

The Outlook of Machine Tool Technological Development: JTEKT Pursuit of Machine Tool Development Responsive to Globalization

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As customer needs diversify and production sites globalize within the machine tool business, we must respond to the low cost advantage held by manufacturers in developing countries and engage in added value competition with European manufacturers. This report concerns efforts supporting the monozukuri of customers from the standpoint of technological development, while covering the basics of monozukuri. Along with commodified JTEKT technologies, I would like to observe what we are enhancing within our technological developments, such as accuracy stability, improvements in productivity and net productivity rate, the shift to all-purpose, and system proposals.

Key Words: *High-precision technology, low thermal displacement, visualization of production status, skiving*

1. Foreword

Japanese machine tool technology has developed to be the key industry supporting the growth of domestic monozukuri companies as well as production by these companies. The country proceeded aggressively with the change to CNC in 1970 to become one of the leading machine tool manufacturing countries in the world. Since then, Japan has been pulled into the automobile and electric industries as well, furthering technological innovation while raising productivity and reliability. Technologies which support mass production, such as automation and increased speed, were developed at this time.

However, as the market diversified in the 2000s, machine tool technology in Japan became unable to respond to customer needs if merely focused on mass production. Over the years, it has become increasingly important to implement efficient production while accommodating fluctuations in production volume, a trend made decisive by the great economic stagnation due to the Lehman Brothers crisis.

Furthermore, competitive monozukuri is unable to be conducted only within Japan, and therefore competition has moved into the global market.

This report observes the machine tool situation and looks at various JTEKT engagements within this environment from the perspective of technological development.

2. Changes in the market and strengthening of technologies with high added value

2.1 Rise of manufacturers in developing countries

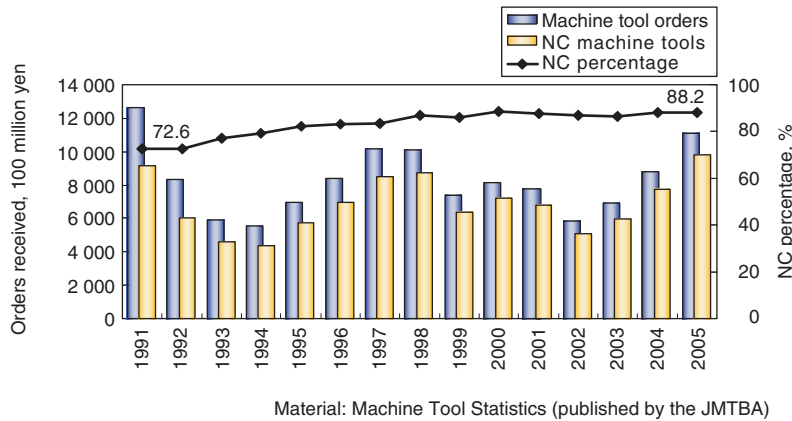
With the development of the CNC unit, machine tools became numerically controlled, able to perform even the most complex movements with a high level of freedom and accuracy. Prior to this, machine tools operated by repeating a number of single motions. Recently, control technologies have enabled machine tools to maintain a high level of machining accuracy. Positioning accuracy, the life of these “mother machines”, as well as straightness accuracy and perpendicularity accuracy, are also now able to be offset to a certain degree.

The evolution of CNC facilitated the improvement of performance in machine tools of developing nations as well, creating an environment where simple machine operations could be easily achieved by any operator in any location.

Machine specifications are also improving, as high performance machine elements (bearings, ball screws, spindle units, etc.) from Europe and other areas can also be easily obtained. **Figure 1** shows the state of progress of NC machine tools.

2.2 Trend of efforts within developed countries and developing countries

At present, market needs have diversified and there has been a rapid progression of low performance, low price machines for each model mainly within developing countries. Therefore, the volume zone of monozukuri has fallen into a market driven by low price competition.



The NC was first developed in 1952 in the United States, and Japan developed practical NC machine tools shortly afterward. NC evolved rapidly during the 1970 era. These machine tools simultaneously achieved automation and cost reduction, leading to the expansion of shares both domestically and internationally. Currently, the evolution of CNC is further intensifying global competition.

