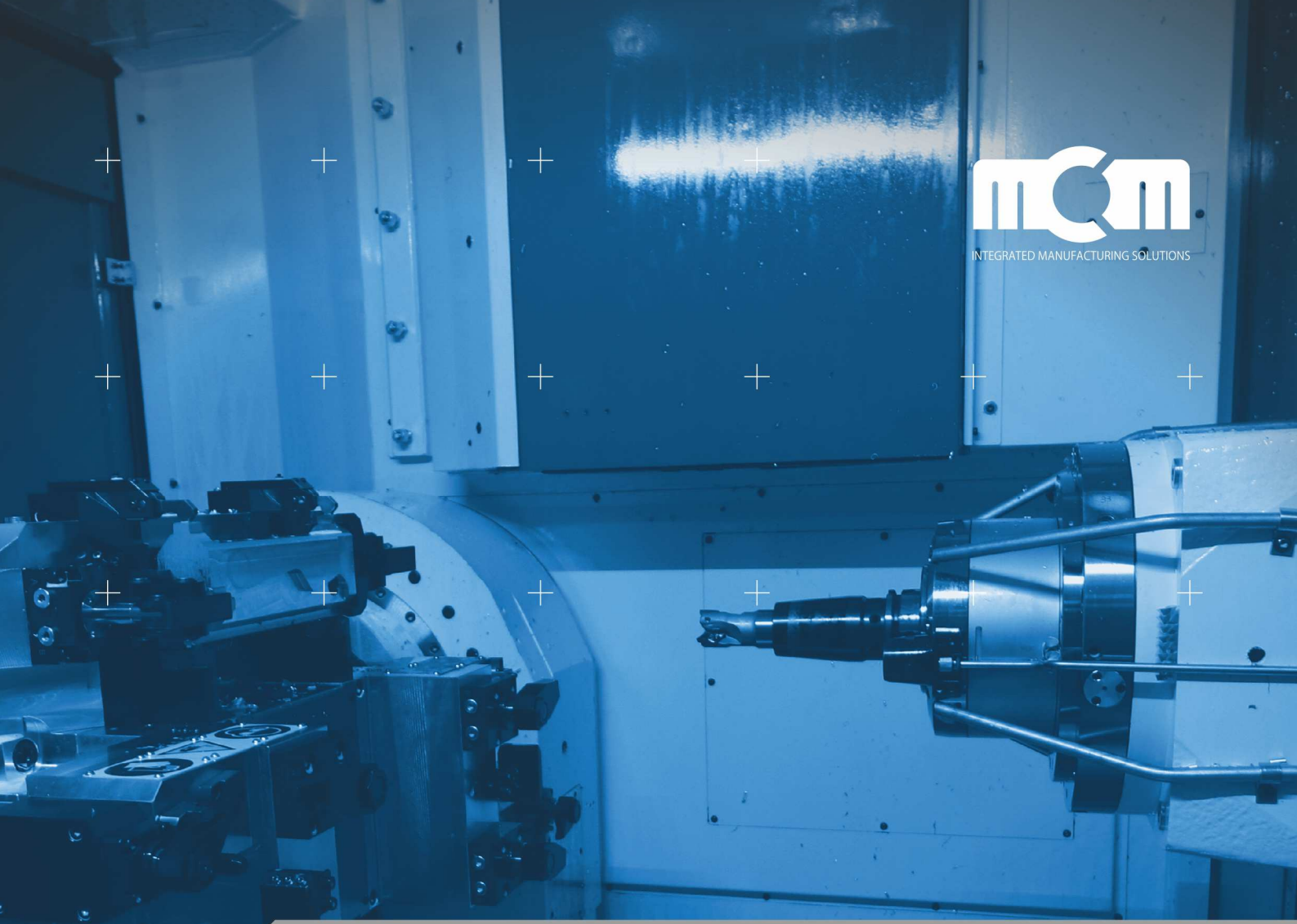
