All pictures: StarragHeckert AG

■ StarragHeckert AG, Switzerland

Simulation for Greater Productivity

Mechatronic Support from Siemens aids in the achievement of ambitious turbine blade production goals.

When Swiss company StarragHeckert decided to develop a successor for its established HX blade machining series, it had a clear and ambitious target in mind: reduce the total cycle time by 30 percent. Only by achieving a high Overall Equipment Effectiveness (OEE) is it possible to turn a short cycle into high productivity. So what did this mean for leading designer Lukas Betschon? "We had to determine all the relevant factors in blade production that could impact productivity, weigh them and then completely redesign the machine, taking account of the milling technology requirements."

Precision prognoses

Once these factors had been determined, the team from StarragHeckert evaluated the influence they exerted on throughput, production quality and machine availability. To do this, the team systematically varied these relevant parameters using six different blades to generate example scenarios. Among the results yielded by the evaluation came the realization that the extremely precise movement dynamics involved in blade machining are strongly affected by resetting and control settings. While determining the maximum axis speed is a simple task that can be achieved with accuracy, it is not possible to design drive controllability and resets using conventional technology. The control parameters that can be set in the NC are derived from the interaction of the drives with the machinery mechanics. The natural oscillations of the machinery are the key limiting factors here. For this reason, Starrag-Heckert opted for a mechatronic simulation, allowing it to make reliable statements about the feasibility of the target values as early as the concept phase and optimize the machine design accordingly. Siemens provided the Sinumerik 840D for this purpose and took over the high-end simulation featuring interaction of drives, control, sensor technology and mechanical structure.

Mathematical model for simulation

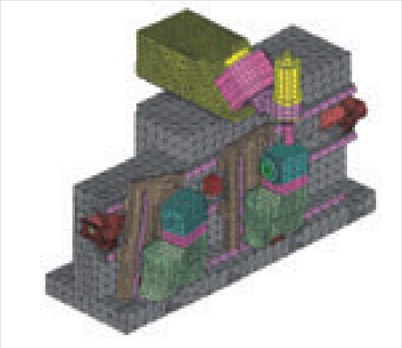
Mechatronic Support uses an FEM (Finite Element Method) model to map the machine mechanics; the dynamic properties of the drives and the control also form part of this model. During this process, the mechanical structure, the force transmitted by the drives and the retroactive effect of the load on the drives, are considered as a single complex system of mass spring oscillators. In the mathematical simulation, the model is subjected to an arbitrarily selected setpoint curve. The model responds in the same way as the machine that is not yet available and it becomes possible to accurately predict the machine's dynamic behavior as a result. In many cases, the machine dynamics influence only minor details. This means that strengthening a motor mounting or providing a more favorable ball bearing screw gradient can make it possible to run the drives at considerably higher servo gain factors, achieve a higher natural frequency for a machine component and adjust disturbance variables more quickly and effectively. The simulation locates limiting factors in the construction, drives and controllers. These limiting factors can then be addressed before the design phase ends.

The first blade in record time

The team from StarragHeckert continued to use simulation technologies throughout the rest of the project. Lukas Betschon tells us: “As soon as the results of the structural dynamics simulation had been incorporated into the design and development, and the first parts orders were received, we created a functional model of the future machine. This enabled the programmers to test the PLC programs and commission them without having to wait for the hardware.” During this engineering phase, the PLC side of the machine – or more accurately the behavior at its signal and data interface – was simulated in full. In terms of automation, this kind of virtual model of the signal and data interface provides a valuable reference to the machine. It enables programmers to work quickly and purposefully while the machine is still under construction. “The software is available as soon as the machine hardware is complete – and it has already been tested extensively and commissioned in advance,” confirms Lukas Betschon. “This means that the journey from commissioning and startup to the production of first blade took just two weeks. Two months is the norm for projects of this kind.”

Outstanding production quality

Even the first blades produced using the new LX 151 demonstrated much better edge precision and surface quality than those manufactured on its predecessor – and in the same machining time. The specialists from Siemens consistently optimized the Sinumerik 840D to the blade machining application and also made consistent use of the control features, such as contour movement management, integrated spline processing, data compression and technology-specific parameter adjustment. Interestingly, the LX 151 with the series number 001 was not actually intended for sale. However, as the practical evaluation of the machine design did not pinpoint the need for any major changes and because the mechatronic models of the machine were sufficient to serve as a complete reference point for further development, machine 001 is now able to prove its quality credentials in production. In addition to dramatically reducing the total cycle time, the focus on OEE-relevant influencing factors also led to an improvement in all quality features that impact productivity and profitability. ■



Overall Equipment Effectiveness (OEE) was the key consideration when developing a successor to the HX machine series

The new machining center produces blades more quickly than the predecessor model and boosts overall quality

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