Facility Automation

Simatic S7 controls every second fab in Taiwan

Semiconductor library now available for PCS 7 V6.0

Equipment Automation

Fastest time-to-market equipment control system
Dear readers,

Staying ahead of the competition in a market as volatile as the semiconductor industry is getting tougher each year. The debilitating cycle of re-engineering of existing and new equipment for a continuously evolving technology sector has meant a strong look at standardization within capital equipment tools from a smaller list of vendors. This trend is forcing automation components and solutions suppliers to offer standardized technologies supported on a global basis. Minimizing the cost of ownership and time-to-market has become downright essential for both chip manufacturers and tool OEMs. As a manufacturer, consumer and supplier of semiconductor products, Siemens has a unique perspective on the needs of this industry. We can draw upon our vast experience for bringing projects in on time and on budget with integrated products for complex process and machine control, power distribution, 200 mm/300 mm services and fab host interfaces. This year at SEMICON Europa and SEMICON West, Siemens will introduce a complete suite of software and hardware products that allow one stop shopping for all OEM tool needs. Siemens stands ready to share the power of its global expertise to customers who see today’s semiconductor market challenges as opportunities.

Gerd Limmer
Director Competence Center
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Automation engineering not only improves product quality but also increases productivity. Moreover, it contributes to exploiting existing resources more effectively, thus providing a significant contribution towards sustainable development.

In the equipment sector, there are currently many demands for state-of-the-art and flexible automation strategies that support increased productivity and the associated rapid amortization of the high investment costs. One demand relates to safety for people, equipment and the environment.

Conventional PLC technology has to be combined with electromechanical solutions, so-called hardwiring. The implementation of interlocks hardwired with relays requires more space in the equipment and would increase the footprint – and this is contrary to the trend towards a more compact design of machinery.

Siemens offers fail-safe Simatic controllers that integrate both worlds by switching to or remaining in a safe state when a fault occurs, while simultaneously featuring the flexibility of a PLC. Safety-related and standard automation components of Totally Integrated Automation are integrated in one system and all communication between the central controller and the I/O points is performed using the Profibus DP and the Profisafe profile, which forms a simple single network system.

For the user this means getting the best of both worlds: an open, distributed and modular system that can be used in safety applications up to SIL 3. On average, 40 percent of assembly time and up to 30 percent of commissioning can be saved.

**Fast return-on-investment in facility automation**

Building a new fab today must proceed as quickly as possible, because the immense costs involved mean that the return of investment for the owner needs to start as early as possible.

In addition, increasingly strict environmental requirements, reduced inventory, improved asset utilization, transparent and optimized plant, production and cost structures, with consideration of total cost of ownership as well as reduced lead time, fast response to unexpected changes and a simpler integration are key demands of OEMs and end customers.

Totally Integrated Automation from Siemens permits all facility packages to be based on a common database, and their monitoring and control by one process control system: Simatic PCS7. This allows achievement of a uniform FMCS (Facility Monitoring and Control System), a platform with integrated monitoring and control interfaces.

This concept has already been repeatedly proven in the construction of new 300 mm and flat panel fabs. Fabs currently in construction worldwide have also adopted this approach.

In addition to the uniform system platform, comprehensive standardization is supported in application programming, and a common application specification produced for all suppliers. These definitions apply to the software functions to be used as well as to the system settings to be made by the selected suppliers.

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Totally Integrated Automation for Chemical Mechanical Planarization (CMP) in the semiconductor industry

Complex and highly sensitive

Just one year after starting large-scale production of memory chips on silicon wafers with a diameter of 300 mm, Infineon has reached the so-called cost crossover at its Dresden factory and has underlined its pole position.
A further increase in productivity is being achieved by miniaturization of the chip structures. The first 300 mm wafers had a structure width of 140 nm. Today, 110 nm have been achieved. Structure widths of 90 nm and less are in development; no limit is yet in sight.

The chip manufacturing process is extremely complex. High-precision masks containing an exact image of the integrated circuit are used as a template for the optical realization of the circuit diagrams on the silicon wafer. Using modern lithography equipment, light is projected through these masks onto the silicon wafer, which is coated with a photoresist. In the case of a negative photoresist, the resist covered by the structures of the mask (e.g. unexposed resist) is removed. In this way, structures can be etched or another material added by diffusion. Circuits are thus built up layer by layer through exposure and addition or removal. The structure widths of modern semiconductors are well below the wavelength of visible light.

**Absolute planarization is required**
To ensure that no defects occur that could lead to short circuits, for example, the surface of the wafer must be absolutely planarized before every new coating process. A maximum of 20 nm difference in waviness is tolerated over a diameter of 300 mm.

Wafer planarization machines from Peter Wolters, Rendsburg, Germany, were involved in the processing of the 300 mm wafers at Infineon from the very start. A machine for the 110 nm technique is also available.

Chemical Mechanical Planarization (CMP) technology mainly is applied in semiconductor chip manufacturing, where the sur-
face of patterned silicon wafers needs to be planarized.

The wafer sits in a chuck which presses the wafer surface onto a polishing pad mounted on the polishing table. Both chuck and polishing table rotate, while the chuck may also oscillate horizontally during the polishing process. Polishing slurry, which typically is a mixture of abrasives and a reactive chemical, is supplied onto the polishing pad.

Availability and transparency are crucial

The operators of the CMP equipment demand above all quality and availability: 70 wafers per hour must be planarized around the clock. The equipment must have an availability of 90%. Time is, after all, money, and this has never been more true than here. Depending on the degree of processing, the value of a single wafer may be up to tens of thousands of EUR.

For continuous monitoring and effective optimization of productivity, every machine must be integrated into the data network of the factory without any problems. The interfaces for this integration are precisely defined. A central PC, linked to the so-called cluster control via OPC, manages the recipes and forms the interface to the host on which production planning is running.

High transparency is achieved by integrating the production planning systems, which in turn are linked to SAP. The availability of every single production unit can therefore be determined exactly. This provides enormous challenges for both the mechanical engineering and the automation technology.

“Service friendliness is extremely important to us,” says Ulrich Ising, who is responsible for design and engineering at Peter Wolters. “The replacement of most analog interfaces by Profibus was very important for us in this context. This means that the system diagnostics go as far as the periphery – a major contribution to faster troubleshooting.”

