




*Machining of an impeller at  
Piaggio Aero*



**MANDELLI SISTEMI'S EXPERIENCE  
IN THE MACHINING OF  
TOUGH ALLOYS IS AN EXAMPLE  
OF HOW, EVEN IN SPECIAL  
MARKETS, GOOD PLANNING AND  
RESOURCE MANAGEMENT  
HELP GO WELL BEYOND  
MERE PRODUCTION.**

**[DEDICATED MACHINES]**

by Andrea Pagani and Loris Cantarelli

# Aerospace, when special is normal

Even more than in other markets, the Aerospace sector brings companies to precise choices in every aspect of their programming. To go into detail we meet Marco Colombi, Mandelli Sistemi's Sales Manager.

**The current situation**

Mandelli Sistemi traditionally produces machining centers for tough materials, HMCs characterized by high stiffness and stock removal as well as great accuracy over time, characteristics that blend well with the current trends of Aeronautics. The machining of tough alloys has always been in Mandelli's DNA but, in addition, all market researches confirm the growth of the aerospace sector for at least two decades, both for the replacement of the current fleets and to increase them with new airplanes: from now to 2035 Boeing expects 38,000 new aircraft while Airbus expects 32,500, data which are expected to grow even more.

Meanwhile the construction materials have changed: an airplane designed in the 80-90s had up to 70% of aluminum compared to the modern Airbus 350 and Boeing 787 having about 50% of composite and 17% of titanium - the latter being used in particular for structural applications - and nickel or cobalt based super-alloys for motor applications.

Besides, this development in materials has an impact on costs and on CO2 reduction, so it must also be considered under a "green" point of view: the direction is to use more and more sophisticated materials with a more and more



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efficient ratio between effective strength and mass. This is the reason why Mandelli has focused its resources towards solutions that would make the Spark line ( which also machines aluminum and traditional materials such as steel and cast iron with the same level of performance) even more performing also in titanium and super-alloys machining operations.

**Recent developments**

The innovations made by Mandelli in recent years can be basically divided into two areas: structural and engine-oriented.

«The first - explains Colombi - mainly consists in the manufacturing of components for landing gears ( *main cylinder, brake rod, torsion link* to name a few ), control components for wings like *flaps* and *slat tracks* and connecting elements between engine and wings like

*pylons* and *engine mounts*. Titanium dominates here and raw parts are usually forged with very important oversize: the most effective thing is to increase the volume of chips the machine can generate on these materials and for this we have worked in three directions». «One is to further improve the HMC rigidity - continues Colombi - and we have developed new HSK125 spindles with up to 1200 Nm continuous torque. The second, equally important, was to find solutions to reduce the vibrations generated by machining. Both on the rotary and the linear axes we adopt solutions based on sensors that, in the presence of vibrations, activate damping systems so as to reduce them. From the tests we have carried out ( in a typical roughing with an 80 mm helical mill cutters, both with and without these devices), the difference is a 75% reduction of vibrations

## AEROSPACE, WHEN SPECIAL IS NORMAL

detected at the spindle nose: so, if the component is tough enough, you can increase the cutting speed thus diminishing the cycle time. Otherwise, if the cutting parameters cannot be modified, the vibration reduction is ensured anyway having positive effects on the tool life and on those parts of the HMC which are less subject to wear. The third aspect is related to the coolant pressure and flow rate: for these structural applications we often have machining operations inside pockets (aerospace components have pockets with rather deep ribs) and have up to a 150 l/min coolant supply through the tool and pressure levels up to 100 bar to have a better chip removal».

### Higher efficiency

All aerospace parts have complex shapes and require 5-axis machining.

