Powder painting of truck cabs – helping to preserve the environment

Four years ago, Scania, one of the world's leading manufacturers of trucks and buses, decided to invest in a more environmentally friendly method for painting truck cabs. The solution chosen, for a new paintshop at Scania's assembly plant in Oskarshamn, Sweden, was powder painting based on robots from ABB Flexible Automation. Paint robots are easy to operate and the quality of the coating is higher and more uniform than with conventional paint spraying. In addition, a more agreeable, non-hazardous working environment is created for the paintshop personnel.

Scania employs some 1,600 people in its Oskarshamn plant for the manufacture and assembly of driver's cabs for trucks. The simplest description of the production process at the plant is that 'sheet metal goes in at one end and a driver's cab comes out the other'.

The basecoat station in the plant is the first of its kind in the automotive industry to use robots on a large scale for powder painting. Since the robots were installed in the paintshop, the plant has increased its production capacity considerably. In addition, Scania has reduced by about 70 percent the amount of solvents it discharges.

Project engineering began early

The powder-paint project began in 1992 with the preliminary planning of the new station **1**. In a first step, a pilot plant was built at ABB Fläkt Industri in Växjö, Sweden. This was considered to be the best way to discover how the robots should be programmed to enable them to reach every surface of the cab. The pilot plant proved to be a good investment, as only minor fine-tuning of the final installation was needed.

The application of the basecoat is an important step in the process of providing effective protection against corrosion for the driver's cab. Even a small defect in the basecoat can be the cause of corrosion, so precision is essential.

Painting takes place with the help of electrostatically charged powder. When an opposite electric charge is applied to the cab, the sprayed paint powder is automatically attracted by the raw-metal surfaces and not by their surroundings. Surplus powder is collected and re-used.

Dry painting has the further advantage that no solvents are needed.

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Efficient process control and monitoring

The entire painting process in the basecoat station can be supervised by just one operator at a workstation in the control room **2**, **3**. Monitoring of the process is by means of video cameras linked to VDUs in the control room. These cameras and the window between the control room and the paint booth ensure that the operator has a complete overview of the situation.

All the robots are controlled and/or monitored by a higher-order computer system. The PC-based Robot Station Controller, or RSC, which is located on a level between the superimposed plant control system and the paint equipment control system, was developed to this end. Among other things, the RSC is responsible for the direct communication with the equipment in the spray-paint booth.

The electric drives that power the robots guarantee high precision and efficiency for the robot motion. The large work envelope of the robots ensures a high-quality coating even for surfaces as large as those of a truck cab. The robot bodies are completely sealed to prevent powder from getting into their mechanical parts and affecting the way they function.

Programming is both easy and flexible

Powder painting by robot has special advantages due to the flexibility and ease of programming it allows. These are key benefits when the cabs of different truck

models have to be painted. Since the robots and the RSC system work with the Robtalk programming language, this is the only language that the operator has to learn.

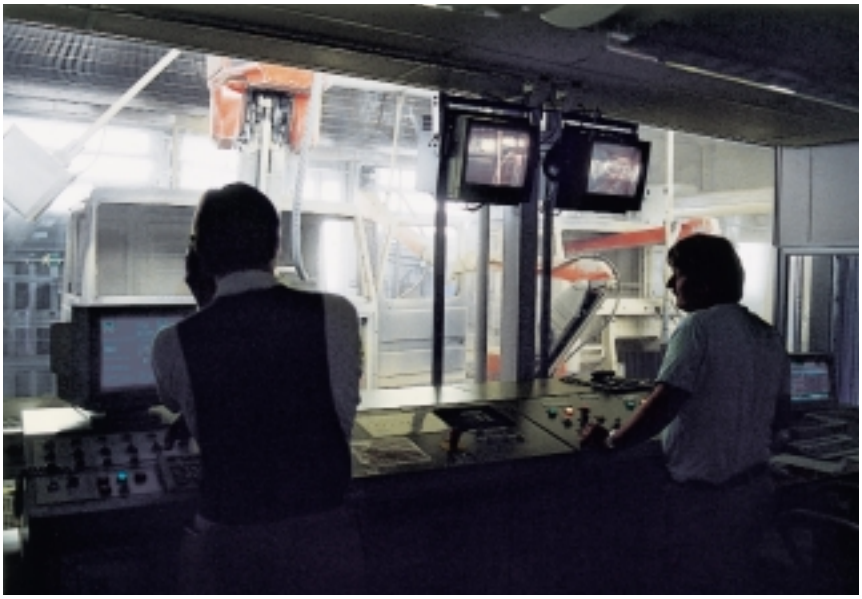
Extra commands were developed for the RSC system at the station control level. RSC features include, among other things, functions for starting and stopping, queue handling of the cab identification numbers, control of each robot's motions and process, and the test runs for the spray guns.

