

COMPETENCE



FALL 2017:

LIEBHERR MACHINES BULLE SA

A BENCHMARK FOR THE PRODUCTION OF LARGE DIESEL ENGINES



strong. precise. customized. digital.

TURNKEY-SOLUTION – COMPLETE MACHINING OF LARGE DIESEL ENGINE CASES WITHIN A SINGLE PRODUCTION CELL.

LIEBHERR invests in a manufacturing cell for two new motor series with 12, 16 and 20 cylinders.

Liebherr Machines Bulle SA (LMB) has completely automated the production of large diesel engines: Together with the companies Liebherr Verzahntechnik GmbH (LVT) from Kempten, Germany and BURKHARDT+WEBER (BW) a unique production has developed that sets new standards for heavy workpieces.

Searching for a strong Partner

According to the ideas of LMB, the complete rough- and finish-machining, including crankshaft and camshaft bores, milling, drilling, deep hole drilling plus process-integrated quality controls, large volume storage of cutting tools, integrated automatic process monitoring, automatic tool exchange and minimized set-up times, reduced component transportation times and reduced process waiting times were to be combined into a low-manpower production solution. "The right machine tool manufacturer was then found rather quickly," explains Klaus Bosch, production manager for diesel and gas engines at LMB. For this size of engine, the number of providers is limited. "BURKHARDT+WEBER was the only one who could offer solutions to all our problems and had already implemented them – albeit on a smaller scale. That created the necessary confidence for such an extensive and large investment."

Five Machining Centers of the MCX series

For the first production phase, the decision was made to start with two well equipped large horizontal machining centers (HMCs) of the MCX series with highest

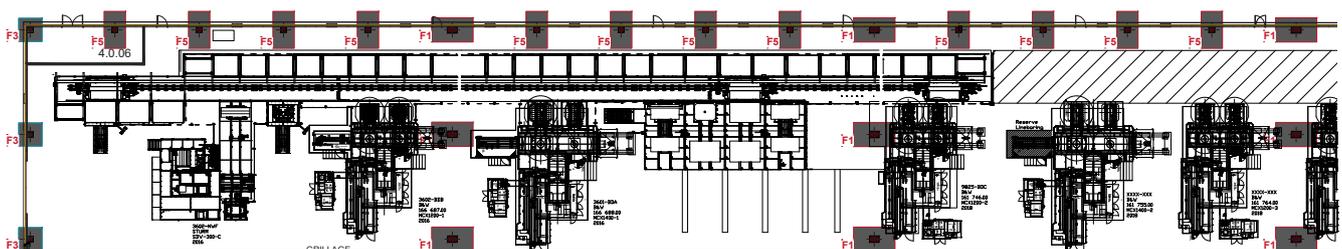
power density and performance. Both HMCs, the MCX 1200 and the MCX 1400, are highly dynamic machining centers with linear roller guide systems. They are integrated into the Liebherr pallet handling system (PHS) 10 000. Payloads of up to 13,000kg (28,660lb) are handled with this PHS. The engines' production volume in Bulle developed even more positively than planned. This resulted in an early order placement for the second phase extension with additional three machining centers of the same series. The final production target at Bulle defines a production line of 150m (490ft) in total length with seven integrated HMC's.

The Production Line

The entire process responsibility of the project was ordered from BW. This comprised the engineering of the complex hydraulic clamping fixtures, the cutting tool design and partially the procurement of special tools. Furthermore it includes that BW, as a turnkey supplier, supplies the time and quality proofs for machining the crankcase. In addition to the BW machining centers, the fully automatic production line in Bulle features a PHS for transporting machining pallets loaded with heavy workpieces and clamping fixtures of several tons, as well as a machine for cleaning the final assembly of the motor.

Flexibility, Precision and Accuracy paired with a High-Level Automation

Liebherr's V20 version of the new D98 engine series is rather impressive in size: With a length of 2,720mm (107 in) and a weight of 2,700kg (5,950lb), it was not possible for LMB to machine the workpieces with their



"The target is a complete machining process for complex engine cases within a fully automatic production system."

