Distributed Safety Concept at BMW

DaimlerChrysler: from Profibus to Profinet Safety

Play it Safe with PROFIsafe
Industrial Ethernet and Profisafe are validated for the new automation standard integraMCG at DaimlerChrysler AG.

The conveyor technology in the “New Paintshop Structure” (NLS) at BMW had been extensively modernized with Profisafe and failsafe Simatic S7.
The modern world of industry is becoming more and more automated so that the protection from dangers caused by malfunction or human error is gaining increasing significance.

The subject of safety has since become part of every technical discussion concerning the automotive industry. The emphasis here is on the processing of safety-oriented signals, e.g. via field buses like Profibus. The crux for many users is still the question of how the high safety standard can be maintained when devices, components, systems and plants are networked. But separate safety-oriented controls and bus systems are no longer necessary. Safe programmable controllers have established themselves in recent years and Siemens has been offering standard controllers with integrated safety functions for the last four years. Using the Profisafe profile, the same Profibus can be used for transmitting safety data as for the rest of the data transmission. The advantages are obvious: Integration of safety in the control technology which you need anyhow. All in all this technology allows technically and economically optimized, fine scalable system solutions.

In the meantime the consistent use of Profisafe has established itself as the technical, economical and of course safest solution with almost all automotive companies. In this special issue of move up you can read how to be "on the safe side" with Safety integrated and Profisafe!

Rainer Frieß
Competence Center Automotive
Siemens AG
To effectively prevent accidents and the resulting injury and damage to man and machine due to technical malfunctions, reliable safety systems are urgently prescribed. Since the standards for electrical equipment of machines were modified, safety functions can now also be realized by programmable electronic systems and field buses which safely connect the sensors and actuators. A similar adaptation of the specifications for the world market is further promoting developments at all levels of safety technology. The latest state of affairs in safety technology is best reflected in the three following expert statements: Roman Wunschik on AS-Interface Safety at work, Herbert Barthel on Profinet and Peter Weiß from TÜV Automotive GmbH and Howard T. Cox of Underwriters Laboratories Inc., USA, on certification of the fail-safe Simatic Controller.

Simatic S7 Distributed Safety certified by TÜV and UL in accordance with NFPA 79

“Fail-safe Automation System in Accordance with NFPA 79”

Peter Weiß, TÜV Automotive GmbH, Automation, Software and Electronics, Munich and Howard T. Cox, Underwriters Laboratories Inc., USA:

“In September 2002, TÜV Automotive GmbH in Munich was commissioned by Siemens AG to test and certify the ‘S7 Distributed Safety’ fail-safe automation system in accordance with the new 2002 edition of NFPA 79 and other standards relevant to its use in the US and global markets (NFPA 85, UL 508, UL 1998, UL 991). TÜV Automotive GmbH, part of TÜV Süddeutschland (TÜV = German Technical Supervisory Authority), and its American counterpart, Underwriters Laboratories Inc. (UL), collaborate closely in this area and have jointly developed an acceptance inspection and testing procedure. Successfully completed certification in accordance with IEC 61508 is a basic prerequisite for testing in accordance with NFPA 79. The product documentation of the manufacturer serves as the basis for the technical briefing which ensures that German and American testers start off with the same level of knowledge. After this, all the requirements of NFPA 79 that are relevant to programmable electronic systems are checked against a detailed checklist and conformance with the standard is then confirmed by means of a certificate.

The Simatic S7 Distributed Safety system has successfully completed all the tests and is thus the world’s first fail-safe automation system that can be used worldwide for purposes of machine safety.”

Simatic S7 Distributed Safety

The fail-safe Simatic S7 Distributed Safety system consists of F-capable central processing units and fail-safe distributed and centralized I/O modules based on PROFINET Communication as well as the ‘S7 Distributed Safety’ option package.

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The fail-safe ‘Simatic S7 Distributed Safety’ system is the first system of its kind in the world to be certified according to IEC 61508 and NFPA 79.
Profibus user organization believes Profisafe is heading in the right direction

“We Will Expand the Functionality even Further”

Herbert Barthel,
Siemens AG, Nuremberg
and Chairman of the
PNO Profisafe working group

“The official launch, i.e. the presentation of products and systems for the Profisafe profile, came at the Hanover trade fair in 2002. At the Profibus users organization (PNO) booth, we were able to present a comprehensive range of safe devices, with which decentralized automation solutions can be realized without a separate safety bus.

The range of products that use the Profisafe profile is increasing steadily as a result, and there are now also numerous applications, in which Profisafe has proven the readiness to use. Such diverse systems as laser scanners, programmable logic controllers and safe I/O systems are all using Profisafe – also integrated motor starters are available, which up until a few years ago would have been totally inconceivable without a safety bus.