The RSC system and the robots communicate with each other over a high-speed network (Ethernet) via a small-diameter coaxial cable. Besides ensuring reliable communication, this also reduces installation and maintenance work. Digital I/O modules are available for the communication with the other parts of the equipment.

The operator can observe the entire process on monitors and, by means of remote-controlled video cameras, even individual cabs or process sectors. The program can be easily adjusted without interrupting the work in progress.

Basecoat station of Scania's truck plant in Oskarshamn, Sweden. The basecoat is applied to the cabs by ABB robots programmed to carry out powder painting. **1**

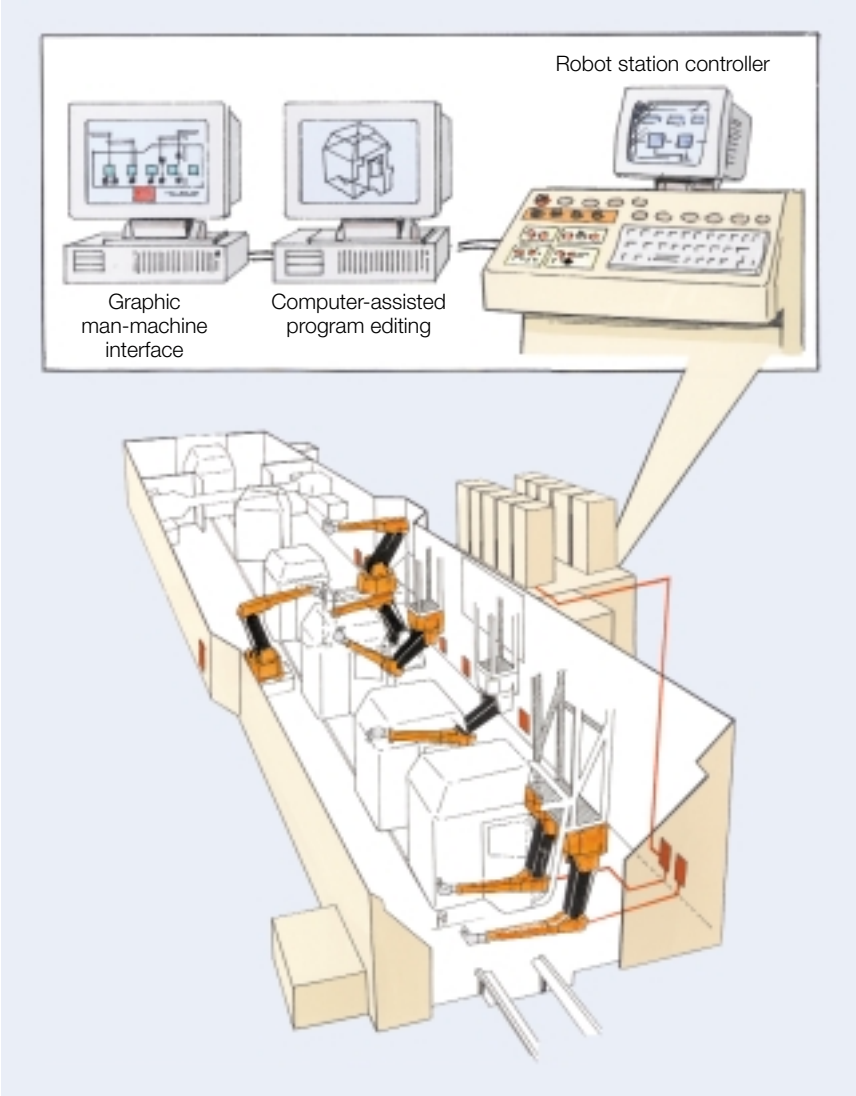
An operator in the control room oversees and controls the entire powder-painting process from a workstation. All of the operations are monitored by video cameras linked to VDUs. **2**



