

MAZAK IS TALKING WITH A NEW “VOICE” NEW CNC – “MAZATROL MATRIX”

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Abstract: This paper tries to point the fact that Mazak philosophy has always been to provide world with a means to realize higher productivity and enhanced competitiveness by developing new machines and manufacturing technologies regardless of the economic environment. ([1] Mazak Cyber World 2006 Vol.21) With the global launch of the Mazatrol Matrix control, Yamazaki Mazak has taken the development of CNC systems to the next level. Mazatrol MATRIX uses the most advanced hardware available in combination with intuitive developments to provide the highest productivity levels for manufacturing industry. Among the key features of Mazatrol Matrix is its advanced conversational/shop-floor programming capability.

Key words: multi-tasking, advantages, integrated, matrix, ‘Done in One’, advanced Technology, high productivity, tower.

1. INTRODUCTION

Multi-Tasking in the machining world is the combining of processes onto one machine, which were traditionally processed on multiple machines. The ultimate goal is to turn, mill, drill, tap, bore and finish the part in a single setup, what we call “DONE-IN-ONE”.

This may be the single most important innovation in manufacturing technology for any company seeking to become lean, efficient, and globally cost-competitive.

Mazak is a pioneer in the field, introducing the first turn/mill lathe in 1983. Over the past twenty years, we have developed the broadest range of multi-tasking machines in the industry, serving low, medium and high-volume producers.

Advanced Multi-Tasking with INTEGREGX delivers maximum versatility and throughput for complex parts. Information technology and manufacturing technology all rolled into one – that’s the INTEGREGX E-SERIES. These combination machining centers/turning centers are by far the most advanced Multi-Tasking machines in the industry. Complete all operations in a single setup – turning, milling, boring, drilling, etc. This Done-in-One machining concept can now be applied to small and very complex parts. The advanced B-Axis turret design with Y-Axis capability is available on all models. And, deep-hole boring is available on some horizontal models.

All INTEGREGX E-SERIES machines are equipped with the unique MAZATROL MATRIX and MAZAK e-TOWER. From this information centre, setup support, maintenance support, manuals, work scheduling and much more are made accessible either in-office or off-site.

INTEGREGX IV is the marriage of a high-powered turning center and a full-function machining center to produce parts in a single setup. It works to eliminate multiple setups, fixtures, tools, handling and waiting time, which simply add to your manufacturing costs.

In addition, Done-In-One machining brings dramatic reductions in lead-time and efficient lot sizes to satisfy



Fig. 1. “DONE IN ONE Concept”.

customer JIT and cost demands (Fig. 1). Part accuracy is improved by eliminating multiple setups.

INTEGREGX IV comes standard with continuous 5-axis CNC control, bringing added capabilities to many shops. With one machine, you can be competitive on round parts with secondary operations, fully prismatic parts from solid or castings, or sculptured parts such as aerospace components and molds. Enhance your productivity by adding optional lower turret cutting.

2. DONE IN ONE

The “DONE IN ONE” concept incorporates all machining processes in just one multi-tasking machine:

- *reduction of production lead-time* – Considerably improved cash flow;
- *improved machining accuracy* – Customer confidence in products and the company;
- *reduction of floor space and initial cost* – Improved competitiveness;
- *lower expenses* – Stronger competitive edge, environmental considerations;
- *reduced operator requirements and improved work environment* – Improved environment.

This concept develops a production system and we support it with our network, support centers, application engineers, and support teams and so on. “DONE IN ONE” concept contributes greatly in a management field

3. MAZATROL MATRIX

The MAZATROL was introduced world first innovative conversationally programmed NC system in 1982. In

1998, the MAZATROL was fused with a personal computer for unsurpassed operating efficiency and incorporated our extensive expertise.

MAZATROL MATRIX, the newest model in more than 20-year MAZATROL history, has been developed for the best-suited CNC control for the multi-tasking machines by taking 5 years.

Manufacturing solutions always include four factors: High Quality, High Productivity, Ease of Operation and Safety. Development of this new CNC focused on three elements: Shop-Floor Programming, Programming in Office and Hardware. The interrelationship of these factors and elements by the Mazatrol Matrix will provide you with an unsurpassed advantage.

High Quality. *Max. 9 controlled axes:*

- for Mazatrol Matrix simultaneous 4 axes,
- for EIA/ISO simultaneous 5 axes.

