[MILLING CENTER]

by Andrea Pagani

Spark 1300 Titanium

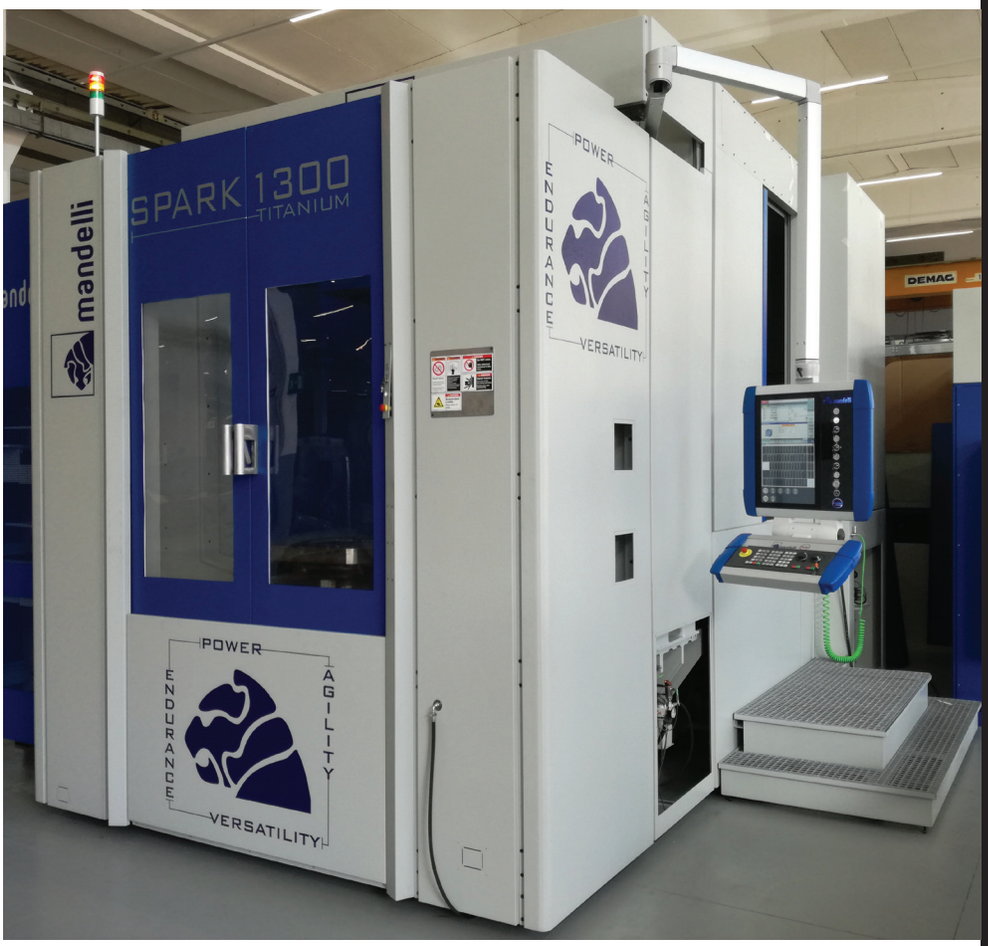
THE NEW SPARK 1300 TITANIUM BY MANDELLI SISTEMI IS SPECIFICALLY DESIGNED FOR HIGH PRODUCTIVITY MACHINING ON HARD MATERIALS, IN PARTICULAR TITANIUM.

Spark is a renowned line among the Mandelli Sistemi models : it distinguishes the high performance HMCs and it has been interpreted over the years in different versions and dimensions to meet the requirements of various industrial fields.
The most recent is Spark 1300 Titanium, an HMC designed, developed and manufactured to meet the requirements of those customers who daily work with this metal as well as with its alloys typical of the aerospace industry.

THE CRITICALITIES OF TITANIUM

Titanium is a material that offers very interesting manufacturing opportunities for designers: when talking about aircraft structures (that need to be lighter and lighter to be more efficient) it is important to know that you can rely on light though very tough alloys. Finished pieces can get to -10/15% of their initial weight with an MRR rate which is quite relevant. Besides, starting from forged work-pieces that present shapes much closer to the finished product, it is mandatory to have remarkable allowances to be sure that there are no forging flaws, inclusions etc. that may compromise the fatigue strength of crucial aerospace components. It is thus strategic to remove a significant amount of material. The downside is that this material is hard to machine.

