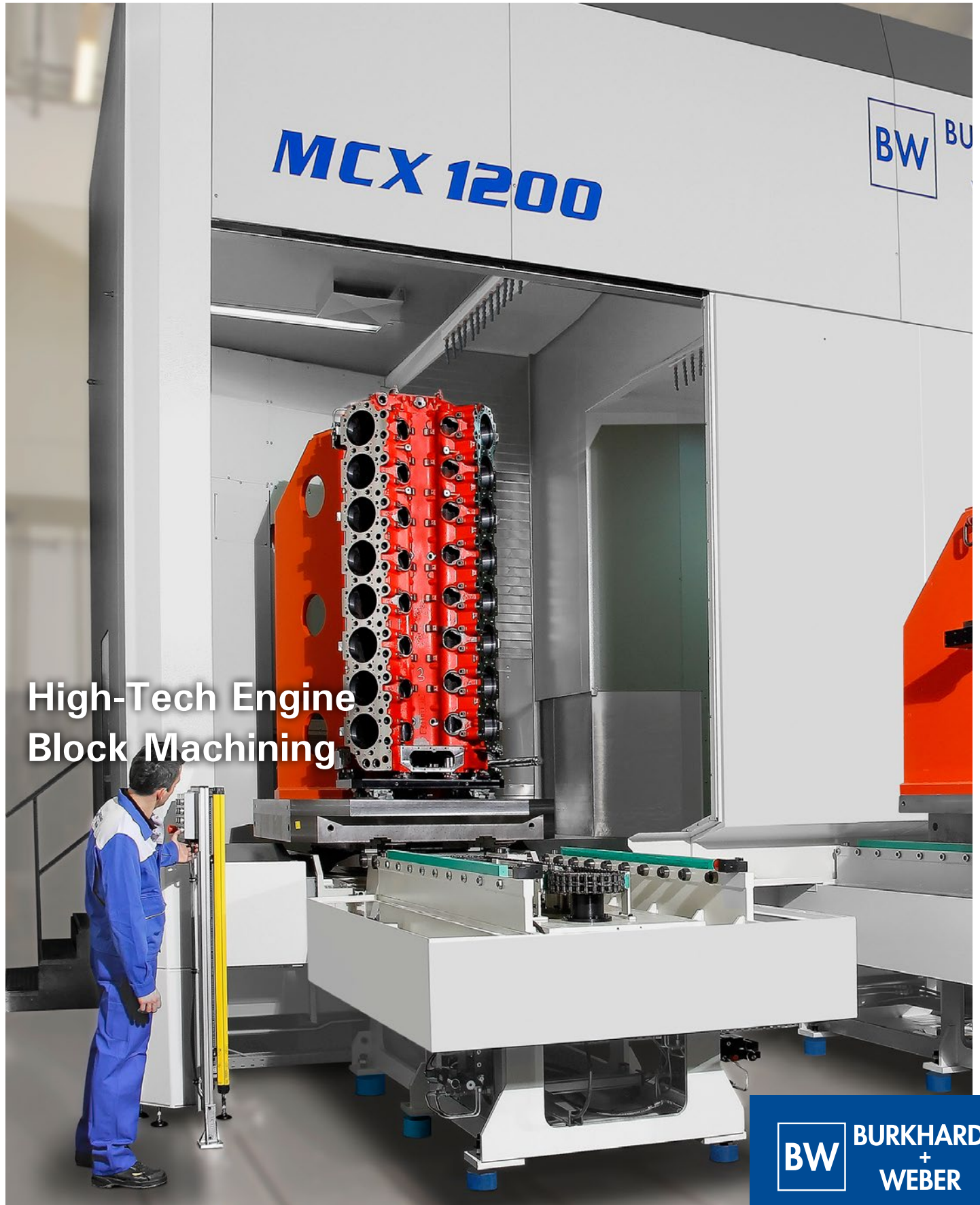




COMPETENCE

BURKHARDT+WEBER PROJECT-REPORT
SPRING 2014



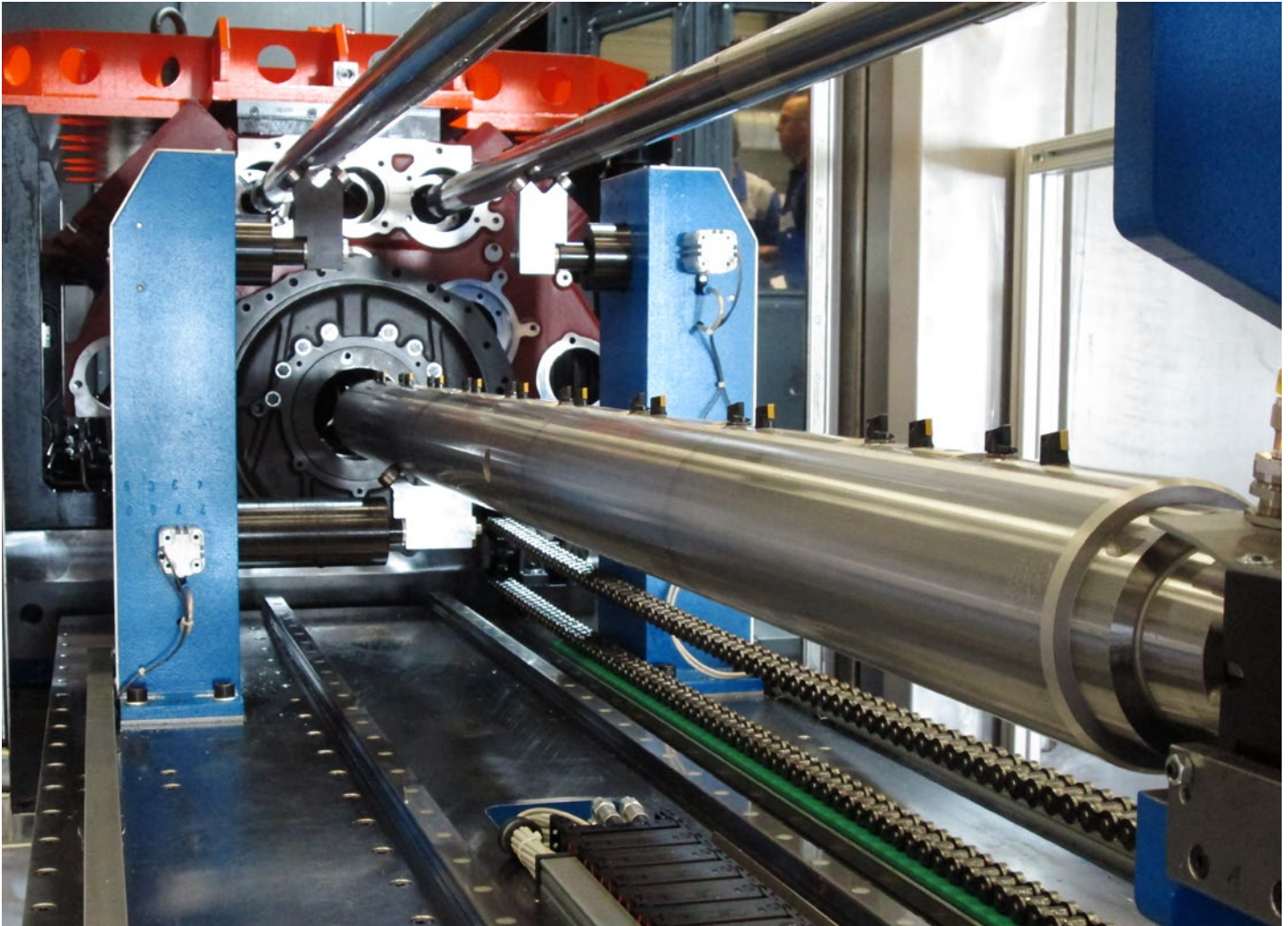
High-Tech Engine
Block Machining



**BURKHARDT
+
WEBER**

Strong and accurate since 1888

New Motor Designs – New Production Plant – New Process Technology



Inserting of 2 camshaft and 1 crankshaft boring bars

With the investment in a complete new engine manufacturing plant, a major diesel motor manufacturer in China is breaking new ground, virtually on green pastures, to expand their production capacity significantly. The driving factor is to offer new, modern V-type engines, for the fast growing Chinese market, and the overall challenging world market.

Led by modern engine concepts, the experts of the motor manufacturer searched thoroughly for a leading supplier for a modern block machining process, best suited for the initial and final production quantities, with a seamless growth potential for higher demands. After comparing all known globally recognizable suppliers, BURKHARDT+WEBER manufacturing systems was chosen as system solutions provider for the engine block machining process.

