What does Industry 4.0 mean for Festo?

Festo is adopting an integrated approach to the change in the world of production which incorporates the interaction between people and technology, training and education as well as technology. Festo is conducting research into new solutions and technologies for future production together with partners from business and science; it is also offering coordinated concepts for basic and further training.

What are the characteristics of the production of the future?

Production systems will become digitally networked throughout:

- Intelligent, self-regulating and self-controlling components for plug and produce
- The system has a virtual image for virtual commissioning and reconfiguration
- Highly flexible production plants: economical manufacturing of batch sizes of 1, fast balancing of the workload in a production network, prompt adjustment to the orders in hand
- Comprehensive condition monitoring helps to avoid downtime and optimises maintenance procedures as well as mobile maintenance
Active in political decision making and standardisation
Festo plays an active role in all relevant standardisation bodies for Industry 4.0 and advises the German federal government on the "Industry 4.0 platform" initiative. Universal, open standard architectures provide significantly more benefits than closed concepts for small and medium-sized machine and system manufacturers, as well as for end users.

Examples:
- OPC UA communication standard
- RAMI reference architecture
- Administration shell model
- AML (Automation Markup Language)*

Research
A crucial factor in Festo’s success is its cooperation with its partners in science and business; this accelerates the innovation process and resolves complex technical issues. For example, in the early stages Festo was involved in Smart Factory KL – the model for an adjustable production system – and OPAK, an open engineering platform for autonomous mechatronic automation components.

Currently the focus is, amongst others, on the AutomationML initiative for designing automation components in a uniform engineering file format. As part of the ENTOC research project, Festo is working with partners from the automotive industry and the scientific community on the topic of "virtual commissioning".

You can find an up-to-date list at
→ www.festo.com/research

Products and Services
Industry 4.0 relies on fully networked, adaptive production through intelligent products with “embedded functions” – the cyber-physical systems. Many Festo components already meet the hardware and software requirements. Festo’s newest production plants, such as the Scharnhausen Technology Plant, both produce and use these products, thus paving the way for Industry 4.0.

Industry 4.0 begins here and now – just turn the page to find out more.

* In progress
Industry 4.0 – always a finger on the pulse thanks to complete networking

Many concepts from the past have been overtaken by the fourth industrial revolution: business models, partnerships, customer interfaces, value chains, and even the traditional pyramid structure of the automation environment – all are undergoing huge change. As an innovator and trendsetter in fieldbus technology, Festo will make a major contribution to reshaping the future with new concepts for Industry 4.0. This includes new products, cloud services, apps, as well as a new online shop with comprehensive, integrated engineering concepts. This will ensure that, in the medium term, data will be available seamlessly and globally on all user devices.

Industry 4.0: things communicate with one another

More communication from controller to controller or subsystem to subsystem, and horizontal as well as vertical connectivity with a single, uniform information model, including the cloud: these are the hallmarks of a fourth industrial revolution – Industry 4.0. The traditional, inflexible automation pyramid will cease to exist in the foreseeable future. Festo CPX and the Motion Terminal VTEM are making an important contribution to this transformation.
These three Festo products thus constitute cyber-physical systems in line with Industry 4.0. They take in data from the application and from the device itself, precompress it by compiling the data into diagnostic modules in CODESYS V3 in accordance with VDMA 24582, and then forward that information to the cloud.

Hardware for unlimited communication: Festo’s IoT gateway CPX-IOT
The industrial Internet of Things gateway is based on the CPX module format. CPX-IOT collects information about Festo devices and their statuses via an Ethernet connection and a standardised communication protocol such as OPC UA, for example.

It sends that information via a second Ethernet connection using IoT protocols such as AMQP or MQTT. Suitable IT security mechanisms ensure data security.

Integration as a subsystem or as a non-hierarchical system
Festo products, such as electric and pneumatic drives, valves/valve terminals, I/O terminals, compressed air supply or sensors, can thus be integrated as subsystems from the traditional pyramid if needed, e.g. via decentralised controllers such as CPX or CECC.

Or alternatively they can be integrated directly, with no hierarchy. For example:
• The handling system YXMx*
• The energy efficiency module MSE6*
• Or the Festo Motion Terminal VTEM*

Cloud services: increased productivity for machine builders and end users
Future cloud concepts and services will initially be very heavily dependent on the particular approach, partner or provider selected. Data will undergo further processing and long-term analysis in the cloud, with a dashboard visually presenting the information acquired. Festo supports machine builders and end users on the road to increased productivity. This includes:
• Simple visual presentation of complex interrelationships in the Festo cloud – worldwide
• Analysis function for rapid data processing
• Greater transparency, e.g. by condition monitoring online
• Optimisation of the applications, preventive maintenance, etc.

