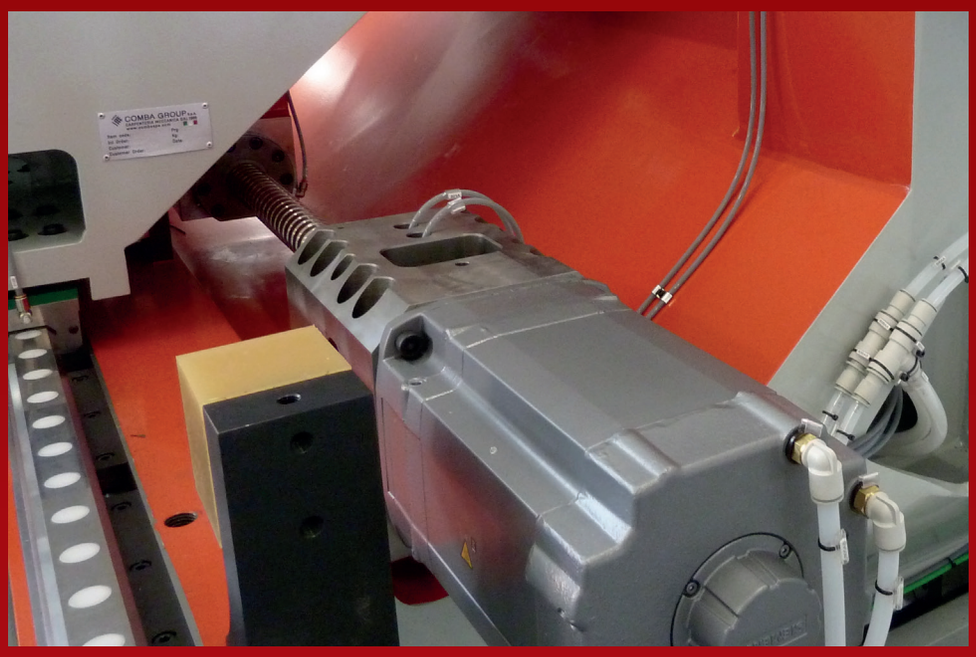
MULTITASKING MACHINING CENTER

SPARK 1200

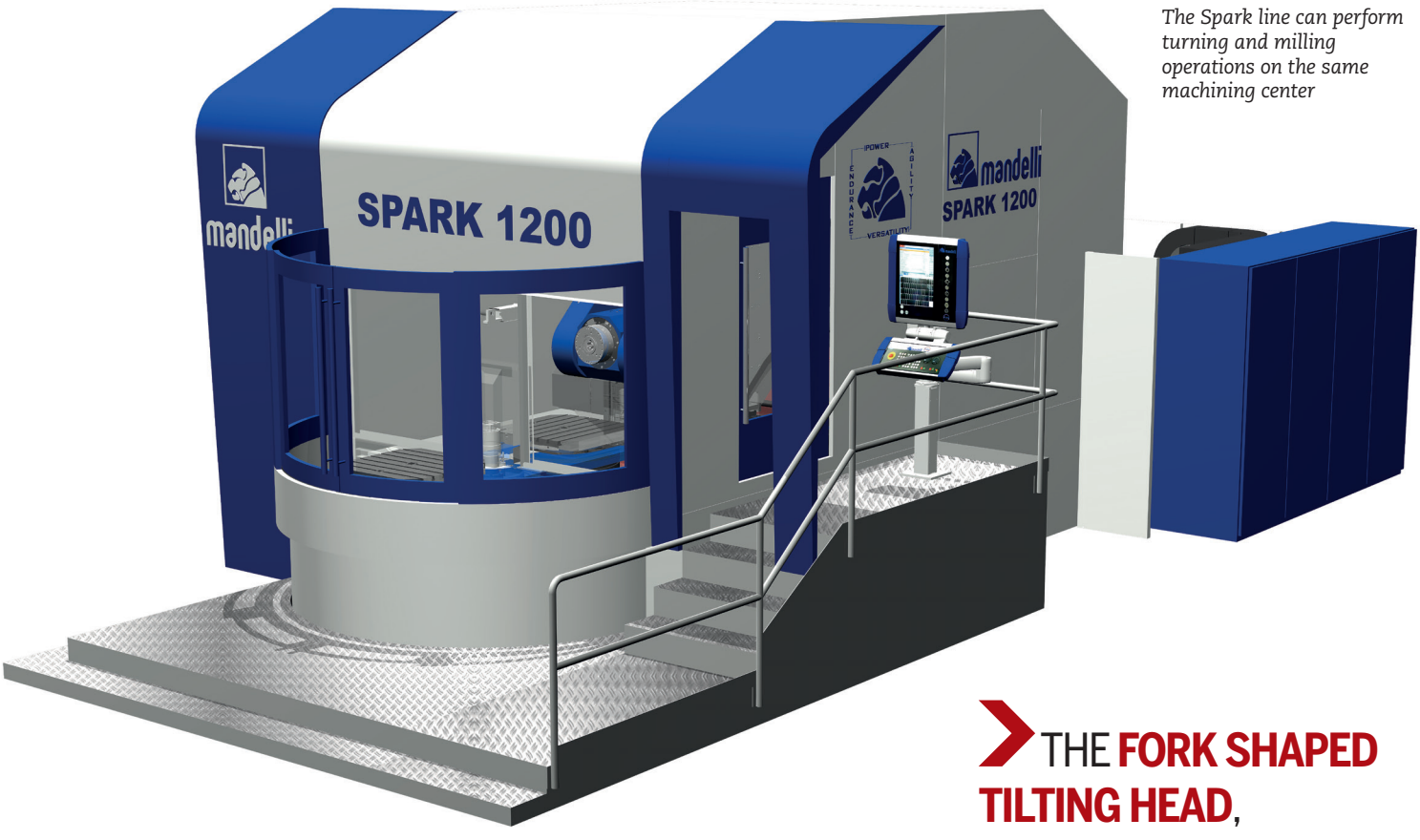
SPARK 1200 HAS BEEN DESIGNED TO PERFORM TURNING AND MILLING OPERATIONS AT BEST ON TOUGH MATERIALS **SUCH AS TITANIUM AND HEAT/WEAR RESISTANT ALLOYS.**