The equipment has a footprint of just 11 square meters, including the parts feeder, the actual CMP process, the cleanroom generation for this process, and the loading of the transport racks in which the wafers are moved to the next processing station. Two Simatic S7-400 PLC from Siemens suffice to control the entire process. This is also due to the fact that part of the intelligence has been moved to the Masterdrives converters – the synchronization functions, for example. The numerous sensors for the monitoring functions are also connected via Profibus and thus integrated into the central diagnostics. Another advantage of the homogeneous fieldbus is the possibility of changing parameters – altering the setpoints during the run time, for example.

PLC instead of PC

The predecessor to the present equipment used a standard PC to control the entire machine processes. Ising’s comment: “We now rely on PLC technology to meet the high availability demands. Robustness, reliability, and defined restart behavior are in our opinion the basic arguments for using programmable logic controls.”

After commissioning in Peter Wolters’s Rendsburg factory, the new R&D equipment will – like its predecessors – complete a 1,000-wafer test at the Fraunhofer Institute in Itzehoe. Peter Wolters has an ongoing relationship with the test laboratory. The Fraunhofer Institute has the facilities to simulate the cleanroom conditions that will prevail later in the wafer fab. The operator still has to run the 1,000-wafer test for production machines. Only then can actual production start. “That’s standard for the industry,” Ising explains. “We are certain of passing again this time. The quality and performance of the controls, especially the consistent distributed structure with its greatly improved diagnostic possibilities, provide a sound basis. Our know-how is in mechanical engineering and mastery of the process. We buy parts externally only from technology and market leaders. For the automation technology, Simatic PLC and drive technology from Siemens was the obvious choice.”

Simatic PLC was already used successfully in the implementation of the cleanroom at Infineon in Dresden, and the CMP 300 once again proved the competence of Totally Integrated Automation in the complex and highly sensitive environment of a wafer fab.
HCT introduced its technology in early 1984. Initially for use in photovoltaic areas, and later in 1986 it was also applied to semiconductor wafer processing. The E500SD-B is extremely fast and cost-effective thanks to its PC-based controller and perfect drive synchronization from Siemens.

Manufacturers of solar-cell wafers have to deal with strong cost pressures. Against this background, HCT Shaping Systems SA makes an important contribution to increasing the competitiveness of solar technology with its E500SD-B wire saw. The E500SD-B is extremely fast and cost-effective thanks to its PC-based controller and perfect drive synchronization from Siemens.

A fine steel wire is run across four rollers with grooves arranged in a square, creating two horizontal wire webs. The wire is then guided at a maximum speed of 18 m/s from the output spool over the four rollers to the take up spool. The silicon ingots, arranged on two tables in the E500SD-B, are then lowered onto the two rotating wire webs. The wire passing first through an abrasiv chemical called “slurry” then cuts the silicon into fragile wafers thinner than 300 µm.

Innovative control concept
HCT has implemented an innovative PC-based control concept for its latest wire saw. The software is written in C++ and runs on Windows NT. “This allows us to achieve optimal flexibility with regard to the configuration while taking account of any additional components,” explains HCT engineering manager Alain Foretay.

Integrated communication thanks to Drive ES
The time-critical motor drives are linked to the PC-based control level via the Proﬁbus DP ﬁeldbus. The combination of a distributed conﬁguration using Simatic ET 200S I/O over Proﬁbus has resulted in fewer machine faults, time and cost savings and optimal tool modularity.

Synchronization of the seven drives for wire management is a necessity to prevent wire breakage that would lead to ingot loss. Constant wire tension must also be maintained for cutting accuracy. A main and slave motor with Siemens Simovert Masterdrives Vector Control (VC) drive the wire guide rollers. Two smaller motors with Siemens Simovert Masterdrives VC frequency converters are used for winding/unwinding the wire spools (constant wire tension). Two motion control modules control the axis for wire positioning on the output or input spools, and one motion control module moves the two tables with the silicon ingots.

Three additional standard Siemens Micromaster inverters are involved in managing the slurry. All these converters/inverters were configured with Drive ES engineering system. In view of the fact that three different inverters are used in the E500SD-B, Drive ES was one of the requirements for integrated communication via Proﬁbus.

Functional safety is the highest priority
A break in the wire or uncontrolled shut down of the equipment can result in total loss of the silicon and damage the wire saw itself. “We have to avoid this scenario with low-cost wafer production in mind,” says Jean-Marc Rosset, head of software and hardware engineering at HCT.

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New low-cost wet processing tool equipped with Simatic CPU 315-2 DP and TP 270 from Siemens

Small footprint is sexy

In addition to enhanced flexibility, productivity and cost-effectiveness, a small footprint is key in the development of the latest low-cost wet processing tool at AP&S Customized Solutions in Donaueschingen, Germany. For this reason, the company decided to implement the Simatic TP 270 touch panel, CPU 315-2 DP and ET 200M high-density I/O from Siemens.

AP&S can trace its roots back to the mid 90’s when HM Reinraumtechnik GmbH was founded and finally acquired by SEZ AG, Villach, a specialist in single-wafer treatment. The company develops and produces automated wet processing equipment for substrate batch treatment in cleanrooms. Based its long-standing experience, AP&S specializes in customer-specific process problems.

In a modern chip fab about 25 to 30% wet process steps are required. Immersion processing of wafer batches is required for a number of process steps in a modern fab.

Meeting new requirements in tool architecture

As a combination of two process stations the so-called TwinStep combines a circulation system with overflow processing. The AeroSonic drying technology with its ability to increase chemical treatments of substrates, allows rinsing and drying within one bath as the core element of its new tool generation. With this combination various process application are made possible. This new equipment type closes the gap between manual stations with its flexibility but low automation and the highly automated systems with its accuracy and throughput but also high costs.

“With a compact design on a small footprint, based on the dry-in-dry-out principle, we needed a flexible tool control architecture, with minimal space requirements and cost effectiveness,” explains Juergen Funkhaenel, project manager at AP&S.

Beyond the simple manual stations the TwinStep contains an automated process control with wafer cassette handling inside the tool for reliable and repeatable process steps.