Last fall, the PNO then presented version 1.20 of Profisafe, which includes a more detailed specification of the Profisafe controller’s software interface. Recently, the PNO’s Profisafe working group has also drawn up standards and guidelines for important issues such as electromagnetic compatibility and the joint operation of ‘standard’ Profibus subscribers and Profisafe devices.

Meanwhile, in terms of configuration, commissioning, diagnostics and maintenance, Profisafe has reached the same levels of convenience and functionality as the ‘standard’ Profibus. At the 2004 Hanover trade fair, we will be presenting the latest expansions and options to the audience.”
Six robot welding cells at Ford Geelong with Simatic S7-400F safety systems

New Safety Technology for Ford Body Sub Assembly Facilities

The safety systems for the recent Body Sub Assembly robot welding cells at the Ford plant in Geelong are implemented using Simatic Failsafe PLC technology and PROFIsafe. Effective use of Profibus distributed components has resulted in cells with a minimum of discrete components, a minimum of field wiring and excellent diagnostics. New cells under construction are taking advantage of the recently released Distributed Safety CPU with safety logic configuration in Ladder.
Ford Australia is enjoying broad praise, industry awards and a healthy order book for its recently released new model Falcon. The BA Falcon released in October 2002 is a large 6 cylinder family car and is totally Australian designed and manufactured at the Ford plants in Victoria.

The facilities for manufacture of the Body Sub Assembly components are at Geelong, south west of Melbourne. The Geelong plant has used a variety of PLCs in the past, and the commencement of design of facilities for the new model saw a review of available automation technologies to select an automation platform for the future. Ford were looking for a platform which would be flexible, simple for their electricians to program and troubleshoot, and which would integrate readily on a “Field Bus” with third party components such as robots and valve blocks.

**Siemens Simatic selected**

Detailed investigation and review ultimately led the Body Sub Assembly engineers to the selection of the Siemens Simatic product range. The selection of safety system technology was then the next consideration. Having traditionally utilised a combination of hardwired traditional safety relays to implement the cell safety, Ford investigated concepts for use of the then newly released S7-400F Fail-safe PLC as an alternative to the relatively complex safety relay circuits traditionally employed. This concept design was assisted by Industrial Control Technology Pty Ltd (ICT) (the local Siemens Solution Provider), in conjunction with Siemens Australia, and a specialist from the Siemens Automotive Competency Centre in Germany.

The result was an elegant design concept which could be applied uniformly across the 6 new cells which were to be built, and which eliminated a large percentage of the contactors, relays and complex interconnecting wiring which were previously required. Safety functionality was also able to be improved relative to earlier cells, plus more safety facilities and automatic checks added. These facilities in particular make maintenance and set up operations easier and safer. Detailed diagnostics from the touch panels streamline troubleshooting operations.

**Robot welding cells**

The Body Sub Assembly cells are primarily for robot welding. Pressed metal parts are typically loaded at operator stations where they are spot welded and in some cases transferred by the robot to other fixtures for further operations. Ford engineers have utilised the Simatic HMI and Profinet distributed I/O technologies to maximum advantage in the design of these cells. Robots are interfaced via direct Profinet Interfaces, providing fast and convenient data exchange. Solenoid valves and proximity switches associated with the fixtures are connected via Festo valve blocks on Profinet. Operator stations typically utilise the PP17 operator panel for clear and robust operator interaction, whilst a touch panel provides access to production statistics and diagnos-
tic information. On the larger cells, an MP370 touch panel provides production statistics and diagnostic information additionally at a central location. The excellent quality graphics on these panels has also allowed the recent introduction of photo images of the fixtures with the dynamic status of clamps and proximity switches superimposed. This promises to be an excellent method of clearly presenting diagnostic information to an operator.

Menu screen from MP370 Touch Panel on robot welding facility

The automation of the cells is controlled by Standard (non fail safe) Ladder code in the S7-400F which interacts closely with the programs in the robots. Ford personnel program the robots according to the process requirements and to interface to the supervisory PLC. Development of standard code for the PLC has been done in most cases by ICT in close collaboration with Ford. Ford personnel have implemented later cells in-house.

Safety systems

The safety systems of course represent a critical component of these cells. As per normal practice, a perimeter safety fence surrounds each of the cells. Light guards protect operator stations where parts are manually loaded, while a Two Hand Control facility allows a part to be pre-clamped while the operator remains inside the area protected by the light guard. Robot base switches monitor the orientation of the robot to allow access to one fixture while the robot is working at the other. Light guards also protect forklift access points where finished parts on pallets are unloaded via forklifts.