Sub-Micron Input & Nano Control. High accuracy machining is ensured by the sub-micron [0.0001mm (0.00001in) minimum program increment is standard equipment for MAZATROL MATRIX. Complex surfaces with sub-micron features can be smoothly machined thanks to the 16,000,000 pulse encoders on each ball screw servomotor. The system's high-speed calculation capability delivers high accuracy, high-speed machining even with sub-micron program commands.

Quadrant Spike Compensation. By minimizing each axe's stick-slip during operations such as circular interpolation, quadrant spikes are minimized to realize high quality machining (Fig. 2).

High Productivity

Matrix CAM. Machine programs can be made and then checked for machine interference in the office using the Matrix CAM systems. Programs can be easily downloaded to the machine CNC over a network for a convenient program management and high efficiency operation.

64-Bit Twin-Engine Processor. High speed, high accuracy machining demands smooth machine control – when combined with sub-micron program data increments and 5-axis simultaneous commands, huge amounts of data are required to be calculated. This is made possible by increased computing power of the new RISC-CPU. Both high accuracy and high speed machining are realized thanks to considerably improved computing power – the maximum vectorial federate is 270 m/min (10630IPM) for contours defined in 1 mm (0.039”).

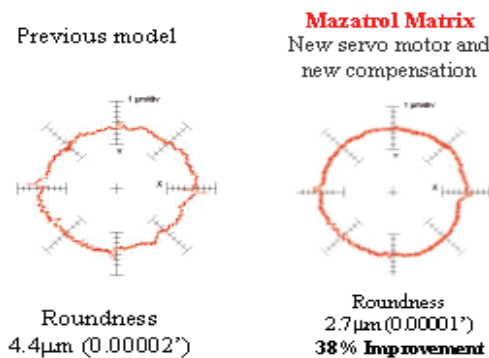


Fig. 2. Quadrant Spike Compensation.

Increased program storage capacity. By increasing RAM capacity for program execution from 1 MB to 8 MB and hard disk capacity from 8 GB to 20 GB, large programs for the machining of complex die and mould surfaces can be smoothly executed as well as providing convenient storage for large amounts of program data.

Machined Chip Breaking Cycle. Chips sometimes wind around tools due to characteristics of the machined material and chip breaker selection. By adding “cut length cycle for each turning pass” in a Mazatrol program, the axis feed momentarily stops at the end of each designated cut length to break the machined chip and then immediately resumes cutting. This contributes to making unmanned operation over extended periods of time.

Mill Turning. The Mazatrol Mill-Turn cycle is extremely effective for the rough machining of difficult to machine material such as aerospace alloys. Both the milling tool and workpiece rotates for this operation to provide improved chip control. Since multiple inserts are used for cutting instead of a single insert as used for normal turning, the effective cutting force is reduced allowing a higher feedrate to be used. This also extends the cutting life of the inserts which allows unmanned operation to be performed over extended periods of time.

Helical Approach Pocket Machining. Helical approach for pocket machining in Mazatrol programs can now be performed. It makes it possible not only to minimize built-up edge by reducing the cutting force but also to realize smoother chip removal. Additionally, since machining can begin with a faster feedrate, the overall machining cycle is reduced.

Ease of Operation

Increased Data Capacity:

- more data can be utilized thanks to increased capacity.
- maximum program size: 2mb (2 times more than previous model), 8mb (option);
- mazatrol tool data registration: 4000 tools maximum (4 times more than previous model);
- tool offsets: 4000 sets (8 times more than previous model).

Large CNC Display. A15" colour XGA LCD display is standard equipment for higher visibility of data, such as machine position, program, machine status and many other displays used by the operator for machine setup and operation.

“QWERTY” Keyboard. A QWERTY keyboard is standard equipment providing the same data input operation method as a personal computer.

Rotary Dial Switches. Allow an operator to detect override and axis selection by feel during machine setup and operation.

Safety

Virtual Machining. Machine programs can be made with minimum errors and time required for test cuts thanks to realistic machine 3D simulation displays that can be used for convenient program confirmation and checking for any machine interference. Additionally, this unique Mazatrol function makes it possible to simulate

the machining of a new program during the machining of the current workpiece.

Mazak Voice Adviser. MAZATROL MATRIX verbally informs which switches have been selected and advises caution as necessary during manual machine operation.