«When roughing, the typical machining is carried out on 3 axes, then you need to do a semi-finishing to get to an even allowance and then you can end with the finishing – says Colombi. When you have to machine an inclined surface, you usually work with locked axes and you terrace it, carrying out first a semi-finishing to reduce the allowance by 0,5 mm and then a finishing to get to the desired stock removal. It is clear that if there is the possibility to perform a 5-axis roughing to get to the desired surface finishing without additional semi-finishing operations, we avoid an operation and we consequently save time. In our case, we have both the roughing and the semi-finishing operations in a single step, without generating terraces. At BIMU we will be exhibiting a head with a 12000 Nm torque on the rotary axis which allows for 5-axis continuous roughing even with long tools to guarantee heavy stock removal and practically eliminate a machining operation, ensuring greater efficiency and maximizing the spindle characteristics».

Increasing the axes and spindle performance means increasing the cost of the initial investment but, in the end, the HMC hourly cost is repaid thanks to the HMC's greater efficiency: this also positively affects a company's organization often traditionally structured with *heavy duty* machines -

sometimes a little old - for roughing and modern production means for finishing, which implies dedicated departments and semi-finished parts in the workshop. On the contrary, roughing and finishing on the same machine optimizes the components flow by decreasing the number of rough or semi-finished parts in the workshop, simplifies their handling and, ultimately, provides greater profitability for the end user in *Lean Manufacturing* oriented organizations.

«It is often possible to take big steps forward with the purchase of new machinery and a collaboration between the owners of the technology and those who are familiar with the machine's features and performance – says Colombi. For example, with a very big project we had in Poland, we dealt with the details of the Boeing landing gear which

included 30 machining setups before and after heat treatment: thanks to Mandelli's contribution, we reduced them to only 12».

### Ad hoc Customization

Alongside with aircraft manufacturers, who often simply assemble subassemblies manufactured by other companies, work Tier 1 producers (manufacturers and assemblers of important details such as engines), Tier 2 producers (manufacturers and assemblers of less important subsets) and Tier 3 producers (generally contractors who simply perform mechanical machining): for this reason, according to its interlocutor, Mandelli must provide a specific solution. In fact, the "catalog machine" does not exist for a manufacturer like Mandelli which tends to supply tailor-made solutions.



*Mandelli's Spark while machining with coolant through spindle*



*Details of a Mandelli head installed on the Spark HMCs*



Left: machining of a landing gear section on Spark 2100X  
Right: a Mandelli application at SABCA



«Special applications and quite demanding customizations are quite frequent - adds Colombi. We have recently sold a couple of them in northern Europe, an application dedicated to the Aero-engine and a very special 7-axis machining center, including 2 diving systems and a third standard pallet table for preparatory setups, an extremely dedicated machine».

#### Production Management

We have mentioned above the lean manufacturing, synonymous with production efficiency: in addition to the main aircraft companies, this organizational method has also been adopted by Mandelli. Born in the automotive sector, where mass operations ( groups of fittings, standard cycle heads and tables ) were the rule, for decades the Lean methodology has

## THE LEAN PHILOSOPHY ENSURES EFFICIENCY

been extended in its broader evolution to all business processes and to other fields. At Mandelli this has had very important consequences " especially the reduction of warranty costs which, within a couple of years, have fallen by 40% - says Colombi. We work according to lean methodologies across multiple levels of the workshop, each month we deal with a specific problem with a full immersion of all the departments involved to solve it as

best as we can (*Kaizen event*). All business processes are mapped and evaluated according to KPIs (*Key Performance Indexes*) and implemented on the basis of the 5S methodology. For those who produce special plants the lean philosophy is very important: if the delivery time of a standard machine can be predicted on the basis of our experience, for special ones it is more difficult to guarantee the lead time because it entails many variables. We usually deliver within 12 months because we do a good job in the pre-sale phase trying to forecast all the possible inconveniences before the final negotiation, in order to have reasonable terms of delivery we can easily respect. Meetings and continuous checks that the lean philosophy requires on the evolution of projects allow for the identification of critical issues and quick action: even in the suppliers management, an accurate control of the progress of both internal and external activities allows us to achieve flattering results».



Morning meeting at the Mandelli Assembly Department Info Point