by Andrea Pagani

The aerospace industry is experiencing a moment of great excitement. Specifically, the most interesting technical and geometrical changes are taking place in the engine branch. The evolution of engines for the civil sector lies, in fact, in increasing the bypass ratio more and more, a design parameter of double-flow turbojets (turboventola). In modern engines the turbine not only provides thrust but also triggers the rotation in the first stage (the one visible from the outside of the engine body) which, just like the propeller models, conveys air to generate the necessary thrust or, in this case, to power the turbine. Increasing the bypass ratio means significantly reducing consumption and noise, two values held in high regard by airlines and, consequently, by aircraft manufacturers. The modification of these parameters implies an increase in the diameter of the first stage while the successive ones decidedly show reduced dimensions: since the external part is not subject to high temperatures, it is lightened thanks to the use of materials such as carbon or other innovative alloys. On the other hand, the inner part is made of tough metal alloys, often titanium based, resistant to wear and high temperatures and difficult to machine. For several years Mandelli Sistemi has given an answer to the needs of the aerospace industry thanks to the Spark line, in particular with the Spark 2100 and Spark 1600 multitasking models. However, the recent reduction in the diameter of the components has required the



The possibility to have a double worm-screw on all the linear axes ensures a perfect balance of the work forces



The Spark line can perform turning and milling operations on the same machining center

