

CYBER WORLD



New Era of Digital Manufacturing

Feature

Evolution of the Mazak iSMART Factory™

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Evolution of the Mazak iSMART Factory™

Wider utilization of the IoT and digitization in the manufacturing industry

The Internet of Things (IoT) connects everything to the Internet. Efforts to use the IoT to create new value have been expanding on a global scale the past few years. The number of things that can be connected to the Internet is increasing rapidly, and it is estimated that the market of IoT-related products and services will be equivalent to roughly \$1.4 trillion in 2021 (report from IDC). The utilization of the IoT, as well as digitization, is also becoming wide spread in the manufacturing industry and companies have started to actively use the IoT to win in today's intensifying competition. In addition to the efforts of individual companies, digitization in the manufacturing industry is promoted as a national project under the initiative of the central government in various countries. Germany promotes "Industry 4.0," which aims to achieve an alignment of the production field with digital data to realize a flexible and efficient production system, through collaboration between industry, academia and government. In China, the central government has launched "Made in China 2025," which is also called the Chinese version of Industry 4.0, and digitization of the manufacturing industry is positioned as a priority area in their industrial policy. The Japanese government has also released a new industrial vision "Connected Industries" to accelerate the utilization of the IoT by manufacturing and other industries as well as digitization.

Activities for the digitization of the manufacturing industry in various countries	
	Germany: Industry 4.0
	China : Made in China 2025
	Japan : Connected Industries
	US : Industrial Internet
	UK : High Value Manufacturing Catapult
	France : Industry of the Future