“Simatic S7-300 controllers have been chosen by our electrical engineers because of their remarkable low-cost configuring and IEC 61131-3 compliant programming,” says Juergen Funkhaenel, “and in addition to that, we can count on powerful, integrated system and process diagnostics functions which increases controller availability and productivity as well.”

“Our customers also want a graphical user interface, which simplifies the handling of the equipment,” asserts Juergen Funkhaenel, “Simatic TP 270 panels provide intuitive and simple operation by touch. With the integrated communication capability of the TP 270, AP&S also saved considerable expenditures on configuration. The touch panels can be easily integrated into the automation environment, using Profibus DP or MPI and above all the on-board Ethernet communication capabilities enable powerful recipe downloads from host systems.”

At the upcoming SEMICON Europa 2004 show in Munich, AP&S will present AeroSonic drying technology with Simatic technology at the Siemens Pavilion for the first time.

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Today, the semiconductor industry is moving towards a clustered approach for process tools to answer the need to provide high-throughput transport of semiconductor wafers. Siemens ECS (Equipment Control System) provides a cluster tool control system that manages wafer travel between high-vacuum process chambers or modules. Overall there can be up to 1,500 to 2,000 I/O points – these being distributed in various modules. A cluster tool can have 3 or 4 process chambers with 300 to 400 I/O points each, and a transport module with 50 to 150 I/O points, handling the robot movement, and all systemic functions.

Proprietary control applications are no longer cost efficient

The semiconductor machine design and manufacturing is a high-stakes industry. The success of a new tool project depends on reaching the market first with cutting-edge technology.

Equipment manufacturers are realizing that it is no longer cost-effective to develop controls applications from scratch, without leveraging off-the-shelf products and systems from global vendors. The value to have re-usable components from one controls solution generation to the next is increasingly recognized. Proprietary languages and development environments traditionally create “point solutions,” which are being phased out as equipment reaches end-of-life.

The practice of deploying proprietary solutions inevitably results in inflexible and non-scalable solutions, while their maintenance costs grow disproportionately with time. Providing support and service for proprietary solutions is extremely costly, as it requires multiple sources of support and service from a variety of different control vendors.

Component based solution

The Siemens Profibus- and Ethernet-based controls architecture used in Simatic ECS is at the forefront of industry trends to manufacture simpler and more reliable process tools. This combination allows equipment manufacturers to configure systems without the delay and expense of
custom engineering. Simatic ECS contains all the necessary automation components required to monitor and control complex semiconductor machines and to communicate with fab host systems.

As the global market leader in automation solutions, Siemens has capitalized on its field proven control products used in more than 100,000 automation applications to deliver the basic components of ECS – Simatic WinCC, industrial PCs, controllers, open network protocols and modular distributed I/O solutions.

WinCC toolcontrol addresses the traditionally difficult and time-consuming aspects of real time system design. A full suite of 200 and 300 mm equipment control services provide a state-of-the-art scheduler, job management, program and recipe management, carrier management, substrate management, configuration and diagnostics tools, and components and sub-components as object-oriented code libraries meeting all appropriate SEMI standards. WinCC toollink-SECS/GEM connects the equipment to the host via our SECS/GEM interface. It handles the entire SECS communication and GEM specific behavior along with all the requirements for complete SEMI compliant communication. WinCC toollink-EDA connects also the equipment to the host. The new SEMI and SEMATECH specified interface EDA provides important process and tool data in real time to perform e-diagnostics. WinCC toollink-EDA port is based on innovative software technologies such as XML, SOAP, and web services and complies with all the new standards.

WinCC toolmonitor is an equipment performance tracking tool which allows complete machine states and errors analysis including RAM values (Reliability, Availability and Maintainability) with standard reports.

Siemens WinCC semiconductor applications have been implemented in fabs around the globe and are helping reduce integration of process equipment to the host from a typical 2 to 3 month cycle to only 2 to 3 weeks.

**Engineering performed in weeks**

Tool control engineering is performed graphically by drawing hierarchical diagrams. Using our ECS configuration tool, modules (e.g. process chamber, tool robot, etc.), components (e.g. RF sources, pump stand, etc.), and aggregates (e.g. valves, pumps, mass flow controller, etc.) can be organized into hierarchical modular trees. The ready-to-use components and aggregates can be easily arranged on a worksheet using drag and drop. The parameters are then set and an export file is created with a single mouse click. Finally the system automatically generates all required automation functions such as hardware configuration, GUI generation, GUI tag management and database population, SEMI compliant GUI frame generation, standard object and screen designs and generation of all system messages in the alarm logging system database.

**Substantial savings**

Product life-cycle costs, including equipment service costs, have reached levels that often seriously hinder increases in productivity. In such cases, the tool price is insignificant in comparison to the costs incurred during operation. Software changes, control modifications, interface management, troubleshooting, training, maintenance, service and spare parts management are frequent problems that plague equipment productivity and desired return on investment. Any savings that can be realized with tool automation can be especially effective in reducing cost of operations. Our experience shows that savings of up to 50% in engineering costs and up to 30% in service costs can be achieved with use of Simatic Equipment Control System.
Founded in 2000, Angstron Systems, Inc. in Santa Clara, California, has developed an enabling wafer processing technology that addresses the increasing limitations of conventional, conductive film deposition technologies for the ultra-small device geometries used in tomorrow’s nanotechnology. A type of atomic layer deposition, Angstron’s technology has the unique ability to deposit high-density, low resistivity, conformal, ultra-thin (1 to 10 nm) metal films at low deposition temperatures for use as barrier and seed layers. This same technology can also be used to deposit dielectric and optical thin films.

Power of communication and performance

Distributed Simatic S7-300 controllers connecting local high-speed IO and third party devices over Profibus DP and Ethernet control Angstron’s ALD process modules. The transport module controller is also a S7-300 PLC and handles all systemic cluster tool control functions as well as the interface to the Brooks tool integration platform (robot, load port). All distributed controllers are connected with each other via Ethernet and tied into a Siemens industrial PC. This modular control architecture is expandable to additional process modules without any degradation in process performance or data throughput and allows a highly-scalable controller bill of materials.

The front end of Angstron’s Atamos ALD tools are powered by Siemens Equipment Control System (ECS). This sophisticated object-oriented GUI handles all host interfaces with 200 mm and 300 mm services and all the semiconductor typical cluster tool applications including optimized scheduling, program, recipe, job, carrier, and substrate management.