Safety interlocks act on the Robot, fixture solenoid valves, servo turntable drives and an overall air dump solenoid valve, according to signals including light guards, access gate and Emergency Stop. The electric lock on the access gate is also controlled by the safety PLC.

All of these safety functions are implemented via the S7-400F Failsafe PLC. Their implementation in software has led to a dramatic simplification of the cabinet wiring, and a more satisfactory implementation of the required safeguarding logic. New maintenance functions have also been added which would have been impractical in the previous hardwired system. Diagnostic functions at the touch panels provide detailed information regarding the safety system status as well as fault diagnostic information to the point level. This aims to simplify maintenance by avoiding the need for personnel to access the PLC for troubleshooting. Failsafe code for these PLCs has been implemented and tested by ICT, although Ford retains a close involvement in system configuration and overall software structure.

A key consideration for Ford was to be able to “lock away” the safety functions, while retaining free access to the Standard code. This is important as changes and additions to the process occur from time to time, whilst the safety functions typically remain fixed. This was readily achieved with the S7-400F, allowing the Ford electricians to modify the Standard code without affecting the Failsafe code.

Distributed safety

The recent release of the Distributed Safety system programmed in Ladder has been well received by Ford personnel. The programming of Failsafe logic in Ladder is seen as a simpler alternative to the CFC used by the earlier S7-400F system and will be adopted for all future systems. Ford have in fact commented that the S7315F PLC is an extremely cost effective and powerful CPU and indicate that they are likely to use it with safety I/O even for small machines which would have required even only one or two safety relays.

Five new cells have recently been commenced for a new vehicle which is currently under development. These cells will use the S7-315F Distributed Safety PLC for all automation and safety tasks.

More information:
www.siemens.com/safety
Opel Belgium, Antwerp: Safety integrated technology forges ahead at Opel body shop

Safety at Body Shop

Opel Belgium N.V., the major Opel site at the Port of Antwerp and one of the jewels in the crown of the Belgian car assembly plants with a reputation for high quality, currently produces different versions of the Opel Astra model. The end product finds its way to more than a hundred international destinations from the Port of Antwerp. The observant visitor will notice that quite a few Astra car bodies on the production line have a dashboard with the cavity for the steering mechanism on the right hand side ...
The first automation and safety project based on safety integration technology was recently implemented at Opel Belgium. This consisted of close cooperation between the local Opel engineering team, safety consultants Cardoen Industries, system integrator Imtech Belgium Projects, and Siemens Automation & Drives who, as system supplier, also implemented the first system and acted as consultants.

Francis Luyckx, responsible for engineering at the Opel Belgium body shop, sketched the scene. In the body shop, potentially dangerous machines and conveyance systems comprising robots and conveyors are made safe by cages, light curtains, safety switches and emergency stops, but are still controlled by old-fashioned relay connections.

Francis Luyckx says: “This was a double project: a new robot welding line that needed a control and safety system, and an existing “traditional” control and safety system that needed to be replaced. This old installation based on relay technology had already been upgraded quite a few times, and could no longer accommodate the latest safety mechanisms and the required additional safety functions.”

The combination of new standards and functionality, particularly in terms of detailed and reliable fault reporting, would also have to comply with modern economic criteria: easy expandability in future and reasonable life cycle costs.

According to Francis Luyckx: “The comparison between a system with separate PLC for control and relays for safety on the one hand and a real “failsafe” PLC on the other, was soon made: the latter system is more flexible and reports on faults right down to the last wire! What’s more, it’s bound to be more cost-effective.”

The almost obvious choice ...

“We selected the Siemens solution in particular based on very clear motives. For one thing, Opel engineering is already extensively tailored to the Profibus field bus. Besides positive experience, we also
gained a huge amount of internal know-how. Now that we have access to recent safety integrated technology via Siemens, the choice is obvious: the failsafe PLC, a control unit with completely integrated safety functions. Open for all future automation developments.”

Opel Belgium of course sees the benefit of the Totally Integrated Automation concept because of the specific characteristics of this enormous assembly plant. Endless preparation cells and typical supply systems for the assembly line of the Opel Astra demand smaller, decentralized automation units. There are numerous practical benefits: flexibility, shorter cables, extensive network possibilities and integration on Profibus, and – just as importantly – the necessary time to perform tests. Francis Luyckx, says: “Everything at that level that can be performed off-line and therefore beforehand, is to our benefit.”

Further refining

Now there is even more extensive integration of safety functions on the wish list. Fault reporting is the most prominent. The intention is to generate fault reports on the operating consoles (HMI panels) simply by using standard parametric Siemens software. Another benefit is that the Opel engineers can now also implement other forms of safety intelligence, for example controlling the muting functions (programmed and safe suppression of safety functions, required for the normal run of production) when using safety light curtains.