The new Spark 1300 Titanium by Mandelli Sistemi



Resistant to high temperatures and aggressive chemicals, it presents a high resistance/weight ratio a condition that is causing trouble to traditional machining centers.

Many machines now on the market have good rigidity, removal and accuracy characteristics but, with respect to traditional types of steel, the variables with more recent materials such as titanium and its alloys are several and may impact more on the output.

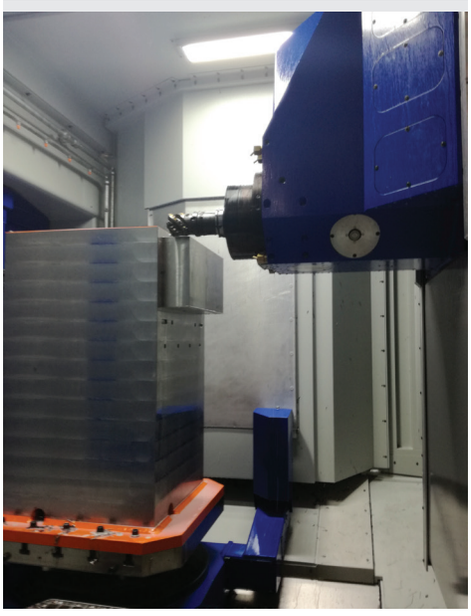
The higher coolant pressure and the modification of cutting parameters do not guarantee optimal machining.

The main step to increase the MRR is improving the dynamic rigidity of the machine-tool-workpiece system: to make such analyses the traditional finite elements method is not enough and more complex mechatronic simulations are needed, a field in which our area is in the forefront thanks to specific university courses and a wide presence of tech labs.

The dynamic rigidity takes into consideration the structural yield, the damping coefficients and the effect of the machining frequencies on the system response and it is namely on these damping factors that Mandelli has been working and developed devices that generate artificial dissipation phenomena during the cutting process.

Nowadays performances are simulated before manufacturing the machine itself so as to know with a good level of certainty how the equipment will be used and understand which component will be the first to undergo a crisis in every single machining.

This approach has allowed us to intervene on some construction aspects to get a perfectly balanced HMC.



