



Making the Impossible possible

Turbine Specialist Alstom: 21-Axes Machine with PC-based Control from Power Automation

If it's about very complex applications in real time, then the CNC system normally requires a highly complex special solution. This often requires several processors, which are adapted to the machine with enormous efforts. Power Automation (PA) demonstrated at Alstom, that often less can be more. Here highly agile machines with 21 axes are controlled by a single PC-based CNC.

into production" machine did not yet exist. "In a first step we tried to change older 3-axes-machines, which were originally meant for bar processing and which therefore disposed of sufficient positioning range, into 5-axes-machines", Elenz reports." Already at that time, Power Automation was on board (at Alstom) as a NC specialist". The Siemens CNC of the original machine has been replaced by a PC-based CNC, which also had the new additional axes to control.

"The dynamic of the changed machines did not meet the present technical standard – but anyway, this was our first attempt", explains Elenz. "And for the lot size of 200 this compromise would have been totally sufficient".

This would be true if the new blade geometries wouldn't have been proven significantly more efficient than the previous ones.

"In this way the exotic special version suddenly became the new standard and we were faced with the challenge to produce it now and also at higher numbers of pieces".

Because at that time no suitable machine existed on the market, the



"The forms of the turbine blades have intensively changed since the early 1990's", explains Andreas Elenz, manager of the turbine blade production at the power station specialist Alstom." At that time a new blade would have been produced to optimize and to test the current reaction in a power

station turbine. Lot sizes were about 200 pieces. We wanted to rough and finish the blade completely in one set-up for economic reasons and also for reasons of precision. With the extraordinary three-dimensional geometry of the blade, 5-axes-processing was necessary".

For this process a "ready to go

The plant for the flexible manufacturing of turbine blades enfolds agile machines with 21 axes each to perform 5-Axes machining, which are chained with one another by an automated workpiece portal - a high-complex control problem.





First the turbine blade blanks are clamped between two hydrostatic rotary axes. Top and bottom surfaces are rough turned, then finished turned and finally dressed one after another. Then the processing of the blade geometry takes place.

Andreas Elenz: "Contour complexity, precision requests and accuracy become more and more critical, but we are confident, to face the challenges in the future".



blade manufacturer decided to develop a suitable solution on their own. They selected the well-known machine specialist Hamül Company from Meeder, Germany, to be their machine partner. And for the rapid controlling of the process the former already PC-based top-model PA 8000 NT from Power Automation (today: PA8000e) was chosen. Working together the team developed the HSTM2000, a high-speed turning and milling machine, which is applied to machine the complicated structures of the new blade generations.

The plant for the flexible production of turbine blades includes five agile machines, each with 21 axes for the 5-axes-processing, combined via an automatic workpiece handling system (an extremely complex control task). The axes machine the blades at up to 16 m/min (630 in/min).

First the turbine blade blanks are clamped between two hydrostatic rotary axes. Top and bottom surfaces are rough turned one after another, then finished turned and

finally dressed. Then the processing of the blade geometry takes place. The PA 8000 NT controls, via channel 1, the axes X (a gantry), Y, Z, A and B (a gantry) as well as the axes U and V, which are working parallel to the X-axis. On the blade an accuracy of 1/100 mm, in the functional area an accuracy of 5 µm is achieved. The surface finish of the blades must be between 32 to 63 micro inches (N7 or N6).

"The turbine blade geometry produces high quantities of data which have to be processed quickly", per Bernhard Hilpert, CEO of Power Automation. "Such a part program includes between

140,000 and 300,000 NC blocks for a file size of about 10 to 20 MB". Conventional CNCs are normally starved for data attempting the processing up to 1000 NC blocks per second. According to Hilpert, the Power Automation CNC processes 7,200 NC blocks per second continuously.

"Our CNC systems are running totally on one single processor", Hilpert explaining the speed advantage". The present high speed PC processors, which we use for our CNCs, are extremely powerful and above all extremely reliable. What nowadays consumes most of the processing time is the



Clearly arranged: The rapid brain of the machine – the powerful PC-based CNC PA8000NT from PA Power Automation.