The task was to find a flexible and expandable, modular solution for the complete range of V12, V16 and V18 motors. Besides the technical factors also the commercial tasks were challenging. The goal was a highly economical solution, already profitable in the production start-up phase, and gradually expandable to the highest production quantities, while maintaining productivity, using a "cookie cutter" type principle.

For the planned capacities, initially 200 motors have to leave the factory in the first year, increasing over the following years to 3,000 units per final production forecast for the V12 and V16 engines. In addition, subject to market demand, a large V18 diesel engine case is added. Every enthusiastic manufacturing engineer will certainly agree that such a project is "a dream comes true" opportunity. The development of such a completely new production plant, leading in tech-

nology and productivity requires manufacturing engineering creativity in every aspect. And with the production quantity forecast, and the product mix at hand, a substantial machine tool investment needs to be contracted and engineered.

The historically proven and still up to date manufacturing philosophy using custom, limited purpose machines adequate for each process step was not to be considered. An example of such a system would be the use of portal milling machines for cutting all engine case sides together with producing the cylinder bores, plus a custom deep-hole drilling machine for the oil bores and a special machine for crankshaft and camshaft boring. Already with the initial investment, such a concept would require for the start-up phase, all special machines built for the final production volume requirements. In general this creates a bad redundancy for several years,

with a significant excess capacity during a gradual ramping up production. The initial poor efficiency, with lack of back-up machines and little time for maintenance and repair tasks, and the excessive high capital investment volume, would have condemned itself as a failure, right from the beginning for such a far reaching challenge.

“Wunderbar” modular – highly specialized, flexible, and openminded

Strategic business decisions and planning for long term success is required in the present, deciding for solutions sustainable in the long run. So the key issues of this project were discussed already at an early stage with the customer and resulted to a technically and economically fully viable, future-oriented, and flexible, step by step implementable complete solution. With BURKHARDT+WEBER such a complete concept always includes the overall process engineering, the machining process, the tool engineering, the corresponding work holding technology, the supply of process-specific machines, and last but not least, the CNC part programming and run-off with proof of cycle time and quality.

Most often supplied for large diesel engine machining tasks is the MCX 1200 as a core machine, together with a “cookie cutter” type multiplication technology from BURKHARDT+WEBER it provides for a risk-free redistribution of good and practical clamping technology and fully tested spindle tools, easy to duplicate for the future growth stages. This concept supports all machining tasks and that right from the production start, while it features a low initial capital investment amount for chip cutting machines. The MCX 1200 has many advantages over comparable machines from other suppliers. Besides a much larger work area overall with long axis travels, the BW series of machines is also equipped with a BW designed and built unique rotary table unit. This features an extremely high radial and tilting torque, the most important feature to rigidly support the motor block machining when clamped on its end faces. Thus, even the machining of large V-engines is completed in only a few machining orientations. The high torque table benefits are resulting from the use of oversized and overdimensioned bearing arrangements together with a wide spacing of the axis guides.