“Siemens has been an indispensable product development partner and offers a broad suite of machine automation and power management components as well as tool level control software built upon a solid foundation of field proven fab tool software interface modules. More importantly, Siemens has the expertise to support product development leveraging best of breed products in the aforementioned product categories and with their global presence in fabs, have the ability to reliably support products in the field,” says Karl Leeser, Angstron’s vice president of engineering. Furthermore adds Mr. Leeser, “Angstron could not achieve a distributed control architecture on their tools at the price point offered by any other automation supplier. All in all, Siemens has been much more than a product vendor, but rather a total automation solution and systems integration resource.”

Simple, fast, modular and flexible – that is the new crop of next generation ALD cluster tools emerging on the market. Siemens and its Simatic S7, Profibus, Profinet and WinCC toolcontrol technology are helping enable the trend.

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Siemens equipment control system helps reduce engineering time

Only speed counts

The success of a new prototype tool project depends on reaching the market first with the latest cutting-edge technology. FHR Anlagenbau, a Dresden based tool OEM, realized that it was no longer cost-effective to develop in-house control applications from the ground up and decided to leverage off-the-shelf control products and automation solutions from vendors with a global presence. Siemens Equipment Control System (ECS) is a powerful family of hardware and software automation tools optimized for semiconductor applications selected by FHR Anlagenbau to reduce tool development, configuration, testing and commissioning time with generic reusable code libraries and object-oriented software.

Founded in 1991, FHR is a leading supplier of thin film equipment technologies for deposition and etching. FHR tools are designed with a modular cluster architecture as well as in-line for a wide array of applications serving the R&D and production sector. FHR is known globally for its innovative equipment solutions combining state-of-the-art thin film technologies capabilities with customized equipment fitting to meet any customers needs.

Flexibility is in demand

FHR cluster tools can handle 100 mm to 300 mm substrates and can be equipped with manifold modules for PVD (Physical Vapor Deposition), RF (Radio Frequency) and MF (Medium Frequency) sputtering or electron beam evaporation or for plasma etching with standard RIE (Reactive Ion Etching) or ICP (Inductive Coupled Plasma) modules. Different type of substrate handling concepts, chucks, and heaters to optimize deposition and etching processes can be designed and delivered to meet customer specifications.

“Each component in a FHR cluster tool is an independent module with autonomous mechanical and electronic components including its own application program. Systems with the design architecture are simpler to maintain than centralized configurations. Siemens has helped us realize lower production and service costs with the reduction of wiring via Profibus and increase in diagnostics capabilities with their distributed controller architecture,” says Wolfgang Hentsch, CEO for technology at FHR. “This new control architecture gives us better expandability for our plasma process and other delicate processes for reactive sputtering.”

A new era of economics

The Totally Integrated Automation concept includes the leading SCADA system WinCC. This SEMI compliant GUI centralizes and simplifies tool operation while maintaining a consistent view of the process. WinCC provides a complete engineering platform for tool control and fab host interfaces (SECS/GEM, EDA).

“The Siemens Cluster Tool Controller approach is exactly what we were looking for,” explains Wolfgang Hentsch, “because medium size tool OEMs like ourselves are not capable to support proprietary languages and development environments in an efficient manner. Providing support from our past proprietary software control solution was extremely costly and Siemens through their global support capabilities adds value to our customers worldwide,” Mr. Hentsch adds. “With Siemens powerful engineering tools and the generic object-oriented code reuse along with their leading fab host interface we are more competitive than larger companies.”
Getting good data for e-diagnostics and APC is the biggest challenge

The new EDA interface

To be productive and competitive in today’s chip manufacturing market, semiconductor fabs need to have the complete support of capital equipment vendors to service their production tools. This is an expensive cost factor in fab operations. The installation of an e-diagnostics solution will improve emergency response time and reduce support and service costs. One of the basic requirements for e-diagnostics systems is connectivity to all production tools in order to provide all necessary data for remote equipment analysis. This task will be covered by new standards defining the Equipment Data Acquisition (EDA) interface.

The Remote Diagnostics and Administration Tool (RDAT) makes it easier to access live data by providing important process management decisions real time without having to leave your desk. The system manages the flow of data from your tools and applications ensuring proper diagnostics. The RDAT system provides your fab with more meaningful data and state-of-the-art digital network connectivity. Rely on the RDAT system to enable the swift flow of information through the fab, and perform e-diagnostics and APC with ease.

Computer-based applications on the rise

The industry will increasingly be implementing integrated computer-based applications to improve the yield and drive down the cost of making a “known good die.” These capabilities include tool data collection and analysis, real time process control, Fault Detection and Classification (FDC), Advanced Process Control (APC), and predictive maintenance.

However, most process tools only support a single SECS connection, which is typically occupied by the factory host. Even with a TCP/IP interface, the HSMS protocol is still point-to-point, and supports only one user at a time.

Therefore it is difficult to get the required information out of the tools. A possible solution is to create a second port on the process tools for delivering the additional information to the Equipment Engineering System (EES) applications. The SEMI and SEMATECH organizations have specified a new interface description (EDA) that has defined in a set of new standards (PR8, E125, etc.) a second port in addition to the standard SECS/GEM port. Using this the communication interface bottleneck can be eliminated.

Four levels of e-diagnostics

In April 2000, SEMATECH International’s board of directors called for the creation at “internet speed” of an accelerated e-diag-

Key components of the e-diagnostics guideline and the Siemens RDAT system

- Open architecture based on mainstream computer technologies, non-proprietary standards and data models
- An Internet-based approach that guarantees that fab data is shared only with the appropriate supplier
- Two-way communication between equipment and suppliers to enhance interactive problem-solving
- E-diagnostics capability for both 200 and 300 mm wafer sizes
- Data security assured, preventing transmission of equipment data to chip or vendor competitors
- Run-time data collection, storage, and retrieval enabling data analysis and decision support capability
- Supplier notification when a tool is in need of routine preventive maintenance
nistics program to drive pre-competitive technology and standards development within the industry.