Fig. 1 The development of NC machine tools

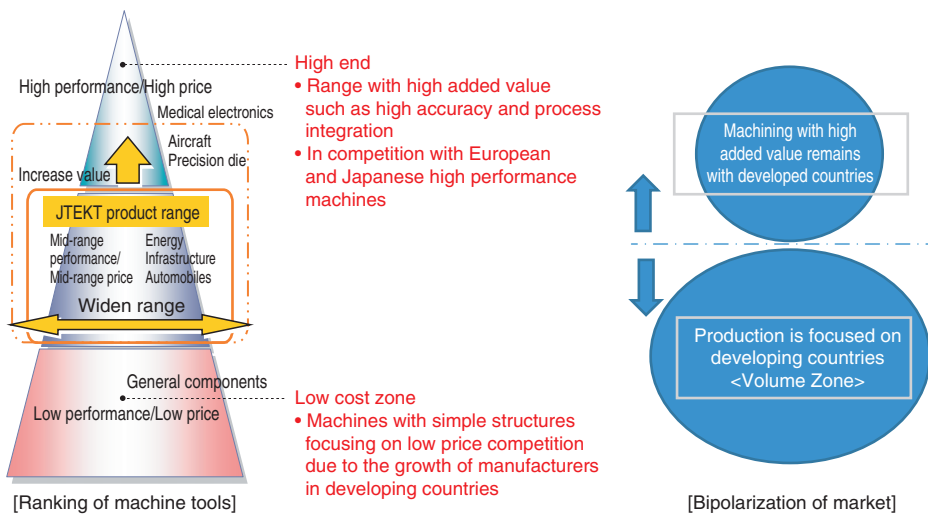


Fig. 2 Changing machine tool market

On the other hand, the mid-range performance, mid-range cost product lines in which Japanese manufacturers specialized were being pressed to correspond to declining prices or convert to machines with high added value. The greatest issue has become the creation of new added value suited for the transformation of monozukuri while also responding to the globalization of our customer range.

Each company is diligently continuing efforts to strengthen its niche area and stimulate initiatives into new areas.

Developed countries are also actively exploring new machining methods that developing nations lack, in order to bring higher added value to the market. It is imperative that companies enhance machines and develop methods for more complex and difficult-to-cut materials. **Figure 2** shows the structure and transformation of the machine tools market.

2. 3 Objective of JTEKT machine tools

JTEKT supports the monozukuri of our customers and strives to propose total solutions for raising value in the

products they manufacture.

Our company continues to create highly versatile equipment which facilitates variations in production volume or workpiece type. We have also furthered the improvement of operational availability without production loss and evolved controls and systems to enhanced system proposals that can be easily used within a global production environment.

Listed below are the aspects of technological development JTEKT is progressing with in order to exhibit our comprehensive engineering amidst global competition. From amongst these, I will introduce leading examples focusing on technologies that will be released into the market this fiscal year.

- (1) Development of technologies able to perform high accuracy machining
- (2) Development of machining methods that enable highly efficient production
- (3) Visualization of production status and errors and the development of the control technologies that support equipment

(4) Development of wheel (tool) technology, as well as total system proposals that include transfer systems and coolant units

[Example of highly accurate technologies]

The guarantee of stable machining accuracy over long periods is essential within production equipment for improving operational availability and manufacturing products with high reliability.

On the other hand, the constantly changing ambient temperature surrounding the equipment causes thermal distortion, which leads to variation of machine accuracy. JTEKT has therefore been continuing technological development to further suppress and control thermal distortion. As shown in **Fig. 3**, 1 to 3 μm displacement in tool position occurs for every 1°C change in room temperature. Consequently, a 10°C change in room temperature would cause 10 to 30 μm of variation in machining accuracy.

As a countermeasure, our company has newly developed a real time thermal displacement offset

technology which measures machine temperature in real time, immediately analyses variation, and corrects machine position.

This technology is able to reduce machining accuracy dispersion of conventional machines by 20%, significantly raising process capability for the user. **Figure 4** shows the mechanism and results of this technology.

The behavior of the machine during machining also has a profound effect on machining accuracy. The effect of the liquid temperature of the coolant flowing within the machine is also an issue, particularly for grinding that requires high finishing accuracy. Accuracy variation can be halved by eliminating the effect of the coolant liquid temperature. **Figure 5** shows an example of the high-accuracy body of a grinder without the effect of the coolant liquid temperature.