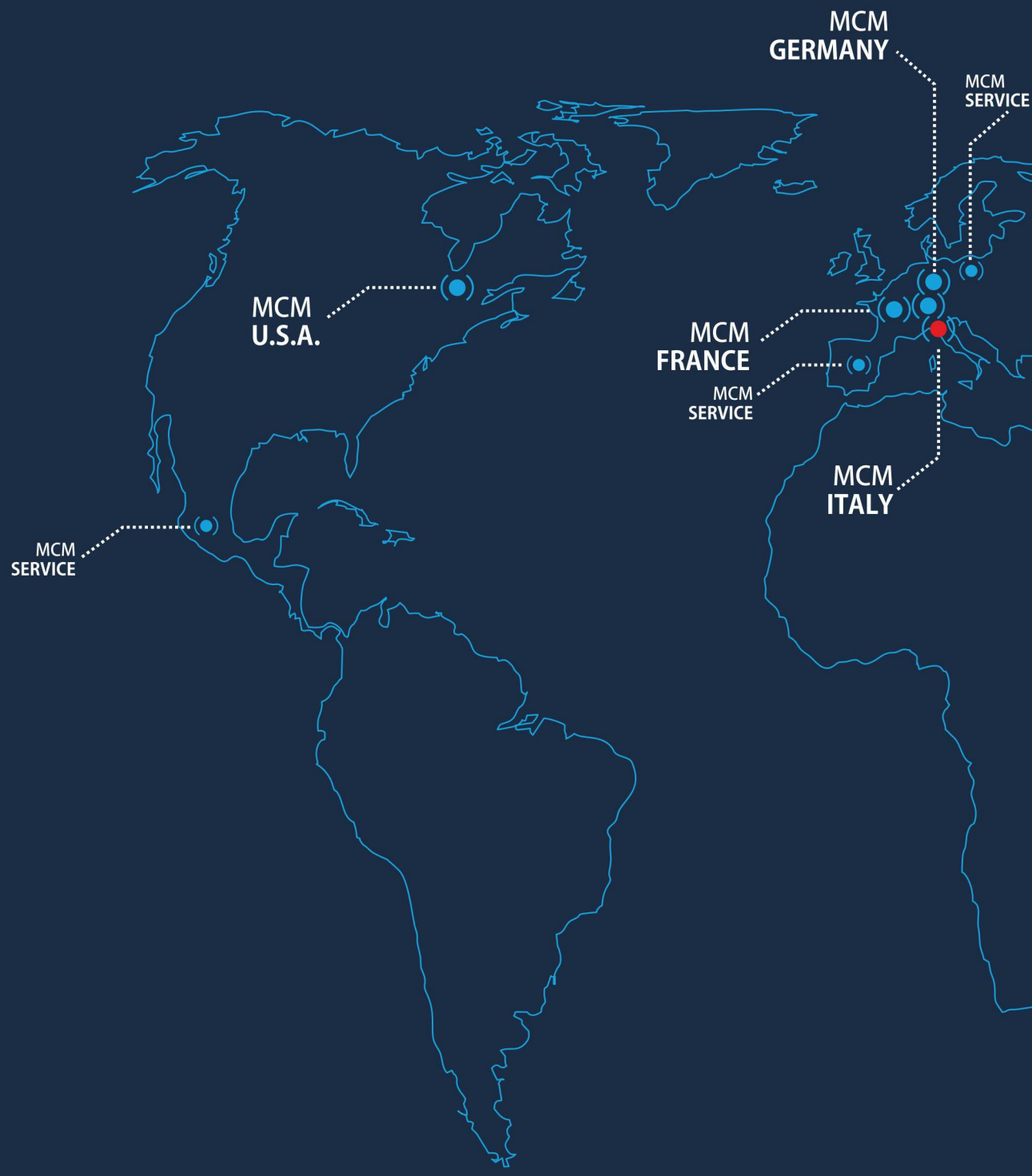


