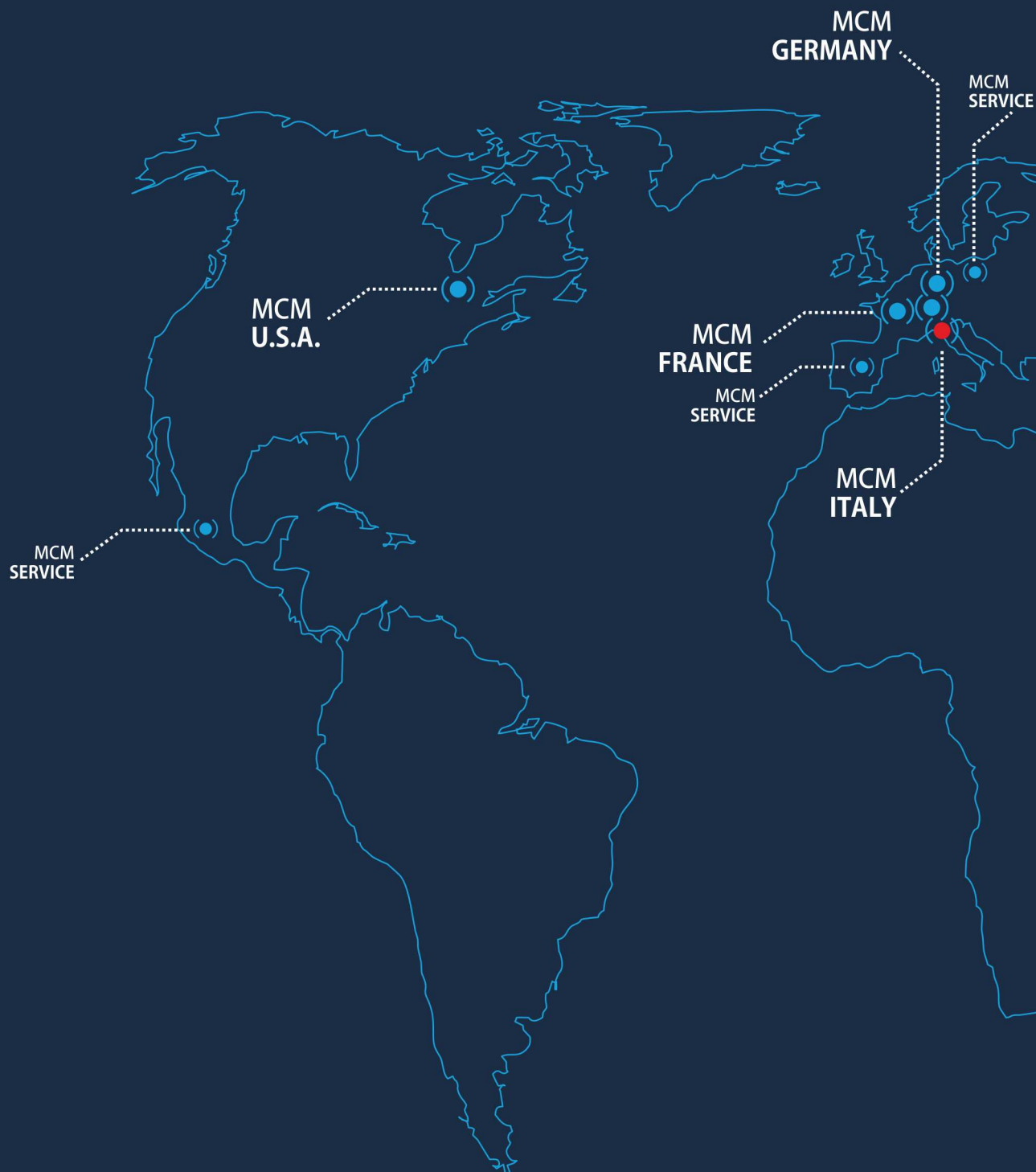


MTU AERO ENGINES

Advanced solutions for complex parts used in airliners engines

CASE HISTORY #03





AEROSPACE



AUTOMOTIVE



INDUSTRIAL



ENERGY
OIL & GAS



MACCHINE
ATTREZZATURE
E DIFESA



COMPONENTISTICA
INDUSTRIALE

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MCM is a specialist in the design and production of flexible manufacturing systems. The core of them are 4 and 5-axis horizontal machining centres, characterized by technical solutions to achieve maximum performance with no compromises. In addition to the units manufactured in-house, MCM is also able to incorporate, into the production lines,

machines featuring complementary technologies. This allows the engineering of complete and customized solutions, giving customers the benefit of a single, competent and reliable partner. MCM's product range includes machining centres, flexible automation solutions, systems integration, management software and process technologies.

The Customer



MTU Aero Engines, with 15 production sites around the world, is Germany's major engine manufacturer. The company specialises in the development, production, marketing and commissioning of engines for commercial and military aircrafts. The MTU group operates across the value chain for turbine engines in all thrust and power categories, equipping all types of aircrafts, from private jets to large Jumbo-jets. In this field, it partners the main field players: GE Aviation, Pratt & Whitney and Rolls Royce. The components

produced by MTU Aero Engines are employed in some of the most important civil aviation propellers, such as Engine Alliance's GP7000, a joint venture between GE Aviation and Pratt & Whitney, Safran Aircraft Engines and MTU, equipping the Airbus A380. The company is also the main supplier of maintenance and repair services for the V2500, produced by International Aero Engines (IAE), a consortium that MTU is also a member of. This engine equips the Airbus A320 aircraft family.