White Paper on Manufacturing Industries 2017

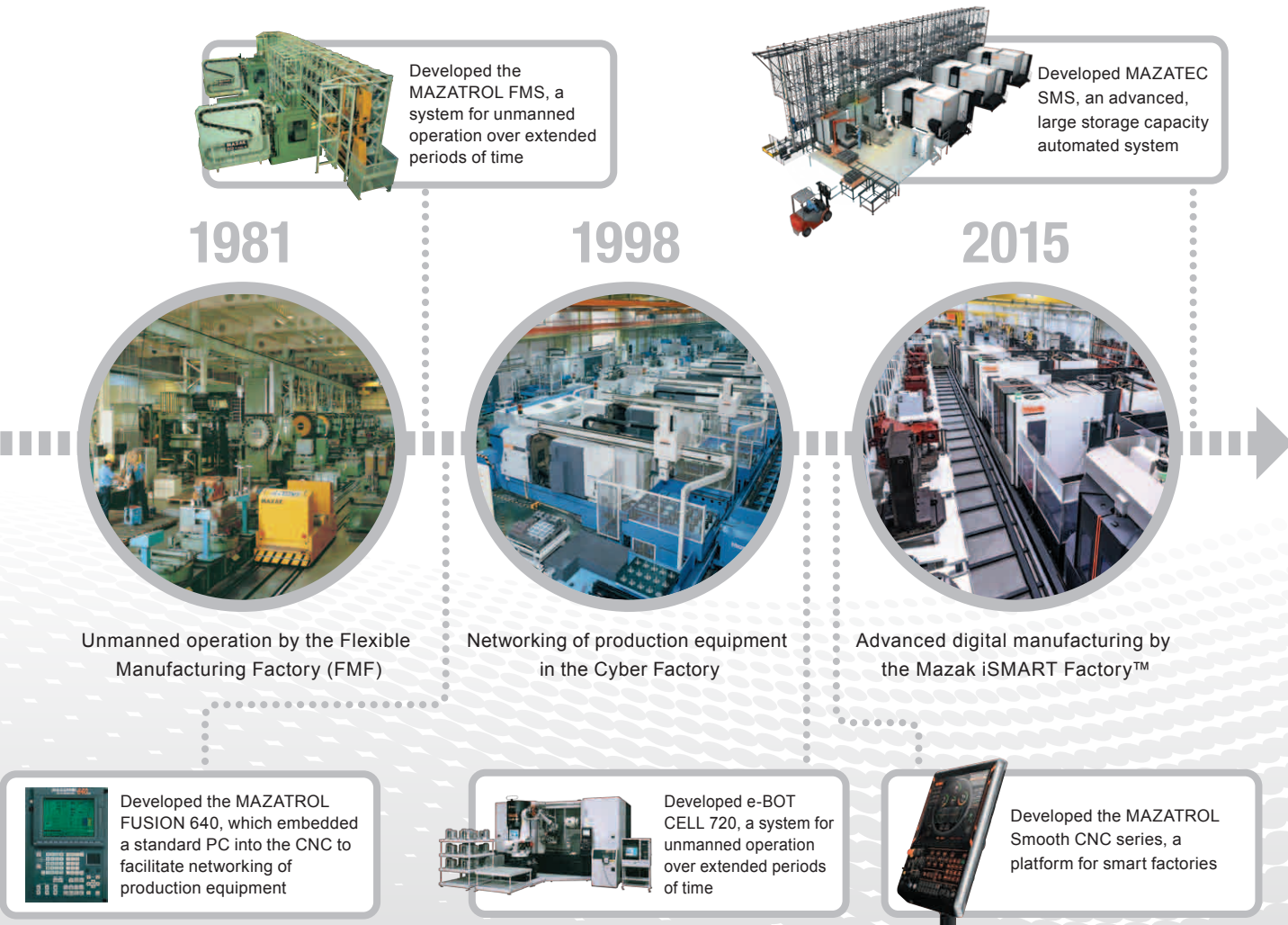


IoT collaboration between countries is also active (The leaders of Japan and Germany (in the center of the photo) confirmed collaboration between the two countries at CeBIT 2017.) Source: METI Journal



The machine tool industry is also making active efforts for utilization of the IoT, which is drawing increasing attention. (IoT corner in Mazak's booth at JIMTOF 2016)

History of automation and networking in Mazak



History of the commitment of Mazak to automation and networking – From the Cyber Factory to the Mazak iSMART Factory™ –

While the manufacturing industry must decide how to best utilize the IoT on a global scale, Mazak is committed to the establishment of its version of a smart factory – the Mazak iSMART Factory™. In a plant that has been transformed into Mazak iSMART Factory™, all production activities are converted into digital data to visualize and analyze the processes for making improvements and to coordinate the data with the main computer system. With such a plant, Mazak is striving to realize "advanced digital manufacturing," in which production activities are optimized in an autonomous manner.

Mazak has promoted the automation and networking of plants as a pioneer in the industry since the establishment of unmanned factories in the 1980s. In 1998, for example, we completed the Cyber Factory designed for networking production equipment based on IT. The Mazak iSMART Factory™ is a plant that

realizes even more efficient manufacturing by making use of the automation technologies and expertise on plant control we have accumulated over many years of operation.

Mazak's efforts to create iSMART Factories in its production bases started with a pilot project launched at the Mazak US Plant in Kentucky in 2015. A project to upgrade all Mazak production facilities worldwide to iSMART Factories is underway. The transformation of the Oguchi Plant at Mazak's headquarters into an iSMART Factory was completed in May this year. The knowledge and expertise acquired from the project in the Kentucky Plant, as well as the introduction of cutting-edge IoT technologies, were applied to the Oguchi Plant, which has initiated its operation as the most digitized production base at present.

Mazak iSMART Factory™ ~ Oguchi Plant ~

Located at the company headquarters, the Oguchi Plant, which has completed the transformation into an iSMART Factory, all of the production activities from parts manufacturing to final inspection processes are now converted into digital data. The information obtained from the analysis of the data is fed back into production to help improve productivity and quality and to work together with the ERP system to realize advanced tracking of errors and optimization of the entire plant operation.



Machining area in the Oguchi Plant

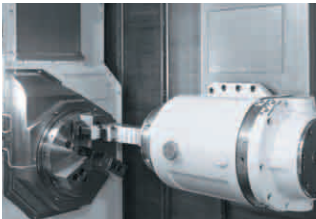
Various types of production equipment are networked in the machining and sheet metal processing areas

The machining area in the Oguchi Plant is composed of the INTEGREX series of multi-tasking machines and other state-of-the-art machines to produce a wide variety of components in small quantities according to the production schedule. Continuous unmanned operation over extended periods of time is enabled with various automated systems including automatic high-rise warehouses and sorting robots as well as tool transport systems, which automatically supply tools to multiple machines, and auto jaw changers, which automatically replace chuck jaws. All of these processing machines, along with peripheral equipment such as integrated chip conveying systems and automatic guided vehicles, are networked to collect more than 10 million pieces of plant operation data per day and monitor and analyze the operation status. Data are collected from all equipment to improve the efficiency of the entire machining area.