INTEGRATED MANUFACTURING SOLUTIONS

BENELLI ARMI

Flexible manufacturing
and dynamic process management

CASE HISTORY **#05**



AEROSPACE

AUTOMOTIVE

INDUSTRIAL

ENERGY
OIL & GAS

MACCHINE
ATTREZZATURE
E DIFESA

COMPONENTISTICA
INDUSTRIALE

BENELLI ARMI

Flexible manufacturing and dynamic process management

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.

Customer

Benelli Armi is the result of an idea of the Benelli brothers, already owners of the homonymous company from Pesaro, famous in Italy and in the world for the production of motorcycles. The brothers owners of the company had a great passion for hunting, and since 1940 they were considering using their knowledge in the field of precision mechanics to produce weapons. The idea materialized almost 30 years later, when Benelli Armi was established, in 1967. Since then, the company has grown, constantly investing in research and development, and acquiring an international market for sport and defence-related products. Since the beginning of the Nineties, the company started to invest considerably in automation, beginning a fruitful collaboration with MCM, which has been repeated several times, particularly in the Urbino factory.

THE TECHNOLOGICAL CHALLENGE

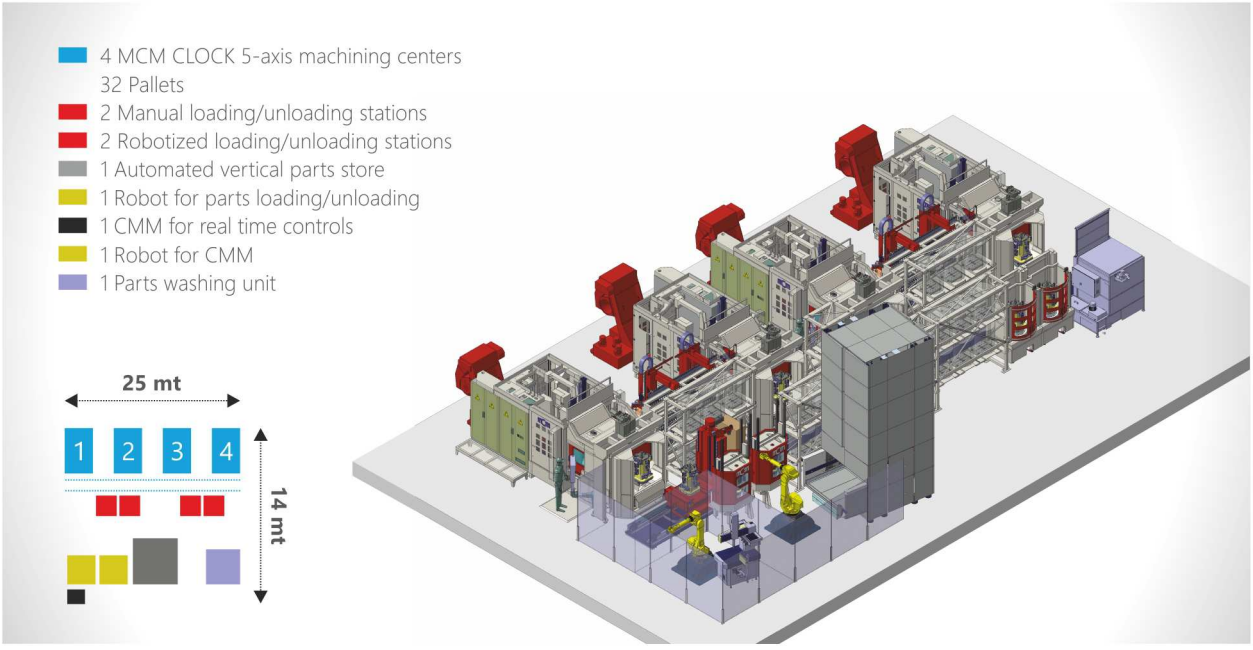
The production of Benelli Armi requires the manufacture of extremely precise parts, with very tight tolerances. It is also characterized by a large number of variables and production parameters. The process must manage a huge quantity of product part numbers and production batches. This need requires process automation compatible with the an extremely precise control, with a very variable production, both for the diversity of batches machined during the workday, and for the number and type of machining required for each workpiece. MCM was therefore involved in the design and supply of a flexible manufacturing system, as the natural development of a process that began in 1992, able to combine the benefits of automation with a great degree of flexibility, exploiting the significant experience and knowledge gained over the years with previous collaborations on the matter of automation. For its production, Benelli Armi uses almost only MCM milling machines - about 40 - which work automatically, even during unmanned shifts, 24/7. The components manufactured by these machines go then to the assembly department, which works two days in advance with respect to the production. The latter, therefore, cannot be interrupted.