THE TECHNOLOGICAL CHALLENGE

MTU Aero Engines took part in the GE9X programme, the engine for the new long-range aircraft Boeing 777X, planned for serial production from 2020. MTU's main objective is to develop and manufacture the turbine hub casing. This highly complex component is based essentially on the tried-and-tested architecture of GE90 and GENx engines. To purchase the machines required to manufacture these new components, MTU turned to MCM, with whom it has been cooperating successfully since 2007. The GENx variant, an intermediate turbine chassis, used in the Boeing 787 Dreamliner, is also manufactured by MTU on MCM machines. To manufacture these components, in 2009, MCM received the order for a highly-automatized FMS system, consisting of 3 5-axis machining centres and one multitasking machining centre, the production of which began in March 2010 and ended in September of the same year, with the production of the first serial piece. The intermediate turbine chassis is an

essential structural component of the engine, because it contains the rear engine bearing seat, and also has an aerodynamic function, channelling the hot gas flow flowing from the high-pressure turbine to the low-pressure one. An essential component of the intermediate turbine chassis is the Hub Strut Case (HSC), consisting of three main parts: external casing, hub and 12 struts. The tough material used, a Nickel-Chrome alloy that is ultra heat-resistant, is particularly challenging for the machines and, above all, the tools. The machining process includes milling, turning, grinding, deburring and assembly, removing 66% of the raw material weight, mainly due to several hundreds of 600 holes made in the flanges, hub and struts and case chamfers. One specific challenge is represented by the need to maintain precise turning tolerances, for example the coaxial tolerance is just a few hundredths of a millimetre. After completing the piece, the HSC has a high - 5-digit - final value.