Removal test at maximum height

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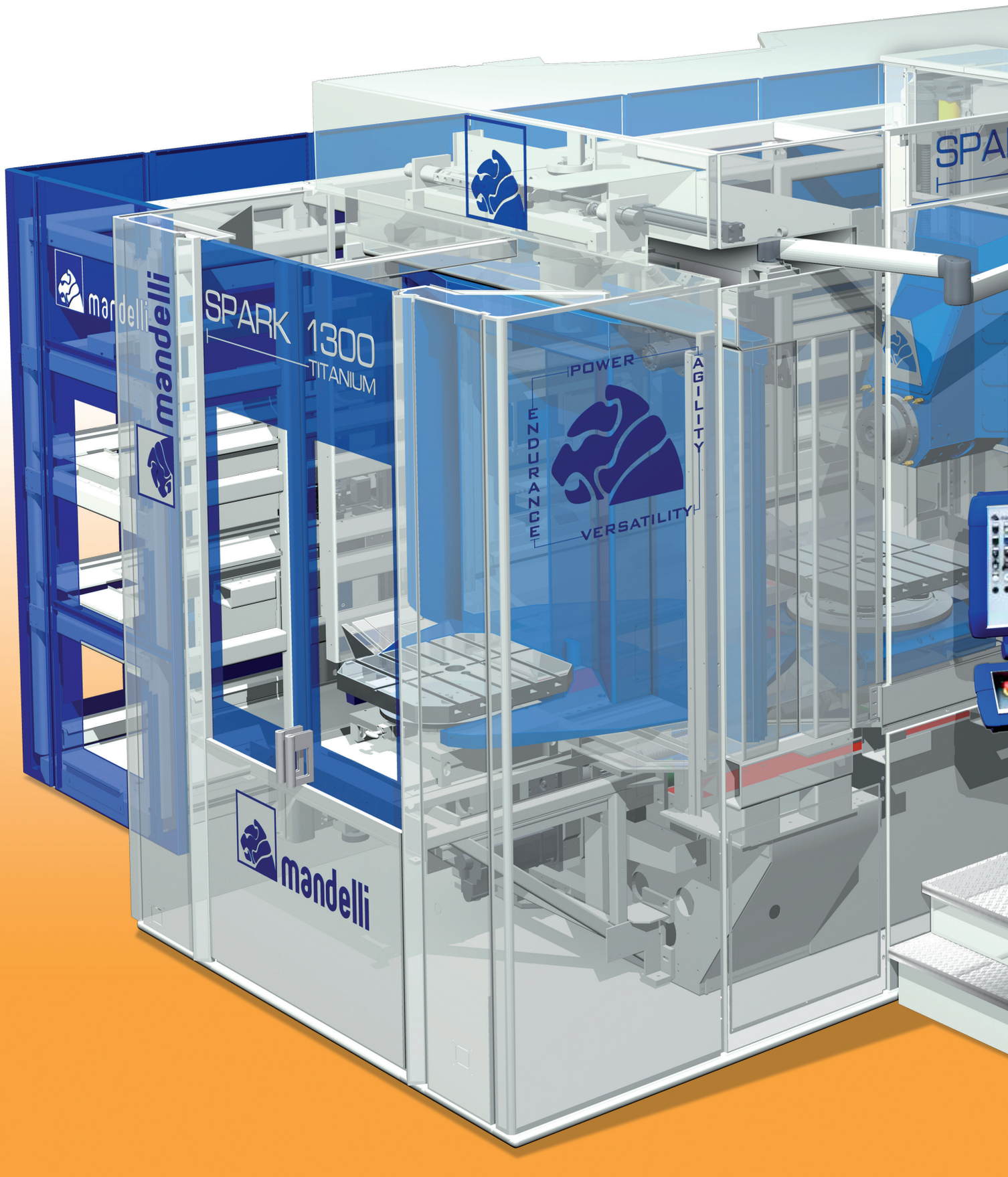
MACCHINA DEL MESE