Tool Magazine

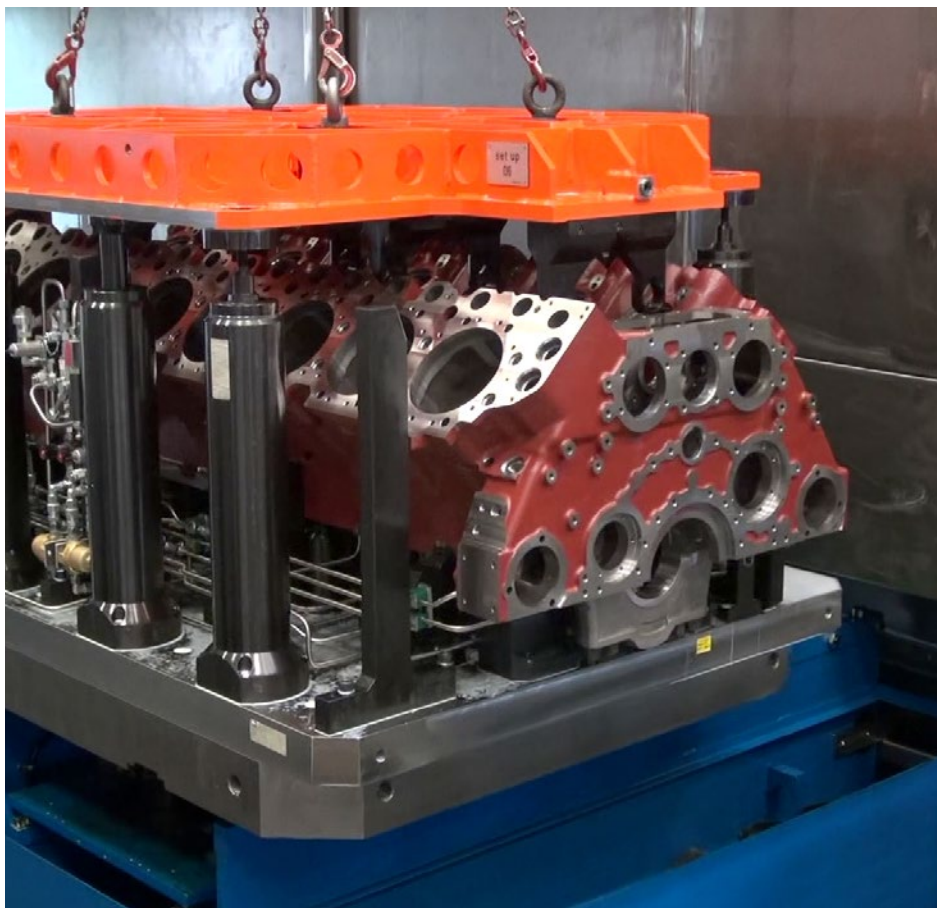
- Total magazine capacity 570 tools
- Designed for 300 tools up to Ø 125 mm, 7 tools up to Ø 225 mm 15 tools up to Ø 350 mm and 15 special angle and milling heads
- Max. tool length = 1,200 mm for deep-hole drilling of oil bores
- Angle heads weighing up to 75 kg with a max. tilting moment of 150 Nm

Pallet Changer

- Pallet size 1,400 x 1,600 B1
- Double pallet changer
 - Hydraulic connection at clamping fixture with p>60 bar
 - Hydraulic connection at set-up stations and machine table

Assembly of fixture cover with integrated camshaft boring guides

In order to deliver an effective cutting performance at the engine case, the BW machining unit features a 4-stage gearbox supplied with power by a 60 kW spindle motor, which delivers a peak performance of up to 80 kW with an up to 3,500 Nm full duty torque rating. Leading in head technology the BW machine features a rigid hydraulic 4-point head clamping technology for heavy-duty cutting heads. With a spindle speed range up to 6,000 rpm the MCX 1200 is also best for the machining of cast iron materials, and has also power reserves for future cutting technology improvements. In order to rigidly power and precisely locate the up to 70 kg weighting tools and especially important for the needed long reaching drilling and facing tools for cam- and the crankshaft bores, the HSK 100 A tool taper is improved with the BW Ø160 mm face support. A special fluid connection for the demanded high volume coolant supply supporting an economical deep hole drilling operation allows cutting fluid pressures of up to 20 bar with effective flow volumes to 54 gpm and complements the BW spindle technology perfectly.



For this project, about 15 customized, task specific milling heads covering all engine types were designed by BW. Stored in the machines' standard tool magazine they are fully automatically exchanged and used as needed. Masterpieces in engineering are the highly challenging work holding fixtures. The customer quickly recognized the outstanding engineering knowledge of the BW expert team and decided to contract this task with BW, especially because BW maintains its own in-house fixture design and manufacturing group. Three basic engine block types need to be accommodated with the same fixtures while a minimum number of work orientations for a complete machining is demanded. The final solution results to 8 part location with only 6 hydraulic activated clamping fixtures. Two of these fixtures are for vertical engine block orientations and provide an outstanding accessibility to many part features on all engine sides via a fast table orientation. This includes the generation of cylinder banks and cylinder bores. A highlight of the BW technology is the integration of a highly reliable, crank- and camshaft boring technology proven as extremely successful and reliable since decades. Up to 2,500 mm long, gang type boring and facing bars with an individual weight of up to 250 kg are safely introduced into the parts and supported rigidly. These special tools are set up with a special procedure on a Leitz CMM and

are adjusted to bore within a straightness of 5 micrometer. For machining, the tools are inserted into the part with a fully automatic sequence using unique BW tool stations, located at end of the X-axis table travel.