[Process integration technology for highly efficient production]

Process integration technology is an important key to achieving flexible correspondence to fluctuation in

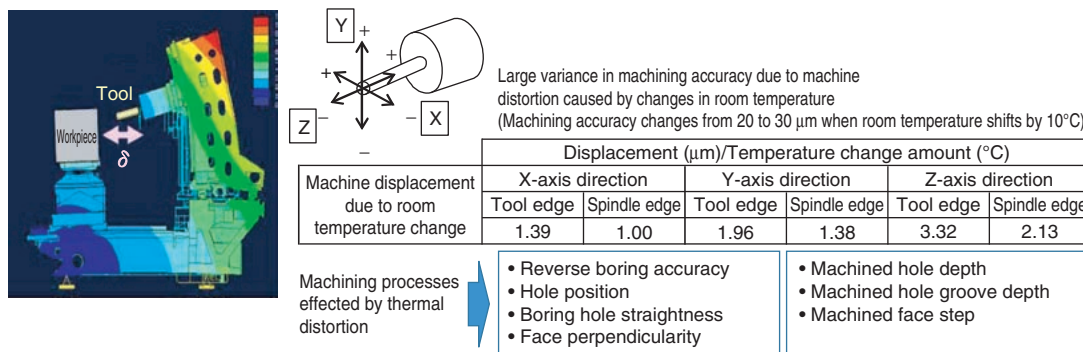


Fig. 3 Effect of room temperature change on machine heat distortion and machining accuracy

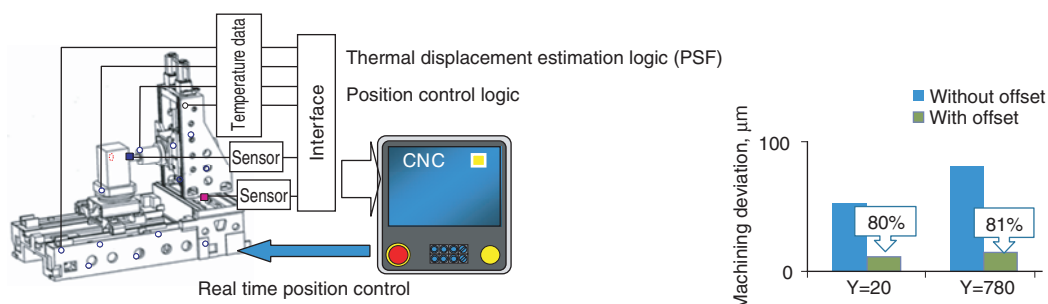


Fig. 4 Real time heat displacement compensation and its results

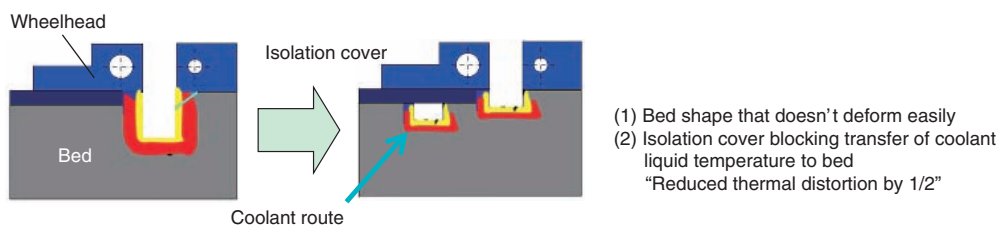


Fig. 5 High accuracy body of grinding machine

production volume and machining type while raising production efficiency. Process integration can eliminate non-machining time such as transfer between machines, which improves net rate.

For the past few years, much effort has been exerted into gear machining by skiving on machining centers as a process integration technology.

Skiving requires control technology that synchronizes the spindle and workpiece shaft with a high level of accuracy, as well as a spindle and workpiece shaft that rotate at high speed and with high rigidity. As such, JTEKT machines utilize our company’s core technologies such as CNC control and a high-speed spindle. **Figure 6** gives an example of integration of gear processes.

[Mechatronics product technology]

Beginning with the management of the entire factory, control of each piece of equipment is supported by many of JTEKT’s mechatronics products, which are designated as one of our important product lines.