The result: increased productivity through improved utilisation and less downtime.

Software functions
• Festo CM-Lib for condition monitoring with the energy efficiency module MSE6—
• Motion apps for automated motion sequences in our electric drives/handling systems YXMx

Please contact your Festo sales engineer about possible implementations. The dashboard shown should be viewed as a pilot model for joint customisation projects together with customers/users.

Festo Software Market: implementing functions digitally
Apps greatly simplify the engineering and use of products and services. Festo will offer apps for numerous technical applications, target systems and working environments.
• Cloud-based apps
• Desktop-based apps
• Apps for mobile devices
• Product/hardware-specific apps

Product-specific apps
• Motion apps for the Festo Motion Terminal VTEM simplify the programming of automated movements, even without advanced knowledge of pneumatics
• Motion apps for YXMx handling systems with electric drives
• Further products are in development

Software/service apps
• Fluid Draw app: CAD functions for electrical and pneumatic circuit diagrams
• Festo Design Tool 3D: a 3D product configurator for generating Festo-specific CAD product combinations with all accessories
• EPLAN schematic services: macro libraries created by Festo for E-CAD software EPLAN Electric P8, version 2.1 or higher.

Our website www.festo.com/iot takes you to the latest comprehensive tools, products and services.
Industry 4.0 – engineering in the virtual and the real world

Engineering and productivity
Our goal is to increase your productivity. State-of-the-art engineering plays an important role in achieving that goal – the kind of engineering which will be central to Industry 4.0 and which will form a cornerstone of your success. That is why we are continuously further developing engineering methods and enhancing our software tools and apps.

Engineering and lifecycle
To meet your needs even more effectively, we have analysed project workflows and defined eight phases. We then allocated our software tools and apps to the appropriate phases. You benefit by being able to find the right support quickly and easily.

Engineering and value creation
We help you tap into unimagined productivity reserves and generate additional productivity along the entire value chain. In every phase of your project, from the initial contact to the modernisation of your machine, you will come across a number of different tools which will be of use to you.*

We're there for you – during every phase of your project. We're always there to help you on your way to success.

* This document shows just a small selection of the tools we have to offer. Discover our world of software tools.

www.festo.com/support
Comprehensive networking: the virtual and the real world

Computer-aided engineering and virtual images are future scenarios that will accelerate development. For example, virtual images will allow the autonomous and continuous improvement and correction of designs. The factory itself will also be redefined. The concept of the future unites the virtual and the real world. The objects produced will be able to communicate amongst themselves in the same way as the tools and machines that produce them, and the processes will virtually run themselves. They will also become more flexible down to a batch size of 1.

For maximum process efficiency:
the Handling Guide Online
From project engineering and ordering right up to delivery, the Handling Guide Online* optimises and shortens work flows by combining the virtual with the real world. You can get to the right standard handling system in just three quick and easy steps:

• Select the type of handling system
• Enter your application data (X-Y-Z measurements and load)
• Order as 1 unit in the Festo Online Shop.

Including the finished CAD model for the complete handling system. This will be presented in AML data packets in the future.

Virtual commissioning:
CIROS simulation software
With the CIROS simulation software from Festo Didactic, Festo is able to put the study “Parallel kinematic system EXPT (tripod)” into virtual operation. This study is prepared for the descriptive language AML (Automation Markup Language), the future standard of dynamic CAD data and parameter exchange for Industry 4.0.

Scan, look, discover with the product key as an auto ID function
All the information for a modular valve terminal with CPX is contained in the product key incorporated in the data matrix code – putting Festo unmistakably on the road to Industry 4.0.

These auto ID functions are small but important building blocks for the transparent, smart and intuitive factory of the future with Industry 4.0. This is underpinned by Festo products with their product key and logistics code, providing centralised access to a “digital twin”.

* Not yet available in all countries.
Intelligent apps and appropriate software are a central component of Industry 4.0. They allow the “things” in the Internet of Things to communicate with one another and to initiate or execute processes autonomously. At the same time, software modules, analysis and combinational logic are making functional integration possible as never before. With the app-based Motion Terminal, Festo has catapulted pneumatics into the age of Industry 4.0.

The access to new information and being able to process it boosts knowledge, adds value and puts you a step ahead technologically. It also provides you with huge benefits in engineering, design and programming, and ultimately increases your competitiveness and productivity. With 4.0 products such as the Festo Motion Terminal, you are buying much more than a mere product – you are buying a comprehensive added-value package.

The future of pneumatics – functions assigned at the press of a button
Digitisation will profoundly alter the world of production as digital simplicity is moving into the world of pneumatics.

With the Festo Motion Terminal, we are offering our first standardised solution that intelligently combines mechanics, electronics and software in the form of a “cyