Integrated PC- and EtherCAT-based solution for special-purpose machine used in the automotive industry

Open control technology for high-precision, networked steering shaft assembly

Vehicle steering column shafts are very sensitive, yet important, components of automotive steering systems. Accordingly, high demands are placed on the production of these products. LCA Automation AG specializes in these types of assembly plants, and values the openness and flexibility of PC-based control and drive technology from Beckhoff.
LCA Automation AG, based in Affoltern am Albis, Switzerland, is a special-purpose machine manufacturer with many years of experience, particularly in manufacturing equipment for the automotive industry. One of LCA’s core production areas includes steering components, which it supplies to almost all of Europe’s vehicle manufacturers. Rainer Pölzl, who is responsible for project planning and control engineering, explains: “We deliver turnkey assembly systems, from planning and development through to construction and commissioning. This includes mechanical construction, as well as electronics, control technology, and software. A key component of our philosophy is close cooperation with our customers, which enables us to respond flexibly to all requirements – such as for automatic or semi-automatic processes, or lean management concepts – and implement them in an optimized manner. A good example is the current assembly line for the sliding connection of a steering column, which not only has to work efficiently, but also maintain a high level of accuracy. After all, in a head-on collision, correct yielding of the steering wheel and the steering column can be crucial for the survival of the vehicle driver and passengers.”

PC Control offers scalability and openness
LCA Automation has benefitted from Beckhoff’s PC-based control technology since 2000. Rainer Pölzl has been involved since the beginning: “Originally we used our own proprietary hardware and software. However, since our customers increasingly demanded standard technologies, a decision to switch was made in 1999. There were good reasons for choosing Beckhoff, including the broad, scalable and open product range, the high performance of Industrial PC (IPC) technology and, above all, the company’s ability to continuously innovate. It was important for us that PC Control offered a highly flexible and integrated system of coordinated software and hardware, right down to the I/O level. The technology also offered significant advantages in terms of horizontal and vertical integration, due to the fact that the openness of the system facilitates the integration of our machines in interlinked assembly lines at the end customers, as well as communication with their MES and ERP systems.

The control system for the steering shaft assembly line at LCA Automation AG is consistently PC-based. Thanks to the openness of PC Control, it can easily be integrated into production lines and in the ERP environment.
There was another aspect through which LCA Automation AG leveraged the flexibility and performance of PC-based control technology. Due to the high complexity of the proprietary axis and process control system, the only way to move forward was a gradual migration towards a full PC Control solution, as Rainer Pölzl explained: “First, the existing control software, which had been specifically tailored to our needs, was mapped to TwinCAT. Over the years, more and more of the numerous processes were migrated and developed further. Thanks to the openness of PC Control, we were initially enable to run it in parallel with our own motion and process control, which we were then able to integrate via PROFIBUS quite easily. Supported by the continuous development of the Beckhoff system, for example in the form of high-performance processors or through the introduction of integrated, very fast EtherCAT right down to the I/O terminal, we were finally able to fully retire our old system in 2010.”

Complex assembly lines with flexible control technology
The recently developed steering shaft assembly line, which covers an area of around 120 square meters, uses PC Control throughout. The production process was implemented in close cooperation with the customer. The finely scalable, modular design of PC-based control, and the resulting high degree of flexibility in the application, proved to be very beneficial during this process. Rainer Pölzl continued: “Meticulous attention to customer requirements is one of the trademarks of LCA Automation AG. Our exceptionally short development times can only be achieved by starting the machine design at a stage where the user only has a prototype of the end product, if even then. It goes without saying that continuous optimization of the end product has to go hand-in-hand with corresponding adjustments to the machine design. The flexible control technology optimally supports such modifications, which can take the form of additional process steps or new axis configurations.”

Based on this approach, the company was able to implement the whole steering shaft assembly line in just eight months. The line features three manual ‘feed stations’, where the individual components are placed in the workpiece carriers of the automated transport system. The carriers then pass through the individual processing stations. At one of the stations, the tubular raw material is pressed and shaped, and before it is connected with other components, it is greased and oiled. At each processing station, checks are carried out for dimensional accuracy and function. For example, the presence of all the required parts is verified as is the compliance with specified forces in joining processes. This results in very reliable part quality assurance and reject identification. The corresponding information is then assigned to the respective workpiece carrier. A complex final examination takes place in a measuring station that represents the most important part of the LCA expertise, as Rainer Pölzl explains: “On the one hand, vehicle steering components must be backlash-free, but on the other, the connections must not be too tight to prevent ‘telescoping’ in the event of an accident. Around three years ago, we were able to migrate this test, which requires in-depth know-how, from our proprietary control system to the PC-based system.”

According to Rainer Pölzl, existing systems also increasingly benefit from the performance of PC-based control technology: “Many of our systems have been operating reliably at our customers’ facilities for 20 years or more. In order to modernize these machines without prolonged production downtime, we simulate our previous control components with the PC-based system. In this way, the existing control system doesn’t even ‘notice’ that the hardware was been upgraded with advanced components. This allows us to exchange different modules one by one, thereby replacing the existing hardware gradually. Due to the increasing variety of product types to be produced, the control software has become too complex to be replaced directly. The approach described above has the advantage that, by simulating the hardware, it is possible to continue using the existing software. During the modernization of individual machine modules, we also benefit from the wide range of IPC form factors. The modules can initially be realized flexibly using the compact Embedded PCs from the...
At a glance:

Solutions for the automotive industry
Integrated control solution for steering shaft assembly

Customer benefits
Open and scalable control simplifies new installations and retrofits.

Applied PC control
- AX5000, AM3000: 18 dynamic and precise servo axes
- C6930, CP7902: four control cabinet IPCs and Control Panels
- EPxxxx: IP 67 I/Os for data acquisition close to the process
- EtherCAT: fast and seamless data communication
- TwinCAT: PLC and motion control as an integrated solution

perfectly blends into the PC Control system, as Rainer Pölzl testifies: “Thanks to the excellent system integration, TwinCAT enables optimum access to the data. As a result, subsequent extensions can be implemented much more easily than would be the case with third-party software.”

Opportunities for further innovation
For future projects, Rainer Pölzl sees further innovation potential, thanks to PC-based control. For example, the software is currently being upgraded to TwinCAT 3: “The main advantage for us is the use of C/C++ as a programming language, because we have long-standing expertise with this and are able to implement complex function blocks. With C programming as an integral part of the process, it is possible to integrate these quickly and easily as encapsulated functions, e.g. for hydraulic axes that are synchronized with high precision.”

Rainer Pölzl also sees many advantages in the advanced multi-touch control technology, particularly in connection with the CP-Link 4 one-cable technology for displays. Smaller target markets, such as the medical or railway industries, tend to be much more open in this regard than more standardized markets like the automotive industry. Multi-touch offers significant enhancements for machine users with regard to operating preferences and safety. On that note, the topic of machine safety is also on Rainer Pölzl’s development agenda: “Together with the introduction of TwinCAT 3, we will also migrate our safety solution, which was previously implemented separately, to the Beckhoff system.”

Further information:
www.lca-automation.ch
www.beckhoff.ch