Within the market, the shares of controllers such as the PLC are divided between two major companies. Our company will utilize our strengths as an equipment manufacturer to establish a unique position within our specialty field of production equipment.

JTEKT is strengthening cooperation with group companies and collaborating with Koyo Electronics Industries Co., Ltd. to establish an assortment of products that can be introduced into the controller market. We are also promoting an “add on” concept for our current customers and equipment to allow the sale of our products through the addition of visualized technologies such as the andon and energy-saving, which we have perfected as an equipment manufacturer.

Because the signal communication method of existing equipment differs for each manufacturer, it was extremely difficult in the past for those other than the original manufacturer to install additional functions. However, as our company’s TOYOPUC®-Plus includes an interface able to respond to all types of communication, it can be sold as additional function of existing equipment. **Figure 7** shows the concept of adding TOYOPUC-Plus to existing equipment.

3. Total system proposals

As previously stated, recently the basic elements which comprise a machine tool have become available practically anywhere. A large quantity of high

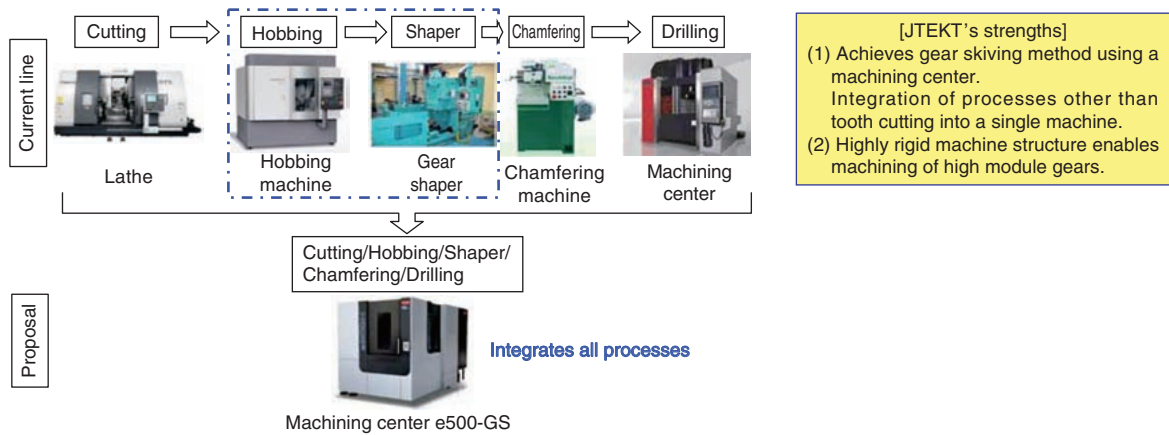


Fig. 6 Example of gear process integration by skiving method

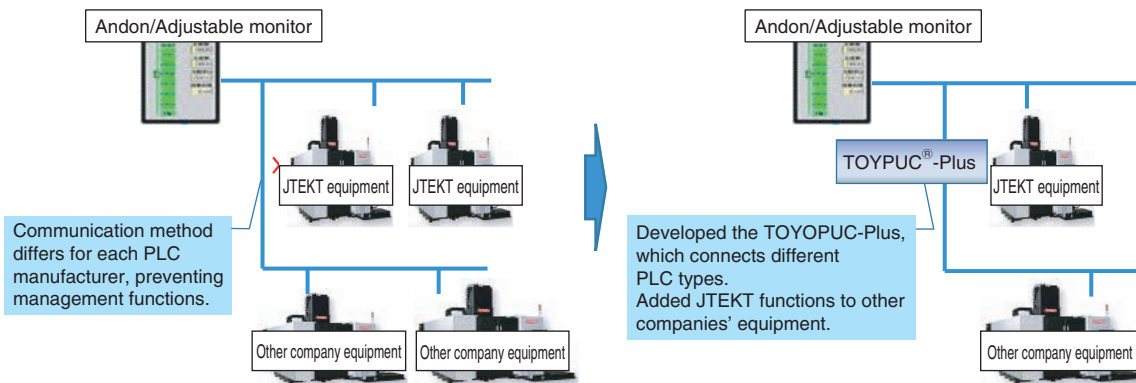


Fig. 7 Add-on concept of mechatronics products

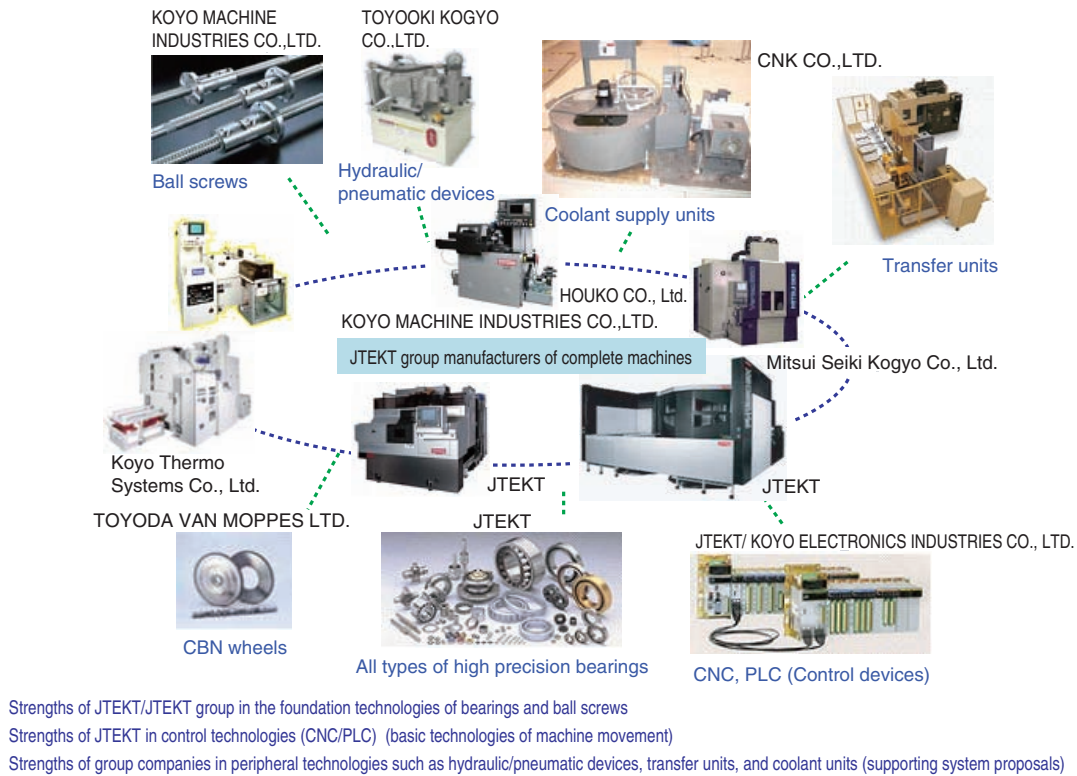


Fig. 8 Core technologies and Group technologies of machine tools

performance components are sold within the market, and therefore machine specifications can be enhanced relatively easily by purchasing and combining high quality components.