Profile

Alstom Germany,
Bexbach Factory Division

In the business year 2003/2004 Alstom did 16.7 billions Euro worth of business. They employed more than 76,000 employees in more than 70 countries worldwide. Alstom Germany employs about 7,000 employees at with about 2.4 billion Euro worth of business. In Bexbach, of the Saarland steam turbine blades, compressor guide vanes, gas turbine guide vanes and gas turbine rotor blades are produced.

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Fire test passed: Suitable for complex tasks

Meeting the complex demands of automation, the PC-based CNC of Power Automation is suitable for such task like the controlling of the multiple axes machine for the turbine blade manufacturing. Her open architecture and the concentration to one processor lead into rapid and flexible production. The integration of parts of the post processor into the CNC provides for an optimal performance.

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communication between the CNC components. In the PA CNC, simply explained, the processing bottlenecks are minimized due to internal structure of the process. Even in the worst case the internal communication still takes place in the processor at 500 MHz. Most traditional CNCs use external communication between processors. Even the fast PCI-Bus runs with a rate of just 33 MHz from which only a fraction is effectively useable.

The PA CNC offers one further important advantage: because enormous parts of the post processor are integrated in the CNC, the part programs can be changed in a very flexible way. Traditional CNCs move single NC-axes, where the movements have been calculated offline. Hilpert explains the difference with the PA CNC: "Mathematically explained we are moving the complete machine around the workpiece. The CNC takes care that the movements of the single axes are calculated in real time!"

The post processor in the CNC has the advantage, that the potential of the machine can

be used to its limits, because the CNC "knows" the dynamic limitations of the axes exactly and takes care of the limitations in the calculation. This is all possible with the 3D-Look-Ahead function: "The programmer can define the maximum velocity. The CNC reduces the speed at critical points itself", explains Hilpert. "In this way the machine works always with the optimal feed".



CNC reduces feed rate automatically.

For demonstration: If a workpiece is shorter than expected or the blade blank is not clamped exactly, then an adjustment can be made by the CNC in real time. "For a blade we now need only one part program. We can run this immediately on all machines", explains Elenz, "because the machine-specific adaptations happen in the CNC".

It took half a year until the new machines produced without problems. "The machines are now running non-stop up to 7 days per

week. They are handled by three colleagues", Elenz says. "We don't test programs anymore – after the simulation run on the CAM-Software we go directly on the machine. So far, we have had no bad experiences. The PC-based CNC from Power Automation is highly reliable".

For Alstom, Power Automation is a reliable CNC partner. This is the reason why the company from Pleidelsheim, Germany is also first choice supplier of CNC components for the machine retrofit programs of Alstom's machinery. Right now several proven machines are retrofitted for new tasks.

With the open PC-based CNCs Alstom feels they are well prepared for the future: "Not only the complexity of the contour but also the exactness required and the accuracy of well defined surfaces are becoming more and more critical – but we are confident to face the challenges of the future with our concept".

RW / translated by Ingrid Hilpert



Full feed rate: The CNC knows exactly the dynamic limitations of the machine. Thereby the full machine potential can be used.



User-friendly: The terminals present an excellent overview of the program execution. Cameras transmit live-pictures out of the production area. In this way the operator receives always all necessary information.



The Users Opinion

The Technology:

PC-based CNC PA 8000NT

The User:

Alstom Power Generation AG Vane Manufacturing, D-66450 Bexbach

Advantages

- Complex CNC Tasks in Realtime
- Economical
- Good Value
- Open Solution
- High Efficiency
- High Throughput
- Flexible

- Post Processor integrated into the CNC
- Simple Handling
- Simple Corrections
- Intelligent 3-D-Look-Ahead
- Very Fail-Safe
- Program runs after Simulation directly on the CNC
- PA is a reliable Partner, with excellent Service
- Solution is prepared for the Future

Disadvantages

According to Alstom: none