Erik Moons, Opel Engineering, also pointed out the e-mail card that is in the failsafe PLCs: “The central Opel safety services now have – as required – a new option to monitor the safety software. If the latter changes, an e-mail message is automatically generated and sent to the safety service.”

Siemens Automation & Drives saw to the commissioning and programming of the first failsafe PLC installation. System integrator, Imtech, was responsible for the second one – independently and without problems. Wim Van Goethem, project engineer at Imtech Belgium Projects, said: “A course presented by Siemens provided the basic knowledge needed for the overall programming and implementation to run smoothly. We had a permanent fallback solution by means of a continuous purging and back-up procedure in our planning. That proved to be a luxury even in the period at the end of the year and with a tight implementation schedule ...”

The findings of the Opel team after two months’ use speak for themselves. Francis Luyckx says: “The system was started up and we just about immediately forgot about it, because it was working well. We did not experience any problems. Although we have to get used to the new philosophy: safety is actually integrated into this system. Before, the safety functions were build up with hardware. Now they are incorporated and although we know that, there is sometimes still the reflex to want to see everything separately. We actually want to see the separate hardware functions in the software.”

On the shop floor

Both failsafe PLC systems are installed in the metal finishing department where finishing work is carried out on the basic bodywork. One unit provides the functions for stud welding and the conveyor system where assembly of the trunk lid or tailgate takes place, depending on the type of vehicle.

The second PLC assists with finishing, careful polishing and visual checking of surface quality, as well as the fitting. That includes fitting the doors into the door openings and opening the trunk lid before the car body glides into the paint tunnels. Both systems require extensive and complicated conveyance, and a lot of specialized human work also takes place in the area, resulting in many potentially dangerous movements having to be screened off.

Francis Luyckx says: “Physical safety measures consist of emergency stop chords, emergency stop buttons, light curtains with or without muting functions, screens for lift apertures, classical safety cages with safety catches, etc. It is a complex scenario, but the failsafe PLC controls it all and communicates with the ordinary control systems via Profibus-DP couplers. We hope to take it one step further later this year; complete integration of both the failsafe and the standard control system in one PLC.”

More Information:  
www.siemens.com/safety
Powertrain

CASE STUDY

Safety Integrated in the steering knuckle assembly at Opel

A Fresh Way of Thinking ...

... for enhanced safety. According to this slightly modified company motto, steering knuckles will be assembled more safely than ever before at Opel in Bochum. Operators, maintenance technicians and owners will soon be next to benefit from the first use of a failsafe Simatic Controller and the Profisafe technology after the automaters. From improved safety, more comfortable diagnostics and consequently higher availability and increased productivity.

Plant 2 at Opel Bochum is the component plant of the automobile manufacturer and specializes in engine, gearbox and axle construction for the European factories. From the summer of 2004 they will be producing up to 120,000 steering knuckles per year for the new Astra Diesel there semi-automatically in two different versions and delivering them “just-in-time” to the production line for shock absorbers.

In a 40-second cycle, a robot takes a brake disc delivered on a pallet and places it on the conveyor belt. It is automatically positioned correctly and the angular ball bearing, steering knuckle and cover plate are mounted at two manual workstations. Two screwing stations screw the individual parts to the “sub-assembly” and the torques are measured without contact by the Moby I identification system. A second robot then takes over the finished assembly and places it back on a pallet.

State-of-the-art safety technology in use

Extensive safety precautions have been taken to protect operating personnel from danger and injury. Sturdy protective gratings and several safety doors with locks which can only be opened in safe conditions are fitted round both robots and the screwing stations for example. Two light grids protect the danger zone on the supply side. Twenty emergency stop switches are also installed around the plant. Among other places on four Simatic Operator Panels OP 17 which supply the workers with information and on the robot control units. The dead-man switches on two of the first portable manual operator units Sicalis PMC Mobile HMI to be used in practice are also integrated in the emergency stop concept.

The automater Com-Tec Communicationstechnic in Leonberg has implemented a distributed concept and installed failsafe peripheral modules of the ET 200S Profisafe series in 11 small local junction boxes. Various peripheral ET 200X modules apart from the robots and screwing stations are connected to this. They are powered by the power modules of the ET 200S and therefore satisfy safety category 3 in accordance with EN 954-1. The robot cells themselves comply with safety category 3. Failsafe motor starters of the ET 200S series which are switched off redundantly in the event of a fault by an integrated power switch and without an external power contactor are also the new standard.
The heart of the control for both the “normal” and safety-oriented part of the plant is a Simatic Controller S7-400F with CPU 416F, a first for automaters and users. The Profibus DP which is ideal for safe communication with its Profisafe profile provides the link to the distributed peripheral units. The failsafe PLC and fieldbus technology from Siemens is gradually infiltrating the whole factory and replacing permanently wired hardware connections. This preference originates from the Opel headquarters in Rüsselsheim where works standards are defined. The employees at the Bochum plant who have had only positive experience of Siemens products are of the same opinion. 