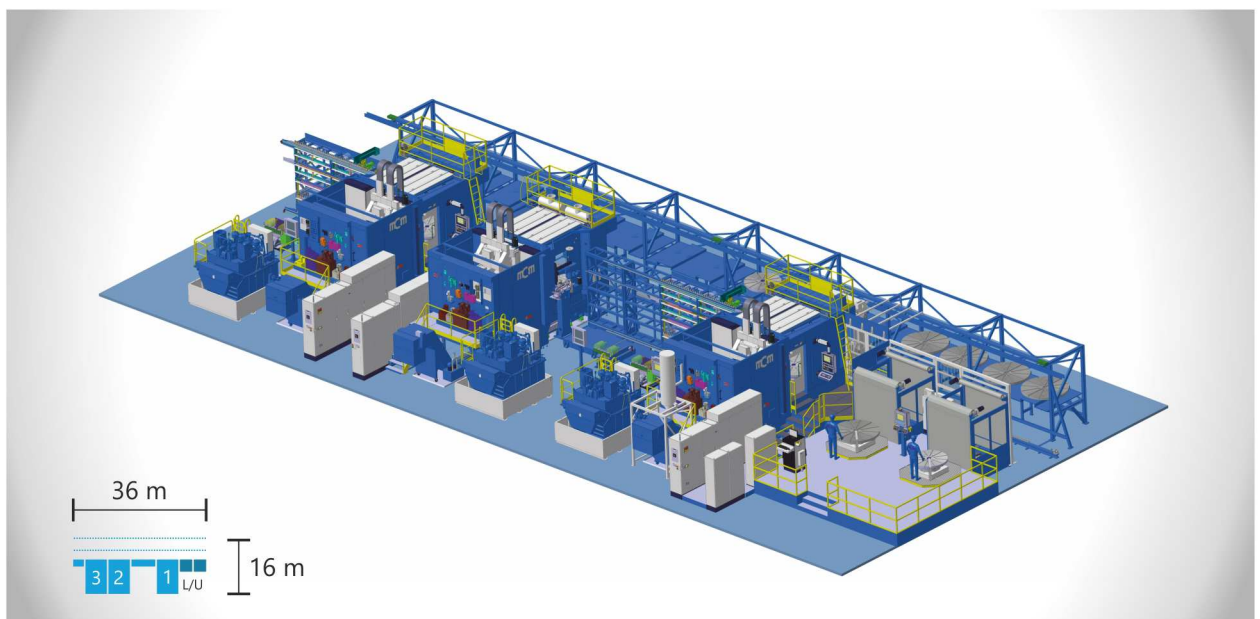


MCM's SOLUTION

The MCM solution for manufacturing the GE9X HSC consists of two FMS cells to be installed in two MTU production sites. The first cell includes 3 TANK 1800G Multitasking machining centres with Automation, equipped with a shuttle for the handling of pallets of different sizes (1.250, 1.400 and 1.800 mm). The store-tower holds a total of 14 pallets. The system also includes two high-accuracy piece loading and unloading stations. Both systems are being installed, and the works should be completed for the first system in December 2019, and, for the second system, in early 2020. MCM had to take into account a series of stringent demands by MTU Aero Engines mainly concerning three key objectives: reducing the space occupied in the factory to a minimum, reducing the number of spares to store, and limiting the training fees for the operating and maintenance staff.

PROCESSING AND AUTOMATION

In MCM Multitasking machining centres, the piece undergoes all processing steps - drilling, milling, turning and grinding - which would normally require the use of different machines. This drastically reduces the piece processing times. A peculiar aspect of MCM solution is the integration - in the machining centre - of the grinding functions and of all the equipment and devices required to perform this kind of processing. Grinders are managed as tools to all intents, they are equipped with Capto C6 taper and fastened to the spindle in a standard way. The machining centre is configured for a maximum grinding disc diameter of 300 mm, revolved by a driven disc placed within the workarea. The grinding disc wear is accurately assessed and compensated by a four-step process that





guarantees that the sizes of the final piece are maintained. This process involves the pre-grinding of the piece on the disc, measuring the size obtained with the probe, subsequent correction of the depth of cut if required and finally finishing. All steps are supervised by a software.

