

Controlled Production Down to the Last Screw



The S60 and V70 production lines at Volvo are being modified for production of the new V40 model. Concurrently, the production line is being upgraded to meet future "manufacturing tracking" requirements by using electric screwdrivers in place of pneumatic models for all main screw connections. The screwdrivers are controlled with a PC-based controller and all data, including tightening forces, is transferred to a central database, where it is easily retrieved over the car's production lifespan.

A total of 125 workstations are being simultaneously converted in factories located in Belgium and Sweden. Both factories 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 developed the IT system which offers maximum security for the operator by checking whether screw connections were made with the right program and registers the results.

For this particular application, Volvo engineers decided to use the CX1000 automation controller from Beckhoff. This small-format PC based controller integrates a softlogic PLC, network and internet access via Ethernet interface, Profibus connection, an interface for the Control Panel and local I/O.

Traceability of class 1 screws

Volvo is a manufacturer with very high quality standards and decided to implement better controls and traceability for all "class 1 screws" by 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. The control checks whether the torque increases along the right curve for detecting broken screws.

In the CX1000 controller an alarm system is provided in case a screw cycle was not executed properly. Additionally Volvo required even more control: they also wanted to know whether the pre-programmed screw cycle was actually executed and, for the purpose of traceability, the tightening torque data for each screw was to be recorded.



Operator shown using the electric screw driver which is being controlled by the CX1000 and Operator Interface

There are several manufacturers of electrical screwdrivers, 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 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 from a laser distance meter.

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 the 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 program for the respective screw is converted into an instruction program for the device.



Beckhoff automates nut runner process using TwinCAT and CX1000 hardware.

The assembly worker 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. 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 assembler 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 re-applied.

All data for each screw connection are stored locally as an XML file and then fed to a central server at the production control room level via the Ethernet network (LAN). Here, the frequency and type of problems is analysed, 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".



CX1000 shown with local I/O, DVI monitor interface, USB, Ethernet, and RS232 interface.

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 their IT platform. The CX1000 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 and the modules 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 serial and Ethernet interfaces as standard. Additional fieldbus interfaces (Profibus, CANopen, DeviceNet and SERCOS) can be easily added. The Beckhoff Control Panel is connected via a 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.