**Easier configuration, installation and diagnostics**

The advantages of the integrated solution are obvious for Hans-Joachim Meyer, Managing Director of the automater Com-Tec: “Once we get used to the new technology we will save at least 10 to 15 percent on engineering and commissioning costs for future applications.” The Profibus technology reduces the wiring effort considerably and the switch cabinets can be designed smaller and cheaper. The configuration and programming of the safety technology is fully embedded in the Step 7 environment and there is no need to re-learn it. It was therefore easy to generate an individual safety program from the existing commands of the software options package F Systems. With pre-fabricated components from the F-library and your own components, for example for moving the inside safety door before loading. A program which is easy to change and therefore a lot more flexible than permanently wired systems.

The automaters and the people responsible at Opel envisage further saving potential in later assembly. The production, information and plant monitoring system Sicalis PMC will provide the same valuable services it did during commissioning. An operator unit with protection class IP65 is permanently installed in a central position. Two portable Sicalis Mobile HMI units with dead-man switch are provided for set-up and maintenance technicians with which the emergency stop circuit can be bypassed simply and safely when the safety door is open. Faults and bottlenecks in the production process and on safety devices can be detected and eliminated more quickly in the immediate vicinity. This, we are convinced, will have a direct effect on the availability and productivity of the steering knuckle assembly.

**Further projects:**

Bodyshop and Conveyer: Antwerp (Belgium)
Paintshop: Bochum, Rüsselsheim (Germany), Saragossa (Spain)
Powertrain: Bochum (Germany)

**More information:**

www.siemens.com/safety
DaimlerChrysler AG has developed a new kind of fully automatic application process for body seam sealing in a pilot project. Potential innovations for the company-wide automation standard integraMCG are to be validated and ensured simultaneously for the control-technical implementation of the process.

The aim of the seam sealing robot tower pilot plant at the DaimlerChrysler AG works in Sindelfingen was to demonstrate a production process for fully automatic, smear-free sealing of the up to 80 meter long jointing seams of the vehicle bodies. A two-tier tower architecture was developed for this which enables application robots to work on the top and bottom body halves at the same time.

A look ahead: Profinet Safety
Basic problems in the control-technical implementation of the project were to work out a basis for the planned mid-term use of the Ethernet technology (Profinet) for conventional and failsafe automation technology in the production. The ambitious schedule for implementing the plant automatically demanded a split-level implementation strategy for the control-technical equipping of the plant.

Proxisafe – a safe bet
To enable the project team comprising the general manager KUKA welding systems, the control technology supplier Siemens and the DaimlerChrysler designers of PWT-VAS to get off to a quick, trouble-free start, a technological basis was required with a high innovation and future potential but which at the same time promises a high degree of real production capabilities. It was decided to implement an initial architecture based on Profibus with Proxisafe technology – but at the same time to take the necessary measures to be able to easily convert to Profinet or Profinet Safety later. The core of the initial architecture is the system and safety control based on a Simatic CPU 416F-2 which controls both the conventional and the safety-oriented plant parts side by side. This solution completely does away with the need for a separate safety control and the installation of a separate safety bus. The connection to all the field components is made throughout by a common bus system, Profibus with Proxisafe profile. In the field level, conventional and failsafe distributed IP20 peripheral devices and motor starters of the Simatic ET 200S have established themselves, the IP65/67 periphery scopes are covered both by conventional and failsafe Simatic ET 200eco peripheral devices. A Siemens frequency inverter available from the mid-year is already being subjected to intensive field tests in prototype versions.

Profinet Safety – open to partners
One of the decisive factors in DaimlerChrysler AG’s choice of the Profinet technology was the extensive integration possibility for the products of other partners. For total implementation of the plant functions, the robot controls, the vision system,
the first implementation stage, all development goals including the integration of the components of third party providers were achieved in just five months and within the budget. The transfer of the new technologies to the planners, operators and maintenance people also worked thanks to the great commitment of those involved in the project. The implemented architecture offers both plant manufacturers and end users a modular system which leaves them freedom of choice between a central or distributed plant structure and leads to provable savings after internal cost analysis.