SEMATECH International subdivided the e-diagnostics functionalities and components in a four-level capability model. Level 0 covers access and remote collaboration (remote connectivity to the tool and remote collaboration capabilities of text, audio, video) – Level 1 encompasses collection and control (remote tool operation, remote performance monitoring, remote equipment configuration) – Level 2 describes automated reporting and advanced analysis capability, and Level 3 is dedicated to predictive maintenance, self-diagnostics, automated notification.

Siemens and AIS Automation in Dresden developed one of the first e-diagnostics systems based on the international SEMATECH (ISMT) guidelines. The basis for this development was the AIS product “Remote Diagnostics and Administration Tool.” This software application was originally conceived and implemented for the first 300mm fab (Infineon Dresden) and has been fully tested and proofed over a 3 year period at Infineon. Siemens and AIS along with ISMT improved the application with the goal to introduce a fab wide e-diagnostics solution and demonstrate the application functionalities interfaced to actual 300mm tools. A demonstration of this solution was presented at ISMT in autumn 2003. The system was proofed by ISMT and the results are documented in the ISMT e-diagnostics compliance list (available on ISMT).

Results presented at Semicon Japan

The results from this demonstration especially performance values have been presented at the Semicon Japan workshop in December 2003.
The new Siemens/AIS EDA interface application is being integrated into Siemens existing Equipment Control System (ECS).

Key features of the new standard

- The data transfer is done by XML-based format, which is a human readable format. This makes it easier to debug the equipment connection in case of trouble
- The data transfer with XML over SOAP/HTTP is a standardized mechanism defined by the W3C and implemented on nearly all operating systems
- The interface described in PR8 is able to communicate to multiple clients. This allows the connection of different EES applications in parallel to the tool
- Applying the E125 the interface is self-describing. Using these functions an automatic configuration is possible. This will lead to plug-and-play solutions
- Data can be transmitted using SECS/GEM or EDA depending on the communication setting on the tool. Therefore a migration of existing SECS/GEM host adapters to the new EDA adapters is possible

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many manufacturers have automated only a small portion of their fab operations, expecting to expand automation incrementally. Reduced cycle time
Siemens has gained abundant expertise reducing cycle time in batch oriented industries like pharmaceutical, food and beverage. The Key Performance Indicator (KPI) was utilized as a systematic, data-driven process improvement approach. This cross-functional, disciplined technique facilitated identification of the KPI that effect wafer build cycle time, and implementation of a low-cost solution to reduce overall cycle time as a transparent shop floor process. Siemens has the know-how and capabilities to master these challenges systematically.

In a typical semiconductor fab, a single wafer travels about six miles during the manufacturing process and undergoes 20–25 process steps for each of 20 layers, passing through 300 process tools. In order to drive down costs, the challenge is to cycle the greatest number of wafers through the process steps in the shortest amount of time, optimizing the use of capital intensive process equipment.

One way “Factory Automation” accomplishes this is by reducing idle tool time and helping to manage the logistics of complex manufacturing.

Right material, location and time
Today, nearly 20% of a semiconductor factory’s output capacity is lost due to idle tools: a machine waiting for material or for an operator, or not scheduled to operate. By using automation to ensure material availability at the right location, idle slots can be reduced or eliminated, adding as much as 200 million USD per year in revenue for a typical factory.

The transition to 300 mm wafers (0.25µm and below technology) is creating even further demands for automation, because wafers of this size and weight cannot be logistically handled without new automation technology, and they cannot be ergonomically handled by operators. More automation is the only way to ensure quality and efficiency. The focus of automation solutions is to drive down costs by increasing yields and productivity, shortening cycle time, reducing work-in-process inventory, and improving fab space and equipment utilization.

Semiconductor factory automation is still in the early stages of market development. Today every new and upgraded fab is built to include “Interbay” automation – a system that automatically moves material from one bay to another. The next major area is in “Intrabay” automation – where automation systems move materials within each bay and load process tools.

More and more manufacturers link all their process tools together – and this is where even more opportunities exist. Today, many manufacturers have automated only a small portion of their fab operations, expecting to expand automation incrementally.

Reduced cycle time
Siemens has gained abundant expertise reducing cycle time in batch oriented industries like pharmaceutical, food and beverage. The Key Performance Indicator (KPI) was utilized as a systematic, data-driven process improvement approach. This cross-functional, disciplined technique facilitated identification of the KPI that effect wafer build cycle time, and implementation of a low-cost solution to reduce overall cycle time as a transparent shop floor process. Siemens has the know-how and the IT-based tools to master implementing these KPI steps. With the Siloc material management system, simulation expertise, Simatic controller technology and mechanical partners for automated material handling systems, Siemens offers turnkey projects including consulting, planning, design, execution and operation.

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Performance management software VitalSuite from Siemens drives down costs for IT operation

Flying the IT helicopter

The constant and easy use of tools for measuring IT performance and availability improves the key quality figures proactively and provides pointers for focusing the – always tight – resources allotted to upgrades and subsequent improvements.

Siemens as your IT partner can help you to determine the current status of performance and availability quickly, efficiently and accurately and will determine the necessary actions. And as with personal fitness, every IT infrastructure also requires constant effort to maintain and improve its shape.

The foundation of the range of services for improving IT performance and availability is the product VitalSuite. According to the assessments of independent institutions, it is the world’s leading performance management product of networks and client/server architectures.

And the needs for improvement can be wide and varied – unexpected events in the service levels with no discernable reason, or inexplicable effects after introduction of a new client/server system or after a change of address, for example.

The involvement of our experts and the use of VitalSuite conclude when the measurements have been taken and the report is submitted.

IT performance solution is an integrated permanent installation for continuous improvement in the quality of service. The life cycle of a customary IT environment is subject to constant change. It makes it possible to handle growth in the volume of data, innovation and adaptation of the technologies used in clients, servers and networks, operational processes to minimize the total cost of ownership, and much more.

The effects of a proper IT consulting, realization and IT performance management ensure the optimization of the quality of network, the increase the productivity and to save money for system purchasing and operation.

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Improve your IT services, make your monitoring more efficient and save time and money: Experienced experts from Siemens with semiconductor know-how and consistently proved methods and IT components ensure projects on time and on budget. For optimized IT operation, Siemens provides the world’s leading performance management software VitalSuite for networks and client/server architectures that help in getting a permanent overview on dataflows just like flying over them in a helicopter.
Particularly in facility automation, the availability of fabs and a safe system restart have top priority. The cleanroom environment runs on the 24/7/365 formula, and unscheduled downtimes must be eliminated. The semiconductor library meets the general requirement to memorize the plant status unchanged after a restart and to preserve all preset modes and actual states. This means that motors, valves and actuators do not cause systems to switch off after a run-stop-run transition of the PLC, thus avoiding any disturbance of the cleanroom conditions.