Our company and group companies must have function component technologies necessary for the creation of unique added value. It is also advantageous for a manufacturer to produce fundamental technologies that cannot be obtained by other companies. The composition of JTEKT group companies ranges from complete machine manufacturers to peripheral unit manufacturers, which enables technologies needed for system proposals to be obtained from group companies. JTEKT will continue to advance technological development while strengthening cooperation between group companies and sharing a developmental vision for the future.

4. Conclusion

Concerning changes to the environment surrounding machine tools, I have given the examples of the perspective of a globalized and diversified customer base, and the polarized perspective concerning the rapid catch-up of manufacturers in developing nations and competition with the technological developments of European manufacturers. From these perspectives, I have organized the development technologies that JTEKT will continue to enhance as a machine tools manufacturer.

Our company will strive towards high accuracy and

high efficiency in order to raise productivity and added value. We will also encourage versatility to respond to diverse production methods, in addition to promoting easiness of setup and visualization of equipment. These actions will enable our company to fulfill the requests of customers throughout the world.

In order to propose technologies for the entire system, JTEKT will utilize the technologies our group possesses to strengthen our overall group technologies.

The machine tools business is a backbone industry of monozukuri. We at JTEKT will devote ourselves to improving the three axes of this business, which include perception of market needs, vigilance concerning the benchmarks of other companies, and constant response to changes.



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