I the safe servo drives, light grids and laser scanner, wireless safety systems and the process diagnostics system are linked to the Profibus with Profisafe profile. The conventional bus also failsafe linking to neighboring plants is done simply, safely and flexibly with conventional DP-DP couplers.

Profisafe – one diagnostics for all

By using the Profibus diagnostics repeater the Profibus with Profisafe profile fieldbus system can play out another of its strengths; homogeneous bus diagnostics for all field devices and conventional and failsafe peripheral devices. For this a new kind of Profibus diagnostic software was developed in close cooperation with the developers and maintenance people at the DaimlerChrysler AG which will soon become part of the Siemens product landscape.

Industrial Ethernet for vertical integration

A terminal server/thin client principle is being relied on for the first time for operation and monitoring of the whole system. The programs integrated on the server such as Step 7/Graph 7 and other HMI software communicate with their target systems such as the system and safety control, the robot controls and slave technology controls via Industrial Ethernet. The cost-optimized, “zero-administration” thin-client systems integrated locally in the operator stations only send the mouse and keyboard information to the terminal server and receive the screen information from the terminal server via the network for display.

A fireworks display of innovations – in time, in budget

The experience in the implementation phase was exclusively positive according to the coordinating staff at DaimlerChrysler. Despite the large number of innovations in the first implementation stage, all development goals including the integration of the components of third party providers were achieved in just five months and within the budget. The transfer of the new technologies to the planners, operators and maintenance people also worked thanks to the great commitment of those involved in the project. The implemented architecture offers both plant manufacturers and end users a modular system which leaves them freedom of choice between a central or distributed plant structure and leads to provable savings after internal cost analysis.

More information:
www.siemens.com/safety
Toyota, Cambridge (Canada), with future-oriented safety technology

A Safe Bet for Increasing Production

Toyota Canada chose a safety solution with Siemens AS-Interface at Work and Simatic S7-300F for their new Lexus factory and a plant retrofit. In addition to the enhanced safety, the automobile manufacturer also profits from the higher availability and thus increases productivity.

Not only is it consistently rated in the top 10 by JD Power and Associates, the southern Ontario facility was honoured by the parent company, when it became the first Lexus plant outside Japan. Toyota Motor Manufacturing Cambridge (TMMC) along with partners Siemens Canada, and consulting engineers Stantec further demonstrated its expertise by installing top-notch, Control Reliable safety solutions that have been cost effectively applied to both the new Lexus RX330 plant, and in a retrofit of the existing Corolla plant. Besides maximum safety, the new system boosts production through increased diagnostic capability. Siemens machine safety program manager Ondrej Benjik recalls planning the retrofit strategy with TMMC project manager Scott Bartlett. Bartlett identified a number of essential criteria for the retrofit, including the integration of the new safety solution with the existing controls platform, the replacement of existing field devices and wiring, the ability to execute the retrofit with no, or limited scheduled down time, and effective use of the new systems, such as the quick recovery from fault conditions.

All safety regulations met

“The Siemens Actuator-Sensor Interface products have proved themselves well suited to the challenge and fully satisfied the requirements of OHSA by passing PSR under Sec. 7 of Reg. 851. The easy transition was accomplished with no resistance,” recalls Bartlett, “and a ready acceptance by Toyota team members that understood the concept and value of the installation.”

Performed on weekends and during the holiday’s shutdown, the retrofit to the Corolla paint plant’s robot cells occurred without production downtime. The “anti-chip” booth which applies protective coating to a vehicle’s rocker panels, and the “black out” booth (which paints under-body components), were upgraded with the new Control Reliable safety systems with minimal changes to the existing PLC control system.
Siemens’ non-proprietary AS-i safety network was an easy fit, since it can be easily integrated into virtually any PLC. The AS-i network easily integrates light curtains, laser scanners, safety interlocks and E-stops with direct connection to a single cable; meeting the Category 4 safety level. As well, the AS-i systems’ unique direct-connection technology of safety devices and/or safety input modules, eliminates the need for distributed I/O stations; which reduces hardwiring down to nearly zero. This ease of installation greatly reduces the commissioning cost and site time required for a retrofit, and allows for full functional testing prior to commissioning.

**Simatic S7-300F for the Lexus**

The new Lexus RX330 plant will feature Siemens safety solutions that meet EN954-1 and IEC 61508 standards. The AS-i will be in service in the new paint shop, while the body and weld shops will be enhanced by the Siemens S7 ‘F’ safety PLC on Profibus. “Toyota has shown that the best in class safety solutions can not only ensure enhanced operator safety,” concludes Siemens’ Benjik, “but maintain business goals like high availability and quick mean time to recovery.”