New functions introduced by Mazatrol Matrix CNC:

Intelligent Safety Shield. When an operator manually moves machine axes during tool measurement with the Tool Eye or changing inserts, INTEGREGX IV series moves 3D model in the CNC screen simultaneously to check machine interference. If any machine interferences are occurred with 3D model, the actual machine stops axis movement.

Intelligent Safety Shield. To minimize heat displacement, the machine units are designed to produce the minimum amount of heat during operation. Additionally, there is automatic compensation for changes in the room temperature that is based on data obtained during tests performed in a temperature controlled room. As a result, machine heat displacement is less than 10 μm with a room temperature change of 8°. The exhaust duct used to remove heated air generated by machine operation is arranged so that it will not affect adjacent machines.

Active Vibration Control. Machine vibration caused by axis-movement acceleration/deceleration can considerably affect the machining accuracy and machining time. The ACTIVE VIBRATION CONTROL reduces the vibration for high accuracy positioning in all axes and reduction of machining time. In addition, since this function reduces tool nose vibration, high quality machined surface finishes are realized and excessive tool nose galling is prevented ([2] Mazatrol Matrix Catalogue, 2005).

4. INTEGREGX IV SERIES

Machining as you like the INTEGREGX has become the most widely sold multi-tasking machine tool in the world. The fourth generation INTEGREGX IV series is designed to provide you innovation.

INTEGREGX - Unsurpassed Versatility

Main Spindle. The main headstock features an integral spindle/motor designed for a wide range of applications, from heavy duty cutting at low speed to high speed cutting of aluminium and other nonferrous material at high spindle speeds. High C-axis positioning accuracy thanks to the 0.0001 degree rotary magnetic encoder and unique brake system provides high accuracy contouring of complex shape workpieces. In addition, because the C-axes positioning detector reads the position even during turning operation, mode changeover from turning to milling is extremely fast for minimum non-cutting time.

Second Spindle. The second spindle has the same speed and same C axis functions as the main spindle to ensure high efficiency machining for the second operation.

Upper Turret. The cam-driven tool changer ensures reliable high-speed tool change cycles. Since the Automatic Tool Changer system and Automatic Tool Changer cover operates simultaneously, the minimum tool change

time is realized. By having the ability to radially index a tool in a turret the same tool can be used as a right-hand tool and a left-hand tool. As a result, higher productivity is realized by reducing the number of tool change cycles, number of tools and non-cutting time. A variety of tool magazines (from the standard 20 tools up to the maximum of 120 tools) is available to meet the machining requirements of a wide variety of work pieces. The B axis can be mechanically clamped in 5° increments to provide heavy-duty, high precision machining performance. B-axis indexing and positioning in 0.0001 degree increments thanks to the roller gear cam which eliminates backlash. This is especially effective for difficult to machine alloys and the machining of complex shapes. The Integrex IV features a rigid, double-slide Y-axis construction to withstand the cutting forces generated by heavy duty turning and milling. To ensure high-accuracy over a long service life, the magnitude and locations of force applied to individual units during machining have been analysed by 3D design structural analysis. Proper counter-measures have been taken to ensure rigidity in order to minimize distortion.

Lower turret (ST). Balance cutting by both the upper and lower turrets reduces turning time as well as ensuring high turning accuracy and high quality surface finishes. In addition, the same tool mounted on the lower turret can be used for machining on both the main and second spindles thanks to the unique turret design that reduces the required number of tools.

NC Electric Tailstock. Controlling the movement and setting the thrust force of the tailstock is a simple operation using the CNC. The operator can set the tailstock position on the setup screen and move the tailstock to the correct position by M-code. Since the thrust force is also easily set by M-code, high accuracy turning of long workpieces is realized.

Traverse Axis. By utilizing linear guides on all axes, not only is non-cutting time reduced-high accuracy machining is ensured even at high speed federates. Additionally, fast, vibration free acceleration/deceleration are realized thanks to the smooth high-gain control and high power AC servo motors ([3] Integrex IV Catalogue, 2005).

5. INTEGREGX-e II SERIES

Equipped with the MAZATROL MATRIX CNC and many newly developed features, INTEGREGX e II series provides innovation to 21st century-manufacturing industry (Fig. 3). INTEGREGX e II series represents a complete fusion of IT (Information Technology) and MT (Manufacturing Technology).