Stated Klaus Bosch, production manager for diesel and gas engines, Liebherr Machines Bulle

installed machine base. For the implementation of a new machining process, some of the operations require an upright block orientation for machining, a demanding technological solution. Even more impressive, when looking at the very tight machining qualities LMB demands. "To achieve this for the large workpiece sizes and the single-digit micron range form and position tolerances, only machining centers of the MCX series were considered," explains Michael Wiedmaier, Global Sales Manager at BW. "These HMCs are generously dimensioned for rigidity and feature powerful high-torque spindles. They are equipped with preloaded precision ball screws or for very long axis travel length with preloaded precision rack and pinion drive systems. This guarantees highest long-term accuracy, even when rough- and finish-machining is combined."

Feed Station for Line Boring

A special feature of the machining process is the integration of the finish machining of the crankshaft and camshaft bores together with generating the thrust faces. Usually a special machine is installed for this operation. BW offers this operation integrated. The respective special boring bars with an overall length of up to 3,100mm (122in) for the crankshaft and camshaft bores are transferred automatically. If the corresponding machining is in progress, the appropriate crankshaft and camshaft boring bars are inserted using a hydraulic part fixturing concept. The sequence is started by a CNC subroutine. The fixture concept in-



Automatic Line-boring Bar Feed Station – Made by BW.



Vertical Workpiece Holding fixture. – Made by BW.

cludes fully automatic installation of bushings for guidance, acting as bearing support for the long boring bars. Thus, this production process ensures achieving the very tight tolerances for roundness, parallelism and angularity.

Highlight Tool Magazine and Management

250 tool positions per machine are available to LMB in the highly flexible variable matrix tool magazines (optional up to 608 tool positions). The stored tools include some special tool designs from BW. The tools can weigh up to 75 kg (165lb) and have a maximum length of up to 1,000 mm (39.37 in). For LMB, the production cell management software has been enhanced with specific features – such as an envelope analysis for stored tools, integrated into the tool management. Also included are drill breakage control and a tool taper cleaning. Both operations are performed outside of the machining process automatically.

Support by Additional Tool Pick-Up Station

The length of the deep hole drill for machining the oil holes has a length of 1,725 mm (68 in) and exceeds the

A 150 METER (490 FT) LONG PRODUCTION LINE WITH SEVEN INTEGRATED BW-MACHINING CENTERS.



2-part fixtures with automatic loading of guide bushings for the camshaft bores.

maximum capability of the tool magazine. This was solved by a pick-up position on a workpiece pallet. A subroutine call automatically picks up the deep hole drill with the machining spindle.

Complex Part Holding Fixtures for Engine Cases

The goal was to develop clamping fixtures for the several ton heavy workpieces, which ensure optimum processing and easy part handling. Re-clamping of workpieces always requires a lot of time. The application engineers of BW analyzed the entire manufacturing process and determined the clamping sequences with practicality in mind. Optimum action sequences provide easy set-up, reliable part clamping and good machining, so that the operator only has to start the hydraulic clamping process. The different clamping actions for aligning, locating and clamping the crankcase require sophisticated sequential circuits to control push-, tension- and clamping-cylinders. Special horizontal and vertical clamps needed to be developed for optimal handling. The final concept for the D96 crankcase utilizes six fully automatic hydraulic clamp-

ing fixtures, and the D98 crankcase requires seven automatic hydraulic fixtures. LVT from Kempten, Germany, together with the machine supplier and turnkey manager BURKHARDT+WEBER, created this new type of production concept for large diesel engines. After two years of intensive planning and project completion, a trend-setting production started operation. Orders are now transferred from the ERP system to the Soflex System-Controller, which coordinates the machining sequences in the machining centers, manages the complete logistics and storage from raw to finished parts and the cutting tools. It transfers the CNC part programs to the machines and provides the employees at the set-up stations with the correct information and supplies the materials needed.



From Left to Right: Sébastien Bussard (Project Leader, LMB), Klaus Bosch (Production Manager, diesel and gas engines, LMB), Stefan Jehle (Department Manager - Sales LVT), Michael Wiedmaier (Global Sales Manager, BW).

With the completion of this highly detailed project, the LMB team enters a cutting edge new production era. "Our system controls all work steps and processes. It ensures an optimum utilization of the machines, the plant and the operators," Sébastien Bussard sums up. "We have successfully achieved Industry 4.0. We are very satisfied with the quality of our products and can respond to customer orders with complete flexibility. Thus, we achieved all the goals we set ourselves for this project."

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