**Further projects:**
- Bodyshop and paintshop: Tahara (Japan); Indiana and Kentucky (USA); Cambridge (Canada)
- Press-shop: Kentucky (USA); Cambridge (Canada); NUMMI (Joint venture GM and Toyota), California (USA)

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**Toyota Motor Corporation**

Toyota Motor Corporation is the world’s third largest automaker, producing a full range of models, from minivehicles to large trucks. Global sales of its Toyota and Lexus brands, combined with those of Daihatsu and Hino, totaled 5.94 million units in 2001. As of March 2002, besides its 12 own plants in Japan, Toyota has 54 manufacturing companies in 27 countries/locations, which produce Lexus- and Toyota-brand vehicles and components, employs 246,700 people worldwide (on a consolidated basis), and markets vehicles in more than 160 countries and regions. Automotive business, including sales finance, accounts for more than 90 percent of the company’s total sales, diversified operations include telecommunications, prefabricated housing and leisure boats.

**Simatic failsafe technology to become company-wide standard in body shop**

**Toyota Mini-Van Production Failsafe**

A fter a long and intensive evaluation, Toyota decided to use the new failsafe technology based on Siemens S7 PLCs and ProSiSafe to be used in the safety installation within the bodyshop of the new “Sienna” mini van. Since a production line gets continuously modified due to model changes, the use of a Safety PLC with distributed system allows a fast, easy and cost effective adaptation. Toyota rated the Siemens Safety PLC as the most reasonable one concerned with functionality and reliability in an automation line among other several other safety PLC suppliers evaluated. Currently three projects are on the way in Toyota plants around the world: Tahara (Japan), Indiana (US) Cambridge (Canada). The overall content of Safety PLCs used in all 3 plants is around 170 PLCs with about 2000 safe I/O modules in use.

**The control architecture:**

Safety-related functions are controlled by Simatic S7-300F. Both controls communicate via Profibus DP

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More information:
www.siemens.com/safety
CASE STUDY

Distributed safety solution in the paintshop

Conveyor technology for the paintshop at the BMW factory Regensburg equipped with Profisafe

The Paint is “Safe”!
BMW uses Profisafe in the field of conveyor technology in the “New Paintshop Structure” (NLS) at their Regensburg factory. The new control concept using the failsafe Simatic S7 controller with distributed “safe” periphery enables optimum switch-off zones to be set up flexibly for personal and machine protection with Profisafe.

Since the spring of 2002 the paintshop at the BMW factory in Regensburg is being extensively modernized. New technology standards in painting techniques for automobiles, capacity bottlenecks and the necessity to replace existing systems prompted the company to undertake the “New Paintshop Structure” (NLS) project with a total investment volume of 225 million Euro.

With the final commissioning of the last new installations in March 2004 (first stage) and March 2005 (second stage), the new installations and conversions in the paintshop at the BMW factory in Regensburg will be completed.

New solution for the conveyor technology

In the course of modernization of the paintshop, the entire conveyor system automation was renewed. BMW decided to use Profisafe for all conveyor systems. This corresponds to a scope of more than 1,850 single conveyor elements with a length of approximately seven kilometers.

In order to be able to control this enormous scope optimally, 36 failsafe controllers of the Simatic S7 416-2F type are used.

These control the approximately 850 distributed peripheral stations equipped with safety technology in terms of both control and safety: “Our criteria for selecting this safety solution were on the one
The project team BMW/Siemens. From left to right: Jens Rutenberg (Siemens), Karl-Heinz Fischer (Siemens), Norbert Schottenheim (BMW), Christian Weitl (BMW)

Schematic plant concept of the distributed safety technology in the paintshop of the BMW factory in Regensburg

Distributed safety solution in the paintshop

CASE STUDY

The project team BMW/Siemens. From left to right: Jens Rutenberg (Siemens), Karl-Heinz Fischer (Siemens), Norbert Schottenheim (BMW), Christian Weitl (BMW)

Schematic plant concept of the distributed safety technology in the paintshop of the BMW factory in Regensburg

Distributed safety solution in the paintshop
Only a distributed, freely programmable safety technology allows a flexible and finely graduated safety concept in the paintshop which enables individual zones in a cell to be shut down. This modular structure allows a very limited area to be shut down without affecting the overall production.

Narrow time windows
Numerous individual measures such as the mounting of lifting stations or linking conveyors were installed at the weekend and during the Christmas, Easter and Spring breaks. Certain conversion and new installations had to be made during ongoing production however.

The demand: flexible safety
A very high safety standard is demanded in the paintshop at the workstations with fully automated production plants. Man and machine work right next to the conveyor systems. Safety components such as light curtains, switches and emergency stop buttons ensure safety of the personnel and trouble-free machines.