The networking of different equipment and the collection and integrated control of the data are realized with MTConnect®, an open communications protocol for manufacturing equipment, and the MAZAK SMARTBOX™, a network connection unit. The MAZAK SMARTBOX™ does not only ensure cybersecurity of the network but also functions as a fog computing device for distributed data processing to reduce server load from data collection and substantially improve the processing speed of data analysis. For older machines and other equipment that are not compatible with MTConnect®, the MAZAK SENSOR BOX is deployed to convert machine status data into MTConnect® format for data collection.



Tools are automatically supplied to multiple machines



Chuck jaws automatically changed by attachment mounted in milling spindle



All data of machines are collected using the MAZAK SMARTBOX™ deployed in different locations of the machining area



Information for older machines is collected by the MAZAK SENSOR BOX



SMOOTH MONITOR AX is used for visualization and analysis



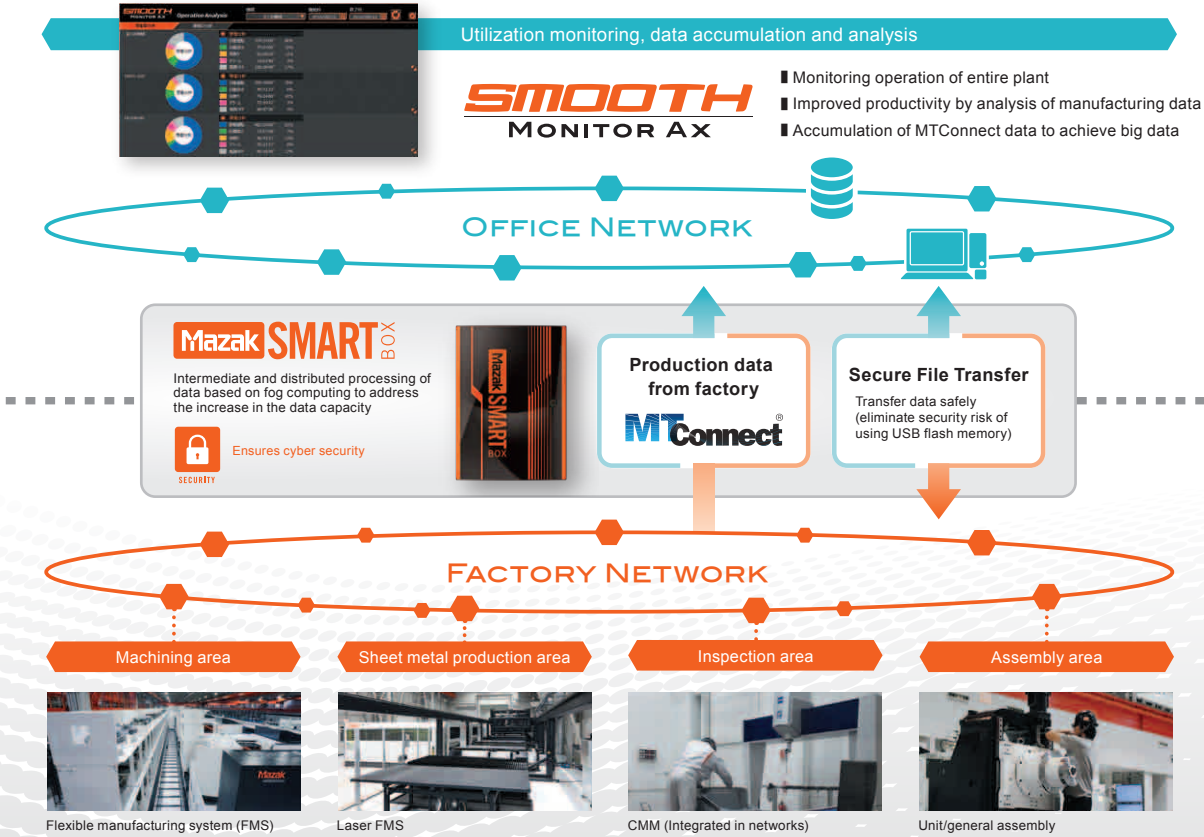
In the event of equipment problems, an alarm notification is sent to the staff by smartwatch, etc.