Consistent, generic configuration

The Siemens semiconductor library was purpose-designed for the Simatic PCS7 process control system and is thus based on the components of the Automation System (AS) of the Simatic S7-400 as well as the Operating System (OS) based on Simatic WinCC.

In addition to the specific technological requirements, the library modules meet all new functions for the generic configuration using the PCS7 engineering toolset.

The AS modules are integrated in so-called typicals, which contain all necessary functions for the switching of input and output signals as well as messages and diagnostics. This limits the configuration effort at the PLC end to the mapping of the physical addresses to the I/O driver modules.

Each technological AS function is assigned a symbol in a corresponding WinCC OS library. The systems are then automatically placed in a plant image based on the configured AS modules. If the library element is an operator-controlled function, an associated operating image (faceplate) can be automatically opened by clicking on the associated symbol.

Copy and paste engineering

Based on the modular functions of the device level, technological functions can be assembled very quickly into new templates at the higher aggregate level. Similarly, the aggregate templates can be easily used to develop standardized plant sections. Functionally equivalent solutions and templates can thus be quickly duplicated, and the necessary adaptations for new addresses and designators are automatically entered via import and export functions.

Continuous maintenance and support

New functions and devices are functionally included in the library in coordination with technology and planning specialists. This keeps the library always current with the latest technology to guarantee innovative and consistent facility automation.

The Siemens semiconductor library has proven its value over the past years in a number of facility automation projects worldwide. Especially the cross-facility solution approach and the inherent operational functionality have convinced planners and end users alike.

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The Siemens semiconductor library guarantees a consistent FMCS solution

One for all

Facility automation including HVAC, water treatment, gas and chemical supply places a wide variety of requirements on the application of automation functions. However, they always share one requirement: a consistent HMI concept and safe functionality in case of failure. With the goal of "one consistent library for all systems," a close cooperation between facility automation technology specialists and PCS 7 system specialists resulted in the development of the Simatic PCS 7 Facility Monitoring and Control System (FMCS) semiconductor library.
Early integration of automation secures crucial competitive benefits

Clear benefits for clean areas

Minimum response times, integrated automation concepts and standardization of user interfaces, IT interfaces and external systems were just a few of the reasons why M+W Zander integrated its 2001 acquired subsidiary Lang und Peitler Automation at an early stage in the cleanroom planning and building systems for semiconductor fabs.

The integration of cleanroom and building control systems at an early stage in the overall planning of a semiconductor fab gives the customer a uniform automation solution with consistent standards. Building automation and process systems take into account the fab-specific, process engineering specifications. “In contrast to conventional plant construction projects, we are actively involved in the project as in-house partners right from the start of the basic engineering,” says Richard Koehldorfer, group manager at Lang und Peitler. “We work closely with the process engineering department to draw up an integrated concept for HVAC (Heating, Ventilation and Air Conditioning) as well as all ancillary process systems. In this way we can select a system at a very early stage, which significantly reduces cost of the FMCS (Facility Monitoring and Control System) and its integration. A very lucrative approach for both the customer and the project planning department.”

Advantages of a standardized system platform

The Simatic PCS7 process control system is suitable for securing an integrated system platform in a semiconductor fab. It has a modular structure and is readily scalable. In addition, it has a fully developed library of software blocks with standard functionalities that are specially tailored to the requirements of the semiconductor industry.

By defining interfaces and standards, homogeneous software structures and standardized user interfaces are achieved across the FMCS and all subsystems. Thanks to the standardized look and feel, operators quickly learn to use the system. This makes a considerable contribution to the ease of system maintenance and, where required, to a fast and reliable response – thereby ensuring the maximum possible availability of the overall fab.

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Integrated project design and management from Siemens

Fast track – low risk

Modern semiconductor fabs are built much faster than in the past despite increasing demands and higher complexity. The timeframe between the decision to build a fab and the installation of the first tool is often less than 18 months. The introduced Integrated Project Design and Management process (IPDM), developed by Siemens Industrial Building Consultants enables the user to complete ambitious projects successfully within set cost budgets and time schedule.

The Integrated Project Design and Management process (IPDM) from Siemens provides significant benefits. A dedicated highly experienced IPDM core team is installed to design, coordinate and manage all efforts from the very start of the project to the final delivery of the completed facility.

Project programming

Key decisions are made during the project definition and design phase and cost saving potential is at its highest. The Project Programming (PP) starts with an intensive workshop including the owner, user and representatives of all relevant technical disciplines to set up a qualified program for the entire building and infrastructure scope. Special requirements and characteristics are identified and discussed with external specialists if required. The common approach secures the efficiency of the workshop and the commitment to the programming results.

Conceptual design

The Conceptual Design (CD) is developed by the core team based on the programming and includes all necessary solutions for building and infrastructure. Supply and discharge concepts are determined based on the site master plan and a generic equipment layout. The facility capacities are defined either on real consumption figures or reference data and a room program is derived. The resulting building layouts and logistic concepts are evaluated and optimized with the client. Target costing derived from the Sematech fab cost model is a key element of the CD and the main guideline for design, aesthetics and function.

Project controlling and coordination

After awarding the design and building contract the IPDM team will take the role of a project controller.

The CD has to be transferred into a detailed design and the tender documents for the subcontractor selection have to be prepared. The IPDM team as the client representative handles and clarifies open items relating to the tender documents; they approve the bidder's list and participate in all vendor meetings. The final vendor selection is a collective decision, based on criteria's like invest costs, operational costs, local support, technical competence, references and experiences gained during previous projects. Well proven tools for change management, documentation and controlling support the core team in achieving the targets set in the project definition phase.

Successful project at Infineon

The IPDM process was used to build the world’s first 300 mm semiconductor fab for Infineon Technologies AG in Dresden, Germany. The high-tech, high-integrated building was completed within a 12-month construction period together with M+W Zander as design and build contractor, keeping both the cost range based on the IPDM conceptual design as well as the scheduled ready for equipment date.