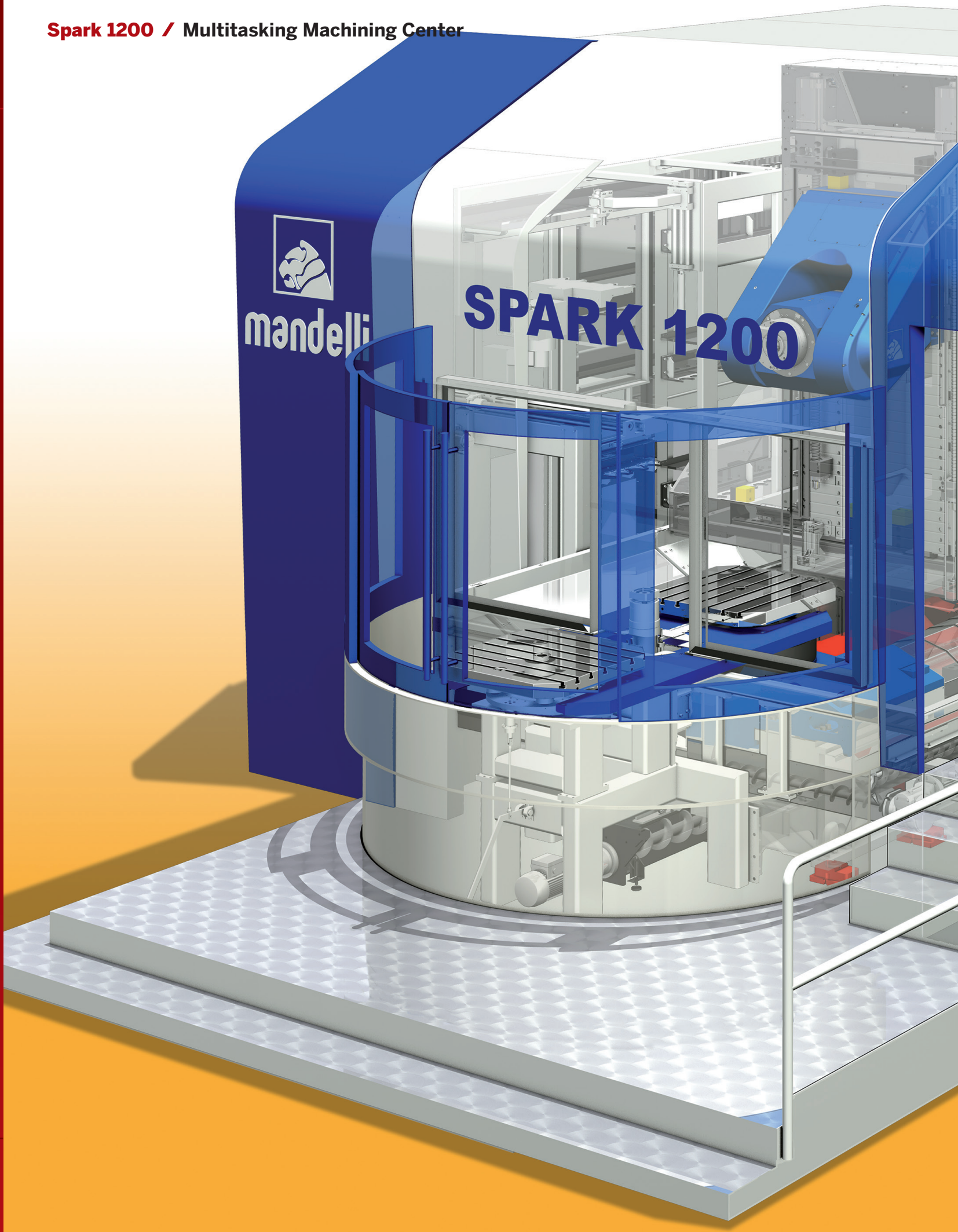
THE **FORK SHAPED TILTING HEAD**, ALTHOUGH REDUCED IN SIZE, CAN ENSURE A SIGNIFICANT TORQUE

The structure features internal beams resulting from FEM analyses and topological software

introduction of a new model, more compact and capable of all the innovations that have characterized this line over the years.

Real multitasking

The most evident characteristic of the Spark line is being able to perform turning and milling operations on the same machine. To reach optimal results it is strategic to be able to count on a totally hybrid technology where a vertical lathe and a machining center merge homogeneously. A specific architecture has therefore been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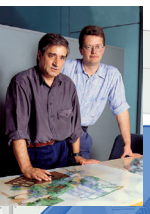
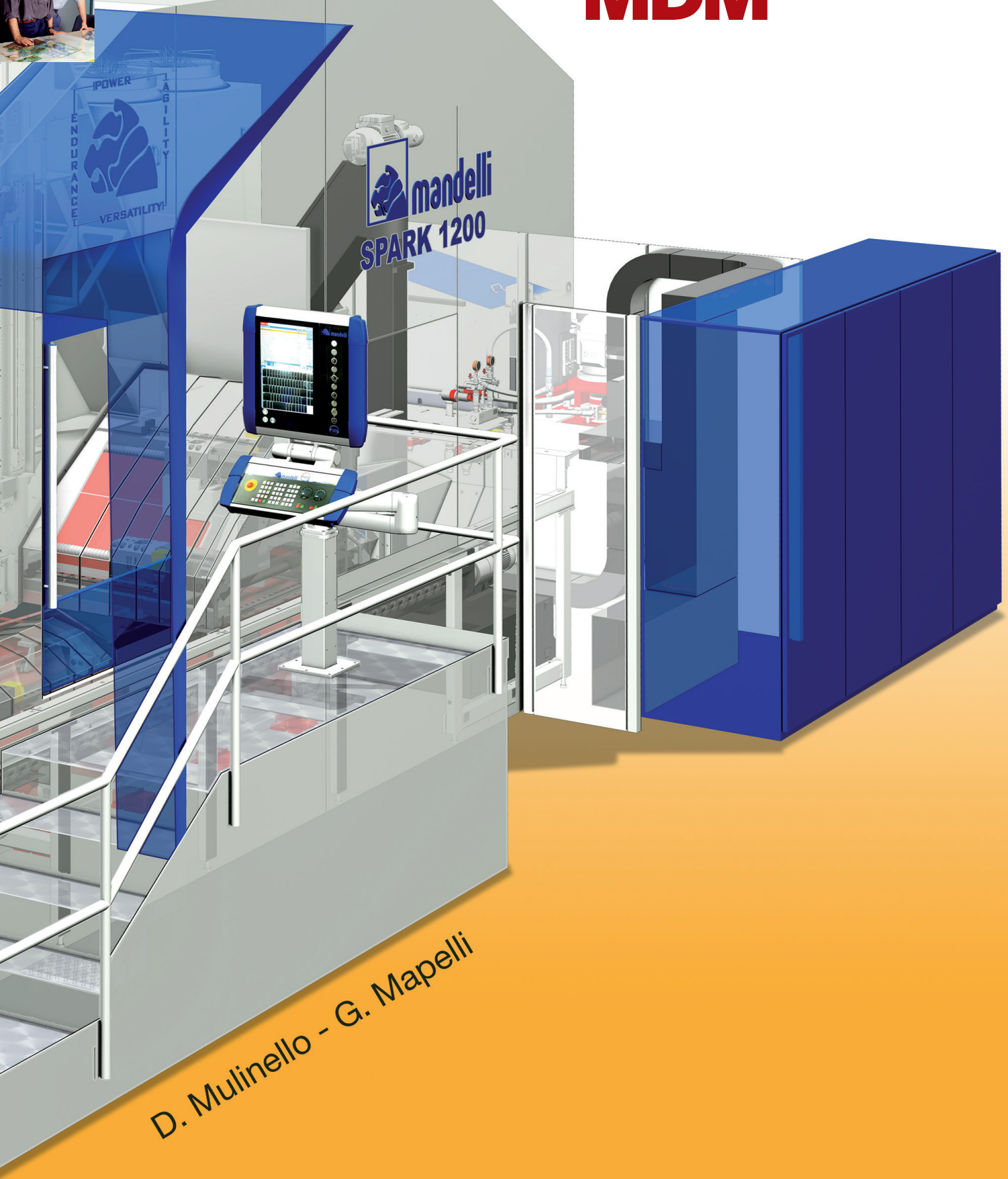
SPARK 1200



Seen by Domenico Mulinello and Giovanni Mapelli

MDM MACCHINA DEL MESE



D. Mulinello - G. Mapelli

IDENTITY CARD

NAME	Spark 1200
TYPE	Multitasking machining center
MANUFACTURER	Mandelli Sistemi Spa
	Via Caorsana, 35 - 29122 Piacenza
	Tel. +39 0523 548548
	E-mail: mandelli.info@mandelli.com
	www.mandelli.com

TECHNICAL FEATURES	
X Axis	1.200 mm
Y Axis	1.200 mm
Z Axis	1.450 mm
Pallet size	800x800 mm
Swing	1.200 mm
Workpiece height	1.100 mm
Rapid feed	60 m/min
Axes thrust (S1)	20.000 N
Axees acceleration	5 m/s^2
Accuracy	0,005 mm
Repeatabaility	0,002 mm

TILTING HEAD	
Spindle speed	6.000/8.000/15.000/24.000 rpm
Milling tool taper	HSK 100A/ISO 50
Turning tool taper	HSK 100T/Capto C8
A axis	+90° ÷ -110°
A axis drive	Dual Drive gears and motoreducers

TURNING TABLE	
Drive	Direct Drive
Pallet size	800x800 mm
Turning max speed	800 rpm
Torque (S1)	7.600 Nm
Power (S1)	72 kW
Max payload	2.000 kg

The rotary table in housed into the base to guarantee the highest turning performance

reserved to the multitasking models of the Spark line, with a rotary table housed within the HMC base and not positioned on a linear axis. This means high performance in turning mode both in terms of speed and stability just like on a vertical lathe. In milling, then, the appropriately dimensioned mobile column structure ensures maximum rigidity even with high axis dynamics, making Spark 1200 competitive both in milling and turning. Though conceived for the aerospace industry, the new Mandelli multitasking is an advanced and flexible machining center which best expresses in applications where it is required to combine stability and robustness in roughing with dynamics and precision in finishing.

Redesigned from scratch

At first glance, Spark 1200 doesn't just look like a "resized" Spark 1600. It is in fact the result of an optimization process over the last 10 years which includes all the distinctive features that characterize it, such as staggered slide-ways to improve rigidity, the option of a double ball screw on all the linear axes for a perfect balance of work forces, electro-spindles and direct drive tables generating very high torques and powers even in small spaces. The structure features internal beams resulting from FEM analyses and topological software where the main lines of force in the various stock removal operations have been identified so as to place the material exactly where needed and have the right rigidity without adding unnecessary mass (even counterproductive in terms of dynamics). The result is a static and dynamic rigidity comparable to those of much more massive machines. In addition to electro-welded steel, Spark 1200 features cast iron wherever vibrations are triggered: the head body, the rotary table support and the heads benefit from the damping power of cast iron

to reduce vibrations from the very beginning. To maintain the highest possible precision (5 micron in positioning and 2 micron in repeatability) Mandelli uses absolute measurement systems: optical lines on all the linear axes and encoders on the rotary ones (optical on the table and inductive on the head). To reach these results it proved necessary to intervene on the transmissions and this is the reason why on Spark 1200 all the engines are direct drives that have eliminated belt drives, source of instability, backlash and power losses; the machine is now decidedly reactive, as confirmed by an in depth mechatronic analysis in which, besides the structure, the engines and numerical control have been evaluated on the basis of behavioral and dynamic rigidity specifications that important aerospace key players have defined as performance targets. Since the machine has been designed to perform heavy machining on titanium and tough alloys, the X axis can feature a second screw to increase the stability of the Y axis and contrast its torsion.

The iPum@ ecosystem includes a predictive maintenance active project

Operating characteristics

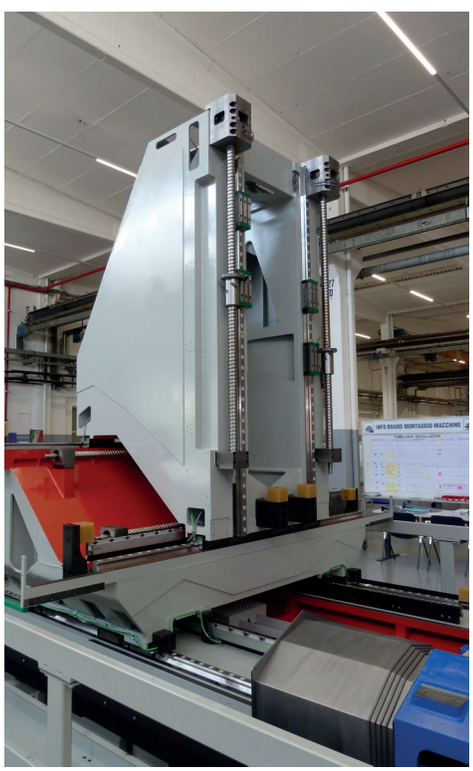
As for the linear axes, Spark 1200 features X and Y strokes of 1,200 mm and 1,450 mm in Z with a maximum workpiece height of 1,100 mm. The careful design has allowed for 60 m/min rapids with a 5 m/s^2 acceleration and a 20.000 N thrust. The Direct Drive table reaches a rotation speed of 800 rpm with a max payload of 2,000 kg the standard size of which is 800x800 mm and is locked on 4 ground cones.
Thanks to the 72 kW torque motor, the table can generate up to 7,600 Nm of torque in S1 (continuous performance) and, in order to limit thermal expansion and ensure maximum precision, an efficient coolant circuit has been studied. There is a double action brake with locking effect during machining and emergency in the event of a power failure or other potentially damaging events for the operator, the machine or the workpiece. The fork-shaped tilting head is innovative because, despite its small size, it can deliver a very significant torque with a backlash recovery system that ensures its accuracy and balances its delivery, makingitperfectlysymmetrical.Basically, Spark 1200 features a high torque electro-spindle (6000 rpm, 800 Nm in S1) but, for applications on less tenacious materials, it has options at 8000, 15000 and 24000 rpm. The temperature and vibration sensors detect any anomalies and transmit the relevant information to the numerical control to intervene appropriately. The tool magazine is a 100-pocket rack type that can be further expanded with other modules of 100 tools each. The standard attachment is HSK100A but it is also possible to have ISO50, Capto C8 or HSK100T tapers. Spark 1200 can either be configured in stand-alone mode, that is with a single pallet and piece loading from the top, or with an integrated pallet exchanger or multi-pallet systems to connect different machines in flexible FMS systems. The correct chip removal is ensured by a system of worm-screws: the lateral ones collect the chips projected against the box walls, the front ones collect those fallen behind the rotary table while a central one conveys everything to the back of the machine where a pre-filtering system with relaunch tanks separates the liquid part from the chips and sends it to the filtering plant. The coolant flows through three different lines: one at low pressure for the internal washing of the box and the workpiece; a medium pressure one that reaches the nozzles on the head; a high pressure one for the liquids flowing through the spindle and the tool. High flow rates and pressures are essential while

> SPARK 1200 REPRESENTS THE **NEW MANDELLI PLATFORM FOR AEROSPACE INDUSTRY** WHERE THE COMPANY IS INVESTING MOST OF ITS R&D

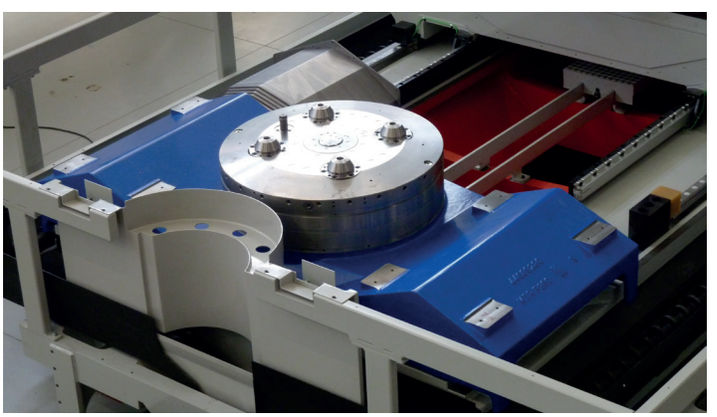
machining titanium, in particular when turning because they represent the best way to break the chips that might get harmfully tangled re harmful thus damaging the workpiece and the process. The increase in the performance of modern tools has allowed us to work with very high cutting speeds: the use of innovative materials, such as some ceramic or CBN tools, allows us to benefit from the dynamics of the turning table, provided that we use high pressure or even UHPC (Ultra High Pressure Coolant), which ensure up to 350 bar through the tool and allow for chip breaking and safe machine use even without supervision. Working with high and very high pressure fluids generates fumes: these are contained inside the box and taken out by the powerful suction system to ensure a healthy environment for the operator even when opening and closing the doors.

A forefront platform

Spark 1200 represents a new platform on which Mandelli is applying a large part of its R&D work for aeronautics.
As for the tool change and the pallet change, for example, the hydraulic and pneumatic actuators have been replaced with electric ones to have greater freedom in the management of the axes in terms of speed and acceleration (useful when particularly heavy tools are loaded) in addition to the simplicity of construction due to the absence of pipes and the related possible oil losses. The use of amphiphobic materials (i.e. oil and water repellent) coating the interior walls of the work area is one of the projects under study: the chips projected against the walls would not adhere to them and be removed more easily from the simple low pressure washing. The tests carried out on the use of cryogenic fluids are interesting too as they involve the use of nitrogen at very low temperature instead of the coolant to modify the performance of the removal process and limit the spread of heat inside the machine. To avoid chattering Spark 1200 can be equipped with active damping systems capable of intervening automatically. A patented system of actuators acts on the basis of the data collected by special sensors (microphones and accelerometers) and processed by a proprietary software. Furthermore, as part of the iPum@ ecosystem, a predictive maintenance project has been started to set the intervention timing based on the actual condition of the machine and its components: instead of replacing parts after a set number of hours (sometimes intervening with excessive advance compared to the real conditions of the components or, worse, underestimating the real conditions and risking a mechanical failure), the data detected



> IT IS STRATEGIC TO RELY ON A HYBRID TECHNOLOGY WHERE A **VERTICAL LATHE AND A MACHINING CENTER MERGE** HOMOGENEOUSLY



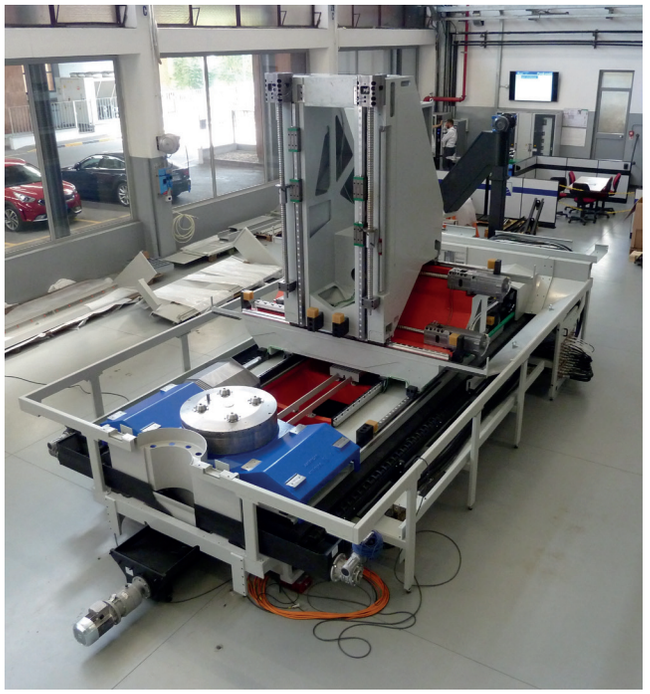
Left : the ball screws all have the same diameter of 50 mm to simplify the spare parts management

Right : the pallet table features standard dimensions, 800x800 mm , and it is clamped on 4 ground cones

by the sensors and appropriately processed by specific algorithms confirm, or not, the need for a maintenance intervention. The aerospace industry demand is increasingly driven both by productivity as well as precision and by the integration of multiple processes on a single machine, even eliminating the need for grinding thanks to the roughness values reachable with new tools. The concept of integration is not just about turning and milling, but also strategies such as power skiving, that is the synchronization of the two milling and turning spindles to make gear toothing. The reduction in the number of phases also improves precision: every time a piece is moved among several machines, inevitable uncertainty of positioning factors are introduced. Furthermore, having machines dedicated to a single operation can be risky in the event of unscheduled downtime. Remaining on the subject of power skiving, a single toothing machine downstream of more lathes means that the entire production will depend on the operation of a single plant. If, on the other hand, all the machines can carry out the toothing, a stop will reduce the factory overall productivity yet without interrupting the cycle.

The importance of details

Spark 1200 is designed to be installed in the workshop taking up a normal footprint without particular foundations: the aerospace industry is also attentive to productivity per m2, a fundamental requirement when the density of machines and the value of their production grows. A good industrial floor is therefore enough to secure the machine without costly foundation works. The panels are designed to be placed at the back of the machine to maintain a clean and regular layout but, depending on the availability of space in the workshop, it is possible to foresee changes. The same applies to the coolant tank positioned at the back near the filtering system to optimize the floor space. Ergonomics is not just a question of work: to simplify maintenance, for example, all the parts subject to periodic inspections are easily accessible. Last but not least, the ball screws all have the same size, ensuring interesting economies of scale for the end user as regards the spare parts warehouse. ■



To ensure maximum accuracy, Mandelli employs absolute measurement systems on all the axes