Furthermore, the system can manage up to 3 different types of angular heads for operations in positions that cannot be reached by a standard spindle head. Both angular heads and their tools can be automatically switched and managed on the tool-magazines. Turning tables are driven directly by gearless torque motors that can reach a high speed and acceleration. An integrated measuring system ensures the maximum positioning accuracy. The pallet is locked to the rotary table by means of 5 hydraulic devices. There is also an external disc brake to obtain a better processing stiffness with the B-axis locked.

PALLET AND TOOL MANAGEMENT



MCM automation involves a high quantity of pallet storage stations per cell. The two new units for MTU are configured for 14 and 20 pallets, capable of managing 1.250 mm, 1.400 mm and 1.800 mm diameter pallets.

The pallets are transferred from both operator stations to the storage stations and machining centres by a shuttle. A centring device monitors the correct locking of the machine pallets with a concentricity accuracy of 20 µm.

The FMS system tool-magazines allow to manage a large quantity of tools. The FMS at the production site in Munich, for example, includes 3 store-towers with a capacity of 480 Capto C6 tools per machine. Two of these have a "Mirror" configuration - shared between two machines - for a total of 960 tools that can be accessed.

SOFTWARE AND ENERGY SAVINGS



The entire FMS system is managed by the jFMX system monitoring software developed by MCE, MCM IT division. The software works on an internal network structure (Intranet) that can show the actual system status in real time and share its data on workstations only with authorized people. The Java-based jFMX supervisor allows to manage a flexible production system: it performs production, coordinates automation, manages pallets, piece loading/unloading operations and tools. The system also monitors the tool life. It also schedules programs, calculates machinability and drafts system efficiency, productivity and availability reports, in full compliance with the Industry 4.0 principles.

Lastly, particular attention was given to the system energy management, by employing spring water available in the installation site. An air-water heat exchanger system allows to cool down all the units that produce heat within the machining centres, from spindles to rotary tables, from tilting heads to electrical cabinets and coolant. Another feature aside from the reliability, efficiency, accuracy, flexibility and customisation that led MTU Aero Engines to continue its partnership with MCM.





TECHNICAL FEATURES

WORKAREA

	Tank 1800 G
X-axis	1.800
Y-axis	1.500
Z-axis	1.630
Rapid feeds	40 m/min
Thrust	2.500 daN
Linear axes measuring system	Heidenhain pressurised optical scales
Circular axes measuring system	Heidenhain pressurised encoders

Linear axes positioning accuracy VDI 3441

Positioning accuracy (P)	6 µm
Positioning repeatability (ave Ps)	3 µm

Circular axes positioning accuracy VDI 3441

Positioning accuracy (P)	5"
Positioning repeatability (ave Ps)	3"

Spindle

Taper type	Capto C6
Rotation speed	14.000 rpm
Maximum power	87,5 kW
Maximum torque	245 Nm
Front bearing diameter	Ø 110 mm

Mirror tool-magazine

Total capacity	480 tools per machine 960 per pairs of machines
Tool type	Capto C6
Maximum tool length	400 mm
Maximum tool weight	15 kg for standard tools 28 kg for special tools 35 kg for angular heads
Presetting station	Capacity: 5 tools

Pallet magazine

Pallet sizes	Ø 1.800 mm - Ø 1.400 mm - Ø 1.250 mm
Fixture + workpiece diameter	Ø 1.900 mm
Maximum load allowed on pallet	1.800 kg
Total capacity	20 pots
Operator stations	2

Continuous rotary table (B-axis)

B-axis positions	3.600.000
Rotation speed (milling)	30 rpm
Rotation speed (turning)	170 rpm
Maximum torque	5.870 Nm

Tilting head (A-axis)

Tilting radius	+30°/-130°
Contouring torque	400 kgm
Max driving torque	4.800 Nm

Integrated customised options

Lay-out for applying angular heads with tool change on the head / Lay-out for grinding processing with grinder scraper within the workarea / Air-water heat exchangers to cool down the system through spring water / jFMX supervisor

MCM

HEADQUARTERS

Vigolzone (Piacenza) / Italia

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