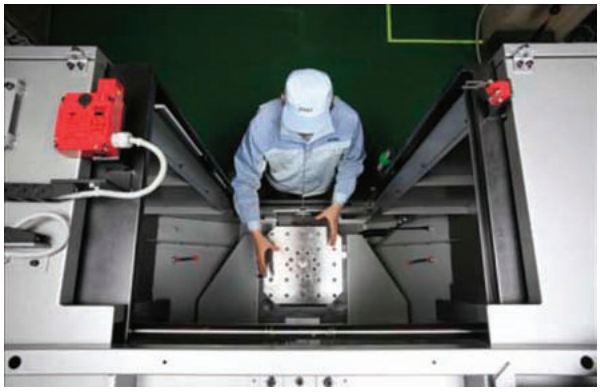

Fig. 5 Operator door

3. 6 Reliability and Energy-Saving

In response to the problem of chips accumulating inside the machining chamber which often arises in the machining lines of mass-produced components, a center-trough construction that can collect chips right below the cutting point is adopted by providing a large opening at the bed center and distributing chip flushing nozzles at the right positions around the ceiling, the bed chute, etc., inside the machine. For supplying cutting fluid to each nozzle, steel pipes and joints with low pressure-loss have been selected to achieve a configuration that can secure a sufficient flow rate without excessively increasing the pump size.

Furthermore, a grease lubrication system is adopted for the spindle bearings, the ball screw and the linear guide in order to reduce waste oil, oil mist discharge and the consumption of air, thereby enhancing environmental-friendliness and saving energy.

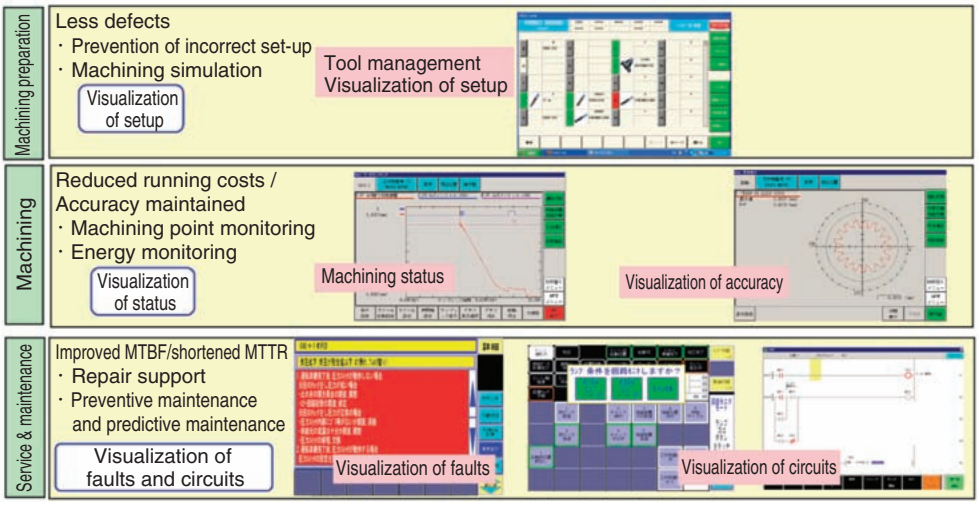

Fig. 6 Visualization achieved by MC50 and TOYOPUC

3. 7 Features of MC50 CNC Unit

The e500H is mounted with a CNC unit developed independently by JTEKT for cutting machines, the MC50, and the TOYOPUC®, which is highly reputed as a PLC that makes visualization easy. The MC50 is a personal computer-based CNC unit with refined NC functions for cutting, and it places particular emphasis on simple and easy maneuverability and high-speed technologies. The MC50 is accompanied by a HMI (human-machine interface), into which the extensive know-how acquired by JTEKT on production lines has been condensed, resulting in an easy-to-follow menu configuration broken down into operation levels such as daily tasks, setup work and maintenance work, and a maintenance screen that makes abnormal conditions and recovery methods clear even without knowledge on electrical sequence circuits or the experience of skilled maintenance personnel.

4. Conclusion

Today, with the world's production bases relocating to emerging countries, Japanese component manufacturers must produce faster and more flexibly in the relevant country, while maintaining the high quality equivalent to components produced in Japan. Consequently, we predict the shift from process-separate type production to process-integration type production, which can achieve quality control and production preparation with more ease, will be accelerated. JTEKT will continue its efforts to develop better machines that meet these kinds of customers' requirements and evolve with the times.


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