by Domenico Mulinello and Giovanni Mapelli

Spark 1300 Titanium

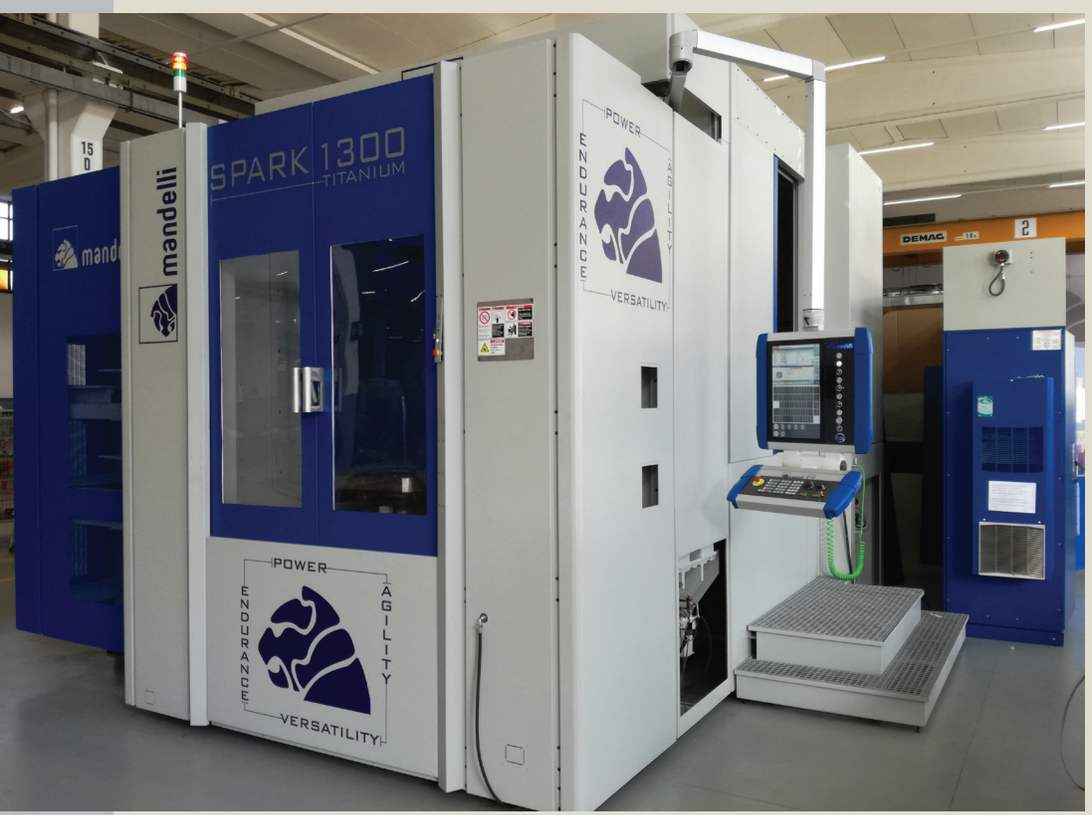
D. Mulinello - G. Mapelli

IDENTITY CARD

NAME	Spark 1300 Titanium
TYPE	Milling Center
MANUFACTURER	Mandelli Sistemi Spa Via Caorsana, 35 29122 Piacenza Tel. +39 0523 548548 e-mail: mandelli.info@mandelli.com Web: wwww.mandelli.com

TECHNICAL SPECIFICATIONS

WORKING AREA	
X Axis	1.300 mm
Y Axis	1.100 mm
Z Axis	1.050 mm
Thrust	18.000 Nm
Speed	50 m/min
Acceleration	4 m/s^2
Spindle power	77,5 kW
Spindle torque	2.666 Nm
Table load	1.500 kg
Table torque	4.800 Nm
Taper	HSK100 - HSK125



H6000 head featuring a 2600 Nm torque

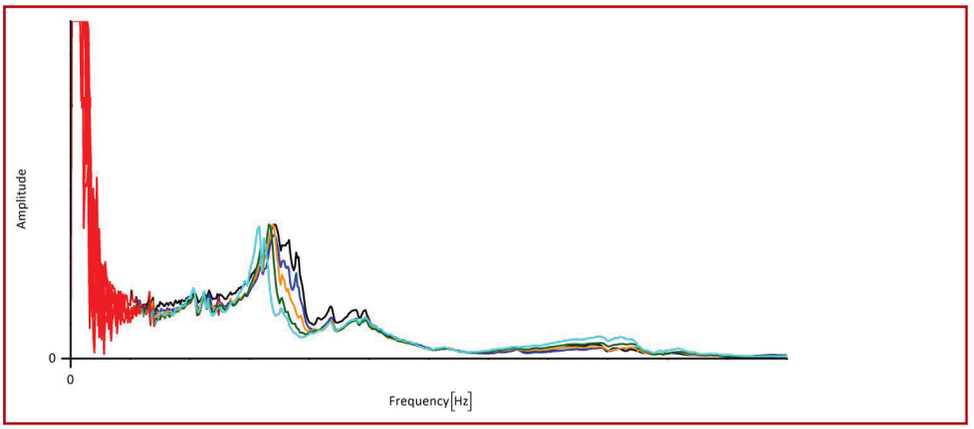
HIGHER MRR

Working with end-users to learn their key needs and problems (mainly a chip removal up to 500 cm3/min), Mandelli has equipped its HMCs with a series of technological devices that contribute to reaching the expected performances.

The most practical thing to do to increase the MRR is to increase the machining speed: ideal with aluminum, more complicated with steel and definitely harmful with titanium. In this case a viable option is to increase the machining depth which implies a higher torque on the tool.

This is why Spark 1300 Titanium features a spindle head equipped with an innovative cam gear that generates a continuous torque higher than 2600 Nm - available either with HSK100 or 125 taper - to