5.1. e-Tower for Operators

The standard information terminal for e-series, “e-Tower”, features a comprehensive range of Information Technology to make them a Cyber Production Module – which can be used independently or integrated into an advanced Cyber Factory.

“e-Tower” for Management. All information, such as current machine operation status, job status and others can be monitored in an office or off-site.



Fig. 3. Integrex e 410 H II with e-Tower and Mazatrol Matrix.

Work scheduling. Jobs to be performed can be transferred from a PC in the office to inform the machine operator.

Mobile Messenger. Machine operational status can be remotely monitored by using a mobile phone. One can quickly and easily check the completion schedule of a job over a mobile phone.

Setup Support e-Tower. reports the current machine status and job status, scheduling of new jobs can be performed accurately and easily. The Monitor screen can display test cutting of a workpiece feature that is difficult to see making it possible to optimize machine setup. Digital machine manuals are conveniently accessible to answer any kind of question. Maintenance Support and Alarm Recovery.

Verbal messages. Various instructions and reports are made verbally to the operator. Available languages are English, German, French, Italian, and Japanese.

Image transmission. Pictures showing machining that the operator cannot clearly see or the status of machine units, such as the tool changer, can be sent to the e-Tower monitor or an off-site location.

Fingerprint identification system. Prevents unauthorized operators from operating machine.

5.2. Specification for Integrex e-II

The Integrex e-II series utilizes a wide variety of advanced technologies in order to provide enhanced productivity.

Milling Spindle. The front-end of the spindle is supported by 4 bearings in order to machine a wide range of applications, from heavy-duty cutting at low speed to high speed cutting of aluminium and other nonferrous materials at high spindle speed. The milling spindle features an integral spindle/motor that provides excellent performance in steel machining. Standard #40 and #50 taper tool holders are used with KM63 and CAPTO C6/C8 optionally available. The B-axis is accurately positioned in 0.0001 degree increments by utilizing a backlash-free roller gear cam.

Column and Carriage Base. To ensure high accuracy over a long service life the Integrex e-V II series utilizes a double column machine design for high accuracy machining. The magnitude and locations of forces applied to individuals units during machining on Integrex e-H II, Integrex e-V II series have been analysed by 3D design structural analysis in order to ensure rigidity.

Automatic TOOL EYE. The Tool Eye can be programmed for automatic tool measurement and compensation as well as inspection for tool breakage. In addition, since tool setup is done by simply bringing the tool

tip into contact with the Tool Eye, tool setup time is considerably reduced.

Automatic Tool Changer. The cam-driven tool changer ensures reliable high-speed tool change cycles.

Tool Magazine. A variety of tool magazines (from the standard 40 tools up to the maximum of 120 tools) is available to meet the machining requirements of wide variety of workpieces.

5.3. Integrex e-H II

In addition to the general functions and options for Integrex e-II series, the Horizontal Integrex e-II series introduce different functions indispensable for horizontal machining.

Long Boring Bar. Two long boring bars for the e-500H II, three long boring bars for the e-650H II (maximum length 1000mm) can be stored in the long boring bar stocker located above the tailstock. Thanks to this system, deep boring of large workpieces can be performed automatically. The cutting heads for the boring bars are separately stored in the standard tool magazine and automatically changed by the ATC.

For high accuracy turning:

Steady Rest used to ensure safe and accurate machining of long workpieces.

Tailstock with Built-in Center (Integrex e-650H II). The tailstock has a maximum thrust force of 35.3 kN (3600 kgf) and is designed for heavy-duty machining: tailstock quill 180mm, center: MT. No. 6, clamping force of tailstock body 18 tons. Thanks to this large thrust force, heavy duty machining using a face driver is ensured ([4] Integrex e-H II series Catalogue, 2005).

5.4. Integrex e-V II

The Vertical Integrex e-II series also introduce unique functions necessary for vertical machining.

Tool Hive Magazine. A dense, hive-type storage system featuring large capacity tool storage in a compact space. The Tool Hive magazine realizes longer periods of unmanned operation and reduction of tool setup time.

Tool data management. An operator can see tool data information stored in the MAZATROL MATRIX on a display attached next to the tool magazine ([5] Integrex e-V II series Catalogue, 2005).

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