QR codes* are scribed by a laser processing machine
*QR code is a registered trademark of DENSO WAVE INCORPORATED



The operator calls the bending processing program by scanning the QR codes scribed on workpieces



The collected data are visualized and analyzed by the SMOOTH MONITOR AX and the results of the analysis are fed back to production to improve productivity. As a specific example, the Oguchi Plant has analyzed alarm stops of equipment to identify the causes and frequency of the alarms. These data are used to perform preventive maintenance, which has reduced downtime by half and improved the operation rates. In addition, the operation status of equipment during the automatic operation was analyzed to identify inefficient processing cycles. The data analysis has resulted in improved productivity such as significant reduction of non-cutting time with optimization of cutting tools and the machining program.

The improvement of productivity through advanced data coordination has also been achieved in sheet metal processing. In the sheet metal processing area, a QR code is scribed on each material sheet by a Mazak laser processing machine to use for

calling processing programs in the subsequent bending process as well as for the registration and management of progress of the painting process. This has reduced the time required for part identification and calling up the appropriate program to improve productivity by 30% in comparison with the previous method.



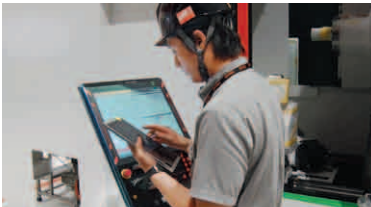
State-of-the-art fiber laser processing machines in the sheet metal processing area



Assembly area in the Oguchi Plant

Information on operations performed by employees is also digitized in the assembly area

Conversion of production activities into digital data is also performed in the assembly and inspection processes. The results of operation in the assembly area are entered on tablets and other smart devices, not on paper documents as was previously done, to convert them into digital data. Large screens installed in the plant display the results of operation for each machine order number which are used by management to check the progress of assembly constantly. With visualization of the progress, any holdup between processes or problem can be identified instantly to help reduce the assembly time. All manufacturing records including tool and measurement data at the time of manufacturing are also converted into digital data to enhance tracking of information on machines that have been delivered, as well as to improve quality. A detailed history of the use of tools and measuring instruments is converted into data to ensure that in the event of detection of any abnormality, the manufacturing processes and item numbers for which the tool have been used can be searched quickly to take proper action.



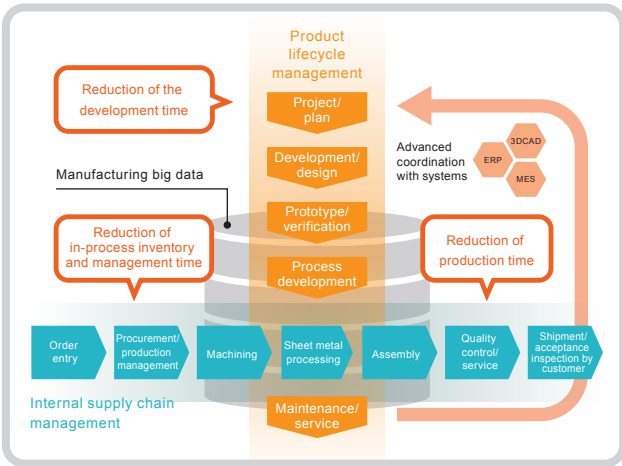
Operation results are entered into tablet



Production records are converted into digital data in the unit assembly area as well as in the general assembly area



Large screens installed in the assembly area display the progress of processes on a real-time basis



Manufacturing big data will be used to further reduce the production time

Use of manufacturing big data

With the complete transformation into Mazak iSMART Factory™, all production activities in the Oguchi Plant, from order entry to shipment, are now converted into digital data to successfully enhance the efficiency of internal supply chain management and reduce the in-process inventory, management time and manufacturing time. In the future, in addition to internal supply chain management, we will also convert information on the management of product lifecycles, which ranges from the planning of products to maintenance service, into digital data to promote the use of manufacturing big data developed through advanced coordination with 3D CAD, ERP, MES and other systems. Through these efforts, we are striving to reduce the development time, along with the manufacturing time, and meet widely diversified market requirements.