Another challenge for the engineers of BURKHARDT+WEBER was leading to a premiere result. The access and the arrangement of the camshaft bore did not allow the conventional inserting of the support bearings for the line boring tools from the bottom up. Thus a different practical concept with highest production safety had to be engineered. A special, top loading and extremely rigid, top fixture was the engineering result. Supported by a special extra strong engine head housing the support bearing is assembled to the part after clamping it in the base fixture on the machine pallet. Locked into position by a zero-point clamping system, this precision fixture supports an ultra-precise concentricity of all bores machined.

During the preacceptance of the complete process at the BURKHARDT+WEBER factory in Reutlingen, Germany, all fixture variations and types were completely run off and tested. The machining quality and process time was demonstrated on three consecutive V16 engine blocks and accepted with all qualities achieved well within the guaranteed limits.

The first BURKHARDT+WEBER Machine, a good decision.

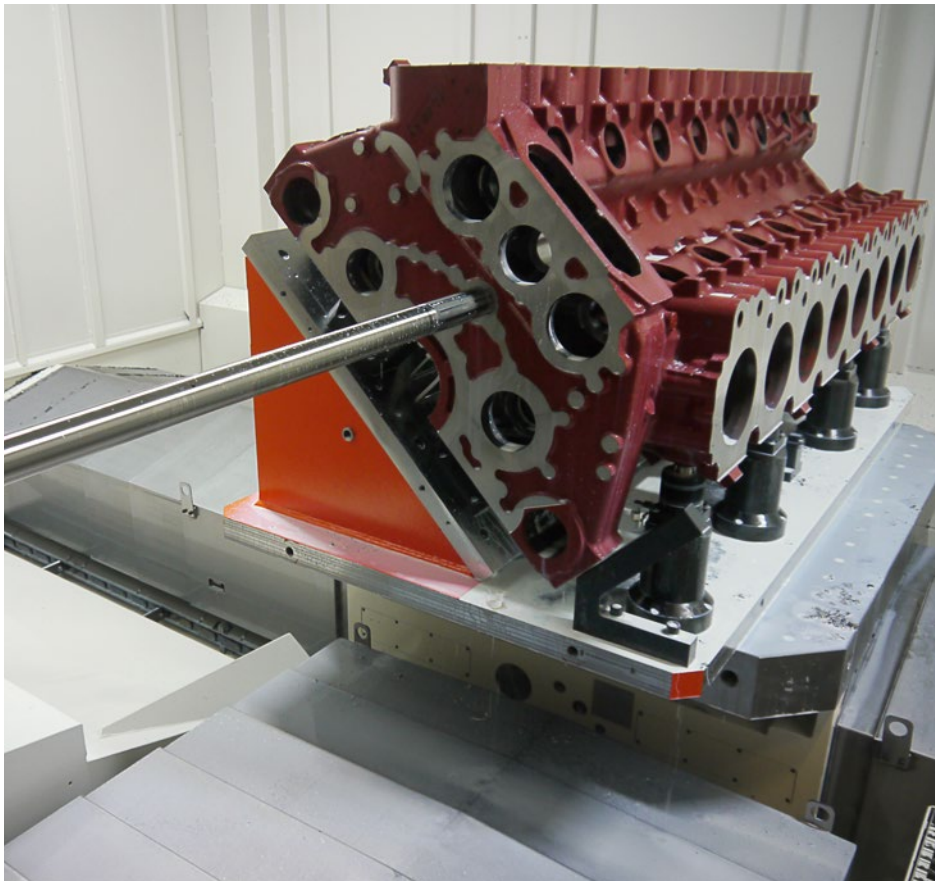
At the conclusion of the final acceptance, the Chinese engine manufacturer emphasized during the review meeting his overall satisfaction with the project and the machining results overall, and reaffirmed his previous decision for BURKHARDT+WEBER, as a premium vendor for such a promising and demanding project, giving us a best partner rating.

The overall benefits when compared to the commonly accepted portal machine concepts:

- Significantly lower initial investment costs
- About 40% less floor space requirement
- More compact foundation as major installation time and installation cost reduction
- Much shorter machine idle times for the tool, head, and pallet changes
- Optimal chip removal and less thermal implications
- Highest line boring qualities with best long term repeatability results
- First-class operator ergonomics with short access distances

THE BURKHARDT+WEBER horizontal concept leads in every aspect: Low investment and manufacturing cost, longevity, production safety, and ergonomics.

Reaming pilot bore for deep hole drilling



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