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Siemens fab automation at Inotera in Taiwan

The platform for control

Inotera will be Nanya’s first 300 mm DRAM fab – the largest in the world. Infineon will provide Nanya with 0.11 µm technology for the initial ramp up. Later on, Nanya in collaboration with Infineon, will develop production technologies for 0.09 and 0.07 µm process structures. By the end of 2005, 50,000 wafers a month with 0.07 µm technology shall be manufactured – and Siemens WinCC will keep a close eye on their process.

Inotera is a joint venture between Infineon and Nanya Technology formed in November 2002. Nanya Technology is one of the largest DRAM manufacturers in Taiwan and part of Taiwan’s largest industrial conglomerate – the Formosa Plastic Group.

A longstanding cooperation

Krantz TKT, meanwhile a member of the M+W Zander Group, had been awarded the cleanroom contract for Inotera. Siemens Industrial Building Consultants (SIBC), representing Infineon interests, provided the fab design and the tender documents for all facility packages.

Nanya started its DRAM production in 1996. Since 2000 two fabs have been built using Siemens controllers. Subsystem controls are stand-alone systems rather than integrated into a central Facility Monitoring and Control System (FMCS).

Uniform system from fab to facilities

The joint venture with Infineon was the opportunity for Nanya to re-think the previous control system design. Local subsystem operation have proved successful and should be maintained for the new fab. On the other hand, integration of the subsystems including Power SCADA into the central Facility Monitoring and Control System had to be improved significantly.

The result was a re-design of the control system architecture based on Siemens WinCC, Siemens controllers and Micromasterr drives. Redundant WinCC servers and clients for the subsystems provide close local operation of the process and the ensure highest reliability. WinCC multi-clients for the Facility Monitoring and Control System allow central access to all subsystems, equipped with Simatic control systems including Micromaster drives. Power SCADA with WinCC SICAM from Siemens could be integrated smoothly into FMCS.

Inotera plans to expand its production capacity in 2005. A second fab will be constructed beside Inotera Fab 1. Siemens is looking forward to continue its successful partnership with Inotera.

On the road of success: Siemens in the flat panel display industry

Taiwanese and Korean FPD (Flat Panel Display) manufacturers are going to expand their output rapidly. This development is mainly driven by the strong demand for flat screen TV. To keep pace with the rapidly growing demand, market leaders like Samsung and AU Optronics will increase their capacity enormously.

AU Optronics will build a fab cluster in Taichung (Taiwan). Core of the new fab will be a cleanroom with 120,000 square meter.

AU Optronics has been evaluating various suppliers and solutions for its new fab in Taichung and decided to go with Siemens PCS 7 for the fourth time.

Samsung SDI is going to invest into a new fab in Tangjung (Korea).

Since 1999, Siemens has been supplying Samsung Electronics with Simatic technology for their DRAM production lines. In November 2003, Samsung SDI decided to use Simatic for its new fab, one of the most advanced that is being built today.

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Treatment of residual process gases and by-products

Mission possible

Thin film processes, commonly used in semiconductor industry and similar applications (like photovoltaic, flat panel display, OLED, MEMS) use gases which can be harmful to the environment. The treatment of the residual process gases and by-products generated in these processes are an integral part of the complete process. The essential issue is to combine high destruction removal efficiency with low costs of investment, installation and operation and without influencing the yield.

Today, over 600 Centrotherm abatement systems installed worldwide in wafer fabs of Samsung, Infineon, AMD and many more as well in research and production sites for flat panel display or photovoltaic (e.g. Shell Solar, RWE-Schott, etc.) guarantee high quality and reliable operation.

Tailored solutions from the shelf

To be an accepted partner in the semiconductor industry means to consider customer specific requirements. Individual local requirements have to be taken into account to provide a 100% matching solutions for the customers. Modularity in product design is the clue.

Following this guideline, Centrotherm developed a new range of products for point-of-use abatement systems.

Dry bed chemisorbers provide specific absorption technology for different gases and different flows. Electrically heated systems are used for thermal decomposition in combination with wet scrubbing and neutralization.

Innovative wet scrubbers, special solutions for epitaxy processes, abatement systems with integrated vacuum pumps (combined abatement and vacuum pump system in one cabinet) as well as customized solutions are just a few example of Centrotherm broad portfolio.

Win – win situation

The fast and cost effective achievement of the design targets including the safety concept was only possible due to the consequent realization of the modular design concept and the long term experience over many decades in heating element technology used in diffusion and conveyor furnaces. Another key ingredient for the successful implementation of the new design concept was having a partner who not only understands the technology but also can efficiently turn the requirements into practical solutions – a partner that also is able to guarantee the professional and competent customer support worldwide. For Centrotherm, this partner was and continues to be Siemens.

The strategic decision of Centrotherm to use Simatic controllers and WinCC as visualization platform provides logistic advantages for operating and service activities not only for Centrotherm but also for our customers.

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Messer Nippon Sanso specialty gas systems have a fundamental design philosophy that strives for intrinsic safety along with a range of secondary safety subsystems. Recognizing that many safety incidents are the direct result of human error a considerable amount of effort has been invested into eliminating this with the careful thought on how the systems should be operated.

Employing fully automatic systems can often eliminate human errors but for specialty gas systems this is unrealistic. Physical activities such as exchanging empty cylinders or performing routine maintenance operations must be performed by operators and maintenance technicians.

Safety by application
Messer Nippon Sanso specialty gas systems offer a combination of automatic and semi-automatic operating modes. Every possible operation has been fully automated to entirely eliminate human errors. The systems check each operator intervention to determine if it has been completed safely. Its built-in intelligence records operator errors and produces a fail-safe response to the errors.

The physical implementation of these automatic and semi-automatic routines are handled by a Simatic S7-300 controller and a Simatic MP 370 touch panel interfaced to all of sensors and actuators.

The software design was based on analysis of operator actions and determining ways in which these can be guided and checked. The safety features embodied in the control system are supplemented by a range of physical characteristics such as safety enclosure, monitored exhaust system, intrinsically safe electrical devices, safety shields and gas monitoring.

