Volvo sets more and more stringent quality standards

Controlled production down to the last screw

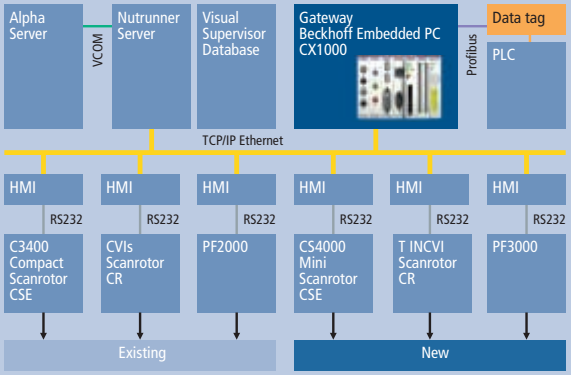
A total of 125 workstations are being converted in this way. The modification is carried out simultaneously in Gent and in the Volvo factory in Sweden. Both factories separately decided to use Beckhoff after an intensive supplier comparison and evaluation which included prototypes designed to meet Volvo's requirements. Volvo chose the American manufacturer GSE tech-motive tool for the electric screwdrivers. For both plants, De Jaeger Automation bvba developed the IT infrastructure using workstations. The system offers maximum security for the operator: It checks whether screw connections were made with the right program and registers the results.

For this particular application, managers at the Gent plant decided to use the CX1000 Embedded PC control from Beckhoff. This small-format PC integrates software PLC, network and Internet access via Ethernet interface, Profibus connection, an interface for the Control Panel and the K-Bus interface for the bus terminals. Multiprox, the exclusive Beckhoff agency in Belgium, supplied the first CX1000 prototypes to Volvo around mid-2002.

→ The production line at Volvo Cars in Gent, Belgium, is being modified to enable production of the new V40 model in addition to the S60 and the V70 models. Concurrently, the production line is being enhanced to meet future, "follow-up", production requirements. Electric screwdrivers have replaced pneumatic models for all main screw connections, and are controlled with a PC-based controller. The controller's data, including tightening forces, is transferred to a central database, where it is easily retrieved over the car's production lifespan.

Traceability of class 1 screws

Volvo Cars is a manufacturer with very high quality standards. After the takeover by Ford, traceability was looked at and it was decided to implement better controls for all "class 1 screws" in the Volvo Cars factories, and to record the results. One control look at is measuring actual force that a screw exerts versus just the torque. Pneumatic tools allow for a torque setting, but the tightening force cannot be controlled. This requires an electric screwdriver and a very sophisticated electrical control system with a converter used for feedback. Both the speed and the screw curve, including the force exerted at the respective torque, can thus be programmed for the complete screw cycle. An auto-



matic control checks whether the torque increases along the right curve, e. g. for detecting broken screws. Moreover, an alarm system is provided in case a screw cycle was not executed properly for some reason. However, Volvo required even more control: they also wanted to know whether the pre-programmed screw cycle was actually executed and second – for the purpose of traceability – the tightening torque data for each screw were to be recorded.

There are several manufacturers of such electrically driven screwing tools, but not many have integrated a direct PC interface. Both factories in Belgium and Sweden decided to go for a solution based on electric screwdrivers from GSE. The workstation consists of the electric screwdriver from GSE and the IT infrastructure that ensures the PLC-specific tasks. Among other things it can be used to control which screw cap was used by the screw cap selector and inserted into the electric screwing tool. This decides which cap and which program is used. Furthermore, the screw movement is controlled, and the correct angular rotation is verified. Analog measurements are carried out using a Banner

With the CX1000, **Volvo Cars in Gent, Belgium,** uses mid-range PC-based control technology for controlling the electric screwdrivers. In the final set-up, the following components are used:

- **Controller:** 125 x CX1001-0121
- 128 MB RAM
- 1 GB IBM Microdrive
- Windows XP Embedded
- TwinCAT PLC Runtime
- DVI/USB Interface CX1000-N001
- Profibus Slave-Interface CX1500-B310
- 24 digital and 2 analog I/Os per system

- **Control Panel:** 125 x CP6801-0001
- Built-in Control Panel
- DVI/USB Interface
- 12 inch display, resolution 800 x 600
- Touch Screen

laser distance meter. This operation can only be carried out within a certain "range" of the production line, since the devices are not operational outside this range.

Each screw is recorded

In addition there are PC tasks, e. g. storage and activation of the "tasks" for each screw, recording of the task executed and establishing the Ethernet connection for transporting the required data to a higher IT level. As soon as the chassis is placed on the assembly line, the screw tasks are passed on to the tooling station by a central server. They have to be tracked locally, until the chassis number has been read at the workstation. The operator then receives a list of tasks that specifies which screws have to be tightened. By selecting the screw head, he indicates which screw is to be tightened. If the operator activates the electric screwdriver, the task program for the respective screw, i. e. the way in which it is to be tightened, is converted into an instruction program for the device.

The fitters can work at four vehicles at the same time. The task program received by the operator depends on the current position of the fitter with the device. Through appropriate selection of the wiring, the operator can only work at one vehicle and receives the corresponding tasks to be carried out, once the workstation is located. Execution is controlled. If everything goes according to plan, the system receives an "OK" as feedback. In the event of a fault, an alarm is triggered, so that the fitter can correct the fault. If the problem cannot be rectified with the appropriate measures, this is registered and the vehicle is removed at the end of the production line, so that the respective screw connection can be reapplied.

All data for each screw connection is stored locally as an XML file and then fed to a central server at production control room level via the Ethernet network (LAN). Here, the frequency and type of problems is analyzed, and statistical quality control is carried out. At this level the XML files are "cleaned", and only the relevant data are relayed to the production tracking system, from where they are stored in the "production archive".

PLC and PC in a single unit

I/O-specific real-time tasks require a PLC, others require a PC. Independent integration of the two systems into the application would be comparatively expensive. For this reason, De Jaeger Automation chose the modular Industrial PC CX1000 as IT basis. The CX1000 device series combines the best of two worlds – Industrial PC and hardware PLC – and is suitable for control tasks in the medium performance range. The modular control system can be mounted on standard DIN rails; the elements are assembled depending on the task. A further basis for the decision was the price, which is lower than that of an Industrial PC.

The CX1000 is equipped with a serial interface and an Ethernet interface as standard. Additional fieldbus interfaces (Profibus, CANopen, DeviceNet and SERCOS interface) can be added without problem. The Beckhoff Control Panel is connected via the modular DVI/USB interface.

Communication between the CX1000 and the GSE electric screwdriver is optionally via RS232 or Ethernet. In order to be "universally" applicable, the control was designed in such a way that Power Focus 2000/3000 screw tools from Atlas Copco can also be connected. With the aid of connection cables with special terminal strips in the connector, the system detects whether a screwdriver from GSE or Atlas Copco screwdriver is connected, and the associated program loads automatically.