Mazak iSMART Factory™ provides solutions

Through the transformation of production facilities into Mazak iSMART Factories™, Mazak does not only realize advanced digital manufacturing internally but also creates and supplies new value to customers. The effectiveness of cutting-edge technologies and new manufacturing concepts utilizing the IoT is demonstrated in our plants. Using the products, services and solutions, we help customers to transform their plants into smart factories. The Mazak iSMART Factory™ has generated various IoT solutions including the MAZAK SMARTBOX™ and the SMOOTH MONITOR AX, which are used for the improvement of production sites through networking and the visualization of equipment operation data as well as through data analysis.

Solutions generated by the Mazak iSMART Factory™

■ Networking of equipment



Mazak SMARTBOX [MAZAK SMARTBOX™]
Any device that uses the MTConnect® communications protocol can perform data communications via the MAZAK SMARTBOX™ regardless of manufacturer and whether the model is old or new. The fog computing function enables intermediate and distributed processing of manufacturing data to identify and discard any unnecessary data automatically and improve the processing speed of data analysis.



Mazak SENSOR BOX [MAZAK SENSOR BOX]
The MAZAK SENSOR BOX is used for older machines that are not compatible with MTConnect®. It converts the machine status, as well as coolant amount, temperature, power consumption and other information, into an MTConnect® format to enable visualization and analysis of operation data.

■ Visualization and analysis of operation status

SMOOTH MONITOR AX [SMOOTH MONITOR AX]



■ Dashboard
The operation of equipment can be monitored to check the status on a real-time basis via any terminal in any location that has network access, including large screens installed in a plant, smartphones and tablets.



■ Alarm analyzer
By indicating the frequency of alarm occurrences, recovery time and other information, this can be used to determine the cause of the alarms so that preventive measures can be taken to increase machine operation rates.



■ Energy Dashboard Plus
Electrical power consumption is displayed on a real-time basis and the history can also be shown. The correlation of power consumption with processing programs, operation status and tool data is displayed to help control and reduce power consumption.

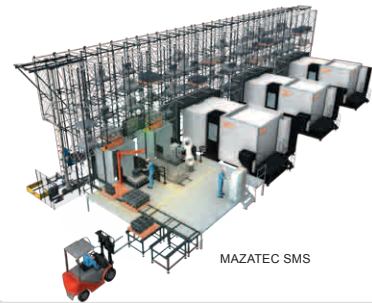


■ Operation analysis
Operation time is analyzed with the time classified into five categories: automatic operation time, automatic power off, setup time, alarm time and power shutdown time. It facilitates the understanding and improvement of problems in processing programs.

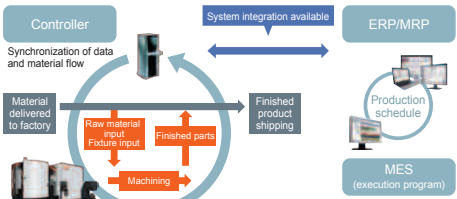


■ Analysis of tool use
(only for machines equipped with the MAZATROL CNC)
The usage rate, usage time and average cutting load of tools are analyzed to determine the optimum cutting conditions for reduced processing time.

■ Advanced automation with system integration



MAZATEC SMS [MAZATEC SMS (Smart Manufacturing System)]



This smart production system combines an automated system of machining centers and multi-tasking machines with an automated warehousing system. The warehouse can be designed flexibly in terms of total length, total height and size of each shelf to achieve large-capacity, high-efficiency storage. The system improves the material handling process in a plant from storage of materials to shipment of finished parts to ensure high productivity. More sophisticated management can be achieved in coordination with ERP and MES (manufacturing execution system).

Evolution of Mazak iSMART Factory™

Mazak is currently working on improving productivity by comprehensive monitoring, predictive maintenance using AI, analysis of big data, and the development of a "Digital Twin", which compares the operation of a digital machine to one on the factory floor. Under the concept of "Constant factory evolution", we will continuously utilize the latest technology as it becomes available to realize the evolution of the Mazak iSMART Factory™ and contribute to the development of manufacturing worldwide.