Modularity at its best
Recognizing that each country, and each individual fab, have differing ideas on processing and approaching safety has driven Messer Nippon Sanso to structure its products with a modular architecture. This enables quick and cost effective solutions to customer specific requirements and extends to the control software which can be easily configured to provide safe and tested versions for all possible hardware configurations.

Messer Nippon Sanso has also adopted the same philosophy for modular design of hardware and control software to the specialty gas distribution systems. Valve manifold boxes share the same family of Simatic controllers – in this case the S7-200 series and touch screen TP 170A panel.

Integrated monitoring and control
Additionally, in today’s sophisticated fabs it is essential that the performance of the vast variety of production equipment are monitored for efficiency and signs of potential problems. Messer Nippon Sanso has a range of solutions for interconnectivity of specialty gas systems that can be interfaced to monitoring systems using cost effective, modular and robust solutions based on Simatic controllers.

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Open Profibus replaces closed proprietary control architecture for chemical dispense systems

New chemical dispense strategy

With over 50 installations worldwide and over 500 chemical dispense units shipped, Chemical Safety Technology, Inc. (CST) is a recognized leader in the world of chemical dispensing systems. CST manufactures units to pump or pressure dispense hazardous production materials (acids, corrosives, solvents and flammables) to manufacturing tools that process silicon wafers for the production of semiconductors.

Chemicals are a primary component in the production of semiconductors worldwide. With stringent production, quality and employee safety requirements, chemical dispense systems play an important role in the manufacturing process of semiconductors. The changing world economy and the ever-changing list of suppliers for chemical dispense systems has resulted in semiconductor fabs inheriting a legacy of obsolete proprietary systems that are unreliable, difficult and costly to operate and support. The resultant risk associated with unscheduled downtime can seriously compromise safety, quality and production goals.

Replacing legacy systems without shutdowns

CST in collaboration with Siemens Semiconductor Automation group has developed the controls, system architecture, and methodology for replacing these proprietary chemical dispense installations, without the shutdown of any production equipment. The new system is functionally comparable to the old system but most importantly it is completely configurable, can be pre-programmed for flexibility and expandability. The extensive built in process and systems diagnostics over Profibus allow shorter hardware debugging and reduced maintenance time. Additional dispense units can be added at minimum cost and downtime. The result has been customers ability to confidently switch their chemical dispense systems to Chemical Safety Technology with zero downtime.

Off-the-shelf technology

The entire dispensing system is monitored and controlled by a Simatic S7 315-2 DP redundant controller system. Redundancy capability with off-the-shelf Siemens components was a critical factor in CST’s choice of Siemens as their automation provider.

Each chemical dispensing unit has a Simatic S7 CPU 226 as its controller with local operator interface Simatic TD 200. In addition each CPU 226 communicates over Profibus to the master S7 315-2 DP redundant controller.

The flexible and modular architecture of Profibus eliminates countless wires – reducing installation time significantly. The high-speed real time, deterministic Profibus network dramatically improves system throughput – resulting in faster response times and higher productivity.

“The partnership with Siemens and the introduction of Siemens automation systems has allowed CST to maintain our leading edge in chemical dispensing systems. We are confident that Siemens can provide CST and our customers with technical support and innovative new control solutions throughout the world,” said Mr. Lincoln Bejan, president of Chemical Safety Technology.

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Chemical Safety Technology, Inc. is a recognized leader in the world of chemical dispensing systems
**Siemens Industry Suite Semiconductor**  
**Gateway to the semiconductor industry**

Increased productivity in the semiconductor industry – that is the explicit goal of the new Industry Suite Semiconductor. It represents a comprehensive package for the semiconductor industry that merges the worlds of automation and power engineering into one comprehensive modularly designed industry package including the particular services for the entire life cycle of a fab.

The technical foundations of the Industry Suite Semiconductor are the open, standardized and integrated system platforms Totally Integrated Automation (TIA) and Totally Integrated Power (TIP). These platforms are enhanced by a profound understanding of user-related production and business processes – covering everything from the products to the production know-how typical of the industry to MES solutions and services tailored specifically to the industry.

The Industry Suite Semiconductor saves time and costs. The comprehensive technical and project-related concepts tailored to the requirements of the semiconductor industry can shorten the bidding phase and minimize interfaces.

Recently, an Industry Portal (www.siemens.com/semiconductor) has been opened that presents the requirements of the industry from a user perspective. A consistent process orientation is obvious at first glance: the semiconductor fab is portrayed with all its service systems such as Water Treatment, Chemicals, Gases, Life Safety and Equipment. Whether fab manager, plant engineer, OEM or system integrator, the right solution for the individual objectives of every visitor is just a few clicks away.

**STEP functional safety seminar successfully launched at SEMICON Japan**  
**Fail-safe seminars**

Fail-safe systems provide the highest level of safety for humans, product, machines and environment. The Siemens fail-safe Simatic controllers are self-monitoring, detect faults autonomously, and change into a safe state or remain in their current safe state based on fail-safe conditions.

SEMI S2 compliance is today a key factor for market acceptance of state-of-the-art semiconductor process and manufacturing equipment. Therefore, functional safety as required by SEMI S2 must be an integral part of equipment design. SEMI S2 traditionally favored hard-wired electromechanical components to ensure a safe machine state in case of failures. In July 2003, Siemens introduced its new safety control technology in compliance with the latest publication of the SEMI S2 safety guidelines. Its related R14 information describes how one can achieve functional machine safety with fail-safe equipment control systems.

Semiconductor Equipment and Materials International (SEMI) offered during SEMICON Japan 2003 a training course to help the OEM equipment industry understand functional safety and fail-safe technology and its adoption in new OEM equipment designs. The course was part of the SEMI Standards Technical Education Program (STEP) and took place at the same time as the trade show at Makuhari. In total 77 attendees joined the training course. SEMI plans to continue the STEP functional safety seminar at SEMICON Europa 2004 in Munich and SEMICON West 2004 in San Francisco.
Something holding you back?

Feel like you’re stuck in traffic lately? Like you want to move forward, but can’t seem to get anywhere? That’s when you really need maximum flexibility, so you can make the right changes. And with Siemens automation technology, you’re ready to handle whatever changes are needed – like installing new setups, expanding, or converting production. And because Totally Integrated Automation is as comprehensive as it is open, it gives you all the flexibility you need – so you can start moving forward again.