The Remains of the Switch Cabinet – the distributed safety concept with Profisafe only needs about a quarter of the previously necessary switch cabinet volume

A three-week production shutdown in August 2003 was planned by the “New Paintshop Structure” team down to the very last detail. During this time, 20 of the total of 36 new conveyor installations were extended or installed and commissioned with the “safe” control technology. Another 20 existing conveyor systems were converted. A Siemens service engineer was on site during all phases of the project, such as compiling the specifications, writing programs, commissioning and training BMW staff.

Distributed safety technology with many advantages
Several plant sections could be commissioned separately with all the necessary safety functions using island solutions with temporary PLC cabinets and distributed technology during production. Only the individual program modules of the island solutions had to be joined up in a general program (standard and safety program) and the networking completed with Profisafe to complete the control technology of a system.

The safety technology linked decentral to the PLC reduces installation times due to the shorter cable distances. The space requirements for the total system is also reduced due to the omitted switch cabinet.

“With Profisafe, standard and safety functions run on one PLC. This gives us a flexible and innovative safety technology for the price of the standard technology,” Christian Weitl explains. Where special knowledge used to be necessary for programming, standard and safety functions can be programmed today by the same editor. This reduces planning and commissioning times per plant. In addition, both the complicated hardware planning and the “inflexible” switch cabinet wiring for the conveyor system safety technology are omitted.

“The safety cut-outs no longer need to be wired “rigidly” but are freely programmable according to the respective requirements. This makes safe shutdown zones easy to change,” Weitl describes other advantages of the new safety technology.

More information:
www.siemens.com/safety
Advantages which the MAGNA STEYR Fahrzeugtechnik AG & Co. KG in Graz-Thondorf has learned to appreciate. The Austrian company paint and assemble vehicles of different manufacturers and in Summer 2003 they fully modernized an existing emu plant. Since then one failsafe Simatic S7-400F has been controlling the normal cleaning process and the safety-relevant devices of the plant all on its own. This saves the safety PLC which always used to be used additionally and the associated costs.

The “normal” jobs of the F-controller includes saving and managing the body data and the coordination of roof, in-
A failsafe Simatic S7-400F controls both the “normal” and the safety-relevant functions of the emu plant at MAGNA STEYR and saves the additional safety PLC.

... cliined and vertical rollers and post-ion-ization which neutralizes electrostatic charges.

... Another emphasis is on the communication to the conveyor technology, to visualization and to the central control technology. Added to this are various safety-relevant functions for the first time on an emu plant such as monitoring of all emergency stop circuits and the light curtains for the access protection. Emergency stop switches are mounted on both sides of the cabin entrance and exit, another one on the control panel. Cabin entrance and exit are protected against unauthorized access by light curtains whereby the muting function prevents the bodies triggering an emergency stop.

... All emergency stop functions are designed as 2-channel version, that means two separate lines are laid for sensor supply and feedback. If the transmitted signals differ (apart from a discrepancy time of a few milliseconds) this is registered in the failsafe input module and reported to the F-controller. MAGNA STEYR also picks up emergency stop signals from other plant parts or controllers through the input modules and evaluates these.

... These include safety-relevant signals from the fire alarm center, the conveyor technology and the process technology.

**Exactly defined safety requirements**

There are various ways of estimating the risk potential on machines and plants including the risk estimate (danger analysis) according to DIN V 19250, EN 954-1 or IEC 61508. The rulebooks are very similar and differ only slightly in the division and emphasis. The DIN norm defines requirement classes (RQ), the EN norm categories (cat.) and the IEC norm Safety Integrity Levels (SIL). According to the risk estimate plants can be classified in an exactly defined safety class whereby it basically applies: The higher the safety class, the greater the demands on the safety concept of the plant. Safety Integrity Level 2 was determined for the MAGNA STEYR emu plant which is easily achieved with the Simatic F-controller (satisfies SIL3).

**New roads to safety**

For the S7-400F series there are no input and output modules which can be plugged directly into the rack but only distributed peripheral modules ET200M. These are connected to the controller by conventional Profibus DP-lines. The Profisafe telegram which contains the checksum for error detection, a consecutive number and a status byte in addition to the normal Profibus useful data is used for communicating with the failsafe modules. Unlike other failsafe controllers the fail safety in the Simatic S7-400F is not guaranteed by two or more processors. The failsafe CPU S7-416F-2 is based on a standard CPU, the operating system and hardware components of which have been extended by various safety mechanisms. It has only one processor and therefore executes every command additionally with negated variables complementary and then checks the results.
Something holding you back?

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