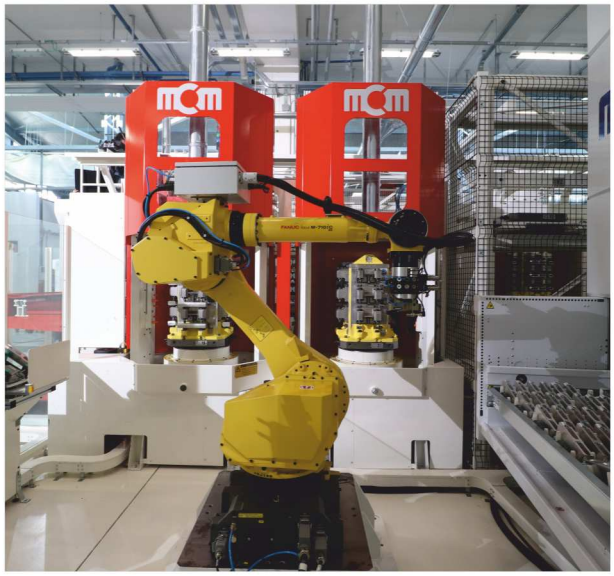
MCM SOLUTION

The innovative solution proposed by MCM for the latest FMS installed at the Benelli Armi factory in Urbino consists of a flexible manufacturing system in which four five-axis Clock machining centres with tilting table are integrated, served by a pallet holder shuttle and two operator stations for manual workpiece loading/unloading. There is also a robotized unit that handles the automatic loading/unloading of the workpieces on two additional operator stations equipped with devices for workpiece washing and blowing and automatic rotation of the equipment, the management of an automatic vertical workpiece magazine and a measuring machine that checks tolerances in real time during machining. There is also a washing unit facing the FMS to complete the machining operations. The double loading/unloading capacity, in automatic and manual mode, and in parallel, allows maximum flexibility in production management, even for minimum batches. In particular, the possibility to operate manually responds to a need of Benelli Armi, which pays particular attention to fixtures, using special multi-sided equipment. The fully automated stations, served by the automatic vertical magazine, give great autonomy to the unmanned production. The system supplied by MCM meets the need for a strong flexibility of Benelli Armi, both in terms of number of batches and active part numbers, managed in a fully dynamic way. This happens in conditions of strong and continuous evolution of the production, with the constant addition of new parts to be processed, the optimization of the production of existing parts and a constant refinement of the processes.

ONLINE CHECK

The characteristics of the workpieces machined by Benelli Armi before MCM intervention included many check cycles, carried out manually. In the new plant concept it was decided to include, in the automated cycle, a measuring machine, whose feedback, linked to the machine process, must be dynamic and also concern the part of the plant dedicated to the equipment selection. Benelli Armi has adopted this solution to obtain a data sharing, essential in the digitization of the production process and have, in this way, the characteristics of the workpiece immediately available online.





PRODUCTION MANAGEMENT

Benelli Armi, in defining the specifications of the plant, has placed particular emphasis on fixtures implementation. The loading operations for the parts to be processed in the production process developed by MCM for the company are organised in a sequence of numerous stages with long times. In particular, in this context, the positioning of multi-sided workpieces entails the presence of extremely binding conditions in the event of anomalies or fine-tuning of the fixture, which does not always maintain its stability. Therefore, in the event of a critical situation, it is essential to be able to interrupt the cycle, check the problem and restart without further downtime and waste of material, or risk of errors. For a long time now, MCM has developed standard management modes for production stages into consolidated machining steps, which allow customers to interrupt the process at any time and to restart exactly where machining was interrupted. In the case of the Urbino plant, this type of solution has been adopted, which allows to avoid adverse effects on the workpieces in the event of a temporary interruption in the machining, a possibility which could also be caused by a sudden power failure. The restart can take place exactly from the point where machining was stopped, without starting from scratch, without the need to have special skills and with an optimum management of the process, through reliable restart procedures managed by the single jFMX control interface. This is done in total safety and without any risk of collision.

FIXTURES

The hydraulic fixture requires the management of pressure and flow parameters for workpiece clamping on it, depending on the different production batches.
The approach taken was to set a fluidic management capacity standard at the operator stations, thus defining loading "parameters" chosen by the operators in charge or by the robot according to the batch part numbers. The simultaneous use of manual and automatic loading stations allows tuning, respectively, at a convenient point of the plant in manual stations, whereas the robot operates in automation mode on automatic stations (as well as verification tuning in case of robot maintenance) without compromising the production progress due to the operational availability of manual stations.
Another feature of the automated loading and unloading stations is the presence of an equipment washing system that allows to ensure, after workpiece unloading, the cleaning of support, reference and locking points before the robot loads the raw or semi-finished workpieces on the equipment.

SMART FACTORY

This solution fully exploits the potential of jFMX, the proprietary suite for supervision of automation systems, services to support machining processes and integration of production equipment. Specifically for Benelli Armi, a set of options are available for acquisition and pre-processing of data generated by the numerical controls of the individual

operating units integrated in the plant, both to set the zero point and replicate it periodically during the cycle, and to carry out online checks and sampling of a set of data coming from the fieldbus of the machines. The layers of the jFMX software, in addition to allowing sampling and pre-processing, at level 0, of the data collected from the individual machines, act as a glue for communication at a higher level with the ERP applications of the customer. Benelli Armi, considering the potential of MCM production systems and the set of software services organized in the jFMX suite modules that allow to have a large amount of data available from the field, decided to explore how to extract the great value associated with them, starting a research project in collaboration with the Università delle Marche. The final aim is to develop big data analytics algorithms for predictive maintenance and for the integrated analysis of the equipment ability to remain stable.

PLANT TECHNICAL DATA SHEET

4 MCM CLOCK 5-axis machining centers
Pallet dimension: 500x500 mm
Working volume: Ø750x600 mm
Spindle: HSK-A63 – 20,000 rpm – 30 kW
Mirror tool magazine: 482 places per pair of machines
Continuous tilting table
2-Position pallet exchanger
32 Pallets
2 Manual loading/unloading stations
2 Robotized loading/unloading stations
1 Automated vertical parts store
1 Robot for parts loading/unloading
1 CMM for real time controls
1 Robot for CMM
1 Parts washing unit

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