Programming can be carried out direct or from a workstation PC

The robots can be programmed either direct or from a workstation PC. In the first case, a portable programming unit is used which is connected to the robot via a control cubicle.

A robot's program can be modified with the help of the computer aided programming (CAP) system. The work in progress is not disturbed in any way by this. A CAP station located in the control room of the spray booth allows the operator to watch over the production process via the RSC system at the same time. The CAP system is linked to the network connecting the robots to the RSC system.



Schematic illustrating the man-machine communication between the paint booth and the control room **3**

The computer-aided programming is configured in Windows, making the software easy to work with. The program editor can be used to write the program in the robot's programming language. Information contained in other programs can also be copied to avoid having to do the same work twice.

Graphic display of the robot motion pattern

The robot motion pattern and the switching on and off of the spray guns can be shown graphically on the monitor screen. Movement of the guns is shown in three dimensions. To test new or potentially better software configurations without interrupting the ongoing production process, all the operator has to do is move the points on the screen and observe how the path changes.

The robots are easy to program. By moving a joystick, the operator can move the robot to different points in space in a sequence that makes up its final motion pattern. At each point, the operator programs the task to be carried out by the robot. The parameters which are entered are stored in the robot controller memory. Also included in the software is a function via which the robot can find the fastest and simplest path between two points itself.

Every cab is identified

Every cab entering the powder-paint spray booth is identified by signals from six photocells in the booth's first zone. The information is transmitted to the RSC system, which activates the paint program developed specifically for the particular type of cab.

The painting process within the spray booth is divided into six defined treatment zones for the powder coating **4**, **5**.

Each zone consists of one or more process stages. The first four zones are equipped with robots which automatically spray powder onto all of the inside surfaces and the underside of the cab floor. In zone 5, the vertical surfaces and the exterior surface of the roof are coated. The last zone is for any manual touch-up painting that might be necessary.

The computer gives the go-ahead

Before a driver's cab can be positioned in a painting zone, the paint robots must be in their starting position. This is confirmed by a signal being sent to the RSC system. As soon as the cab is correctly positioned, the computer responsible for that zone on the conveyor selects a program number and gives the go-ahead.

When painting in the zone has been completed and the robot has returned to its starting position, the monitoring system is told it can proceeed. The cab is transported automatically to the next zone as soon as it is ready.

The RSC system also monitors the automatic opening and closing of

the cab doors between zones 3 and 4. Another robot, mounted on a conveyor, has a dual gun for painting the inside and edges of the doors as well as part of the inside wall of the cab 6. The central RSC system ensures correct coordination and movement of the robot 7.

One robot system handles all the basecoat painting

The robot system installed in the Oskarshamn plant is based on ABB's TR 5000 system, which was developed especially for the kind of conditions existing in paint booths. The robots feature six degrees of freedom. Electrical cables and other supply lines are run inside the robot and its wrist to lessen the risk of disturbances that could be caused by damage to the cables or hoses.

The program also includes functions for blow-cleaning the gun nozzles.

Personnel safety is given a high priority

A safety system is installed which protects the staff throughout the production process and prevents, for example, anyone from entering the work zones while painting is in progress. All of the doors to the spray booths are fitted with special switches.

Photocells are provided at the entrance to zone 1 and between zones 5 and 6 in the booth. Their alarm functions are automatically overridden whenever a truck cab passes.