The dynamic yield is the basis to make an MRR forecast



further improve the tool/machine rigidity, duly supported by a 77,5 kW motor.
The second issue, more difficult to tackle, is related to the vibrations generated by the cutting process.
Once triggered they can splinter the cutting tools as well as the work-pieces whereas a duly balanced machine can preserve the last generation tools which are also rather expensive.
This is the reason why Spark 1300 Titanium features a special-pitch worm-screws kinematic chain allowing for a better thrust on the axes as well as a new vibration damping technology, a solution based on newly designed roller slides that, although available on the market, Mandelli has improved to better meet the vibration damping requirements besides working together with traditional roller slides.
In normal conditions the HMC guarantees maximum dynamics (up to 50 m/min rapids and 4 m/s2 acceleration) but in the presence of heavy roughing the additional roller slides can be activated to eliminate the vibrations created by the cutting process.
In fact, the slides create an additional friction that reduces the vibrations from 50 to 75%, a value measured through a vibration sensor placed on the spindle nose.
This function can be either activated from the machining cycle through an M code or triggered by the sensors and the NC, should higher vibrations be detected.
This adaptive milling does not intervene on the cutting parameters (as we said it is not advisable to slow down or accelerate on titanium) but it cuts the frequencies caused by the tool/work-piece contact. These dampers combine the benefits of roller slide-ways (accuracy, rigidity absence of stick slip phenomena, endurance over time) with those of the sliding ones (essentially a high damping factor) allowing for a 15% higher MRR.

TITANIUM IS A HIGHLY INTERESTING MATERIAL

FOR AEROSPACE DESIGNERS BUT IT IS DIFFICULT TO MACHINE

A TOUGH STRUCTURE

The Spark structure is made of steel (featuring twice the rigidity of cast iron with the same mass), while fixed heavy units, such as the rotary table, are made of cast iron. The Y axis design, usually a weak point of horizontal machining centers together with the rotary table during heavy machining operations considerably distant from the pallet surface, has been studied in detail to generate a staggered design solution to optimize the flexional rigidity and have a closed section at the back to reduce the structural torsional yield.
Those who work with these material know how important it is to know the machine to make the most of its characteristics. The removal of high volumes of chip implies parameters which have to be kept constantly under control to get to the expected productivity as well as avoid damage to the tools or the work-pieces; even the slightest changes in a parameter can cripple the whole productivity. During the testing procedures the HMC rigidity has undergone the hardest conditions, that is at the Y axis positive end-of-stroke, with the spindle positioned at the maximum distance from the pallet table. This condition endangers the stability of the rotary table bearing and Y axis structure but it can really occur during production if the HMC entire working area is needed to work. Spark 1300 Titanium has been able to remove a 1" x 2.5" section (equal to 25,4 x 63,5 mm) with a 60' cutting part useful life. The tests on titanium alloys are always carried out at a 45-50 m/min speed to simulate the real machining conditions and without increasing the rpm that bring to more stable frequencies but generate premature wear on the

The high coolant flow is strategic to machine titanium

SPARK 1300 TITANIUM FEATURES TECHNOLOGICAL

CHARACTERISTICS DESIGNED TO OFFER TOP LEVEL PERFORMANCES ON HARD ALLOYS

cutting parts. The fast ROI is due to higher productivity, reduction of tool costs, finished product quality and reduced downtimes guaranteed by the structure and components which have specifically designed for the purpose.

TECH SPECS

Spark 1300 Titanium can count on a 1.300x1.100x1.050 mm working area (pallet 800) and a rotary table (equipped with a 4800 Nm torque direct drive) capable of machining work-pieces up to 1.500 kg.

To ensure the above described MRR, the linear axes can generate a 18.000 N thrust in S1.

Wide is also the availability in terms of rack tool magazines: from 100 to 500 tools, a useful choice not only for a more profitable management of the tools but also to organize them by classes (dimension, weight, etc) and arrange the racks much better than the chain magazines. The dripping trays are also helpful to keep the HMC and the tools in the bottom racks clean. A high volume of chip requires a suitable disposal system helped by the coolant system.

The HMC is equipped with independent pumps for the spindle (outer nozzles) - one for the high pressure (inner spindle) and the other to wash the chip recovery tank to avoid buildup (always active when the spindle is rotating) .

Suitable worm-screws remove the material and convey it outside the HMC while the liquids are filtered and cooled. The whole system is controlled by the Siemens 840 D SL NC, a very popular model, especially with the aerospace industry, offering a series of functions that maximize the HMC uptime: remote controlling and monitoring are indispensable to ensure uptime rates close to 100%.

In the aerospace industry companies aim at the highest reliability so it is no surprise to have POs with 24 or 36-month guarantees and predictive maintenance plans.

The Siemens NC, together with the large number of sensors and the related devices complying with the Industry 4.0 norms, prove to be winning even under this aspect.

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