Zone 6, in which manual painting can be carried out, features a light barrier which trips a siren in the event of danger. This zone can only be entered after a key-switch on the RSC console in the control room has been actuated and the door switch at the entrance to the zone has been overridden.

Powder is applied to the inside and outside of the cab roof by a robot, equipped with a dual gun, attached to the ceiling of the booth. 4

Potentially dangerous situations cause the safety system to trip an emergency stop. This halts all of the robots. On restarting, the robots begin at exactly the position they were in when they stopped.

A monitor in the control room shows the causes of alarms and emergency stops. To reset the system, all the operator has to do is press a pushbutton on the RSC console.

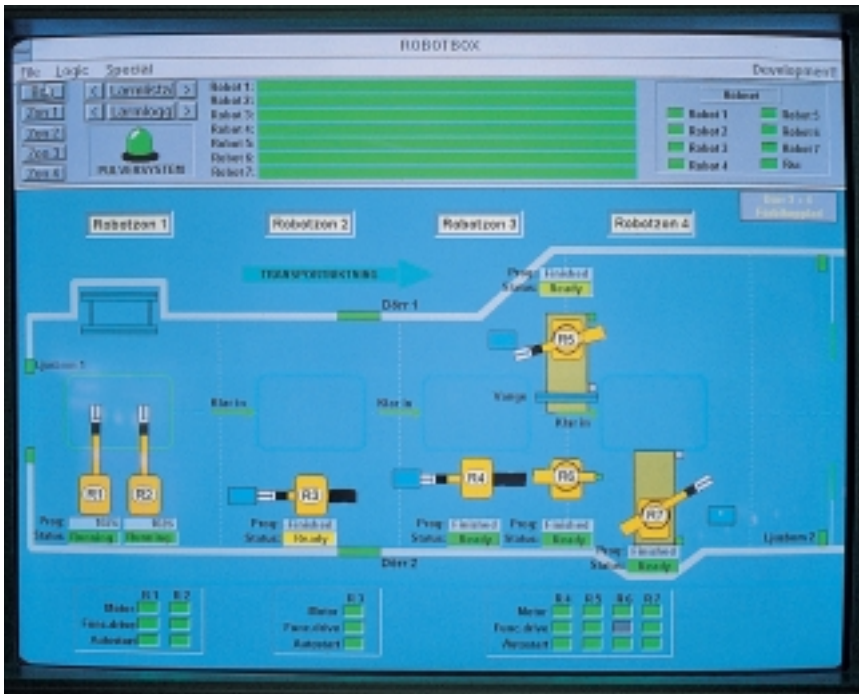
A robot mounted on a conveyor paints the inside and edges of the doors as well as a section of the inside wall of the cab. The doors are opened and closed by another robot (on right). 5

The robot used to apply the powder coating to the inside of the cab is mounted on a conveyor and equipped with a dual gun. It reaches through the windshield opening and applies the powder to the rear and side inner walls; the rear part of the floor can also be painted if necessary. 6

A flexible motion pattern ensures the right painting angle

Since the robot motion pattern is variable, the spray nozzle can be programmed to ensure the correct painting angle for the different surfaces. After the coating has been applied, it is hardened in an oven at a temperature of 180˚C.

Monitor image of the spray booth. The operator can observe the current work status of the robot and identify the cabins being painted. 7



On the rare occasions when they need to enter the spray booth, operators must wear protective clothing to prevent contamination of the powder.

Painting expertise plus robot technology

For the coating to have a uniform thickness, the gun nozzle must be operated at a specific distance and with a certain speed. Robot technology makes it possible for the exact process sequence for one cab to be reproduced for the next one. High productivity and quality are thus ensured.

The manual paint sprayers at Scania in Oskarshamn are now trained robot operators. They are unanimous in agreeing that they do not miss manual painting, which often required them to squat on the floor in difficult positions. Also, by transferring their practical knowledge of spray painting to the robot programmers they have the added satisfaction of knowing that their professional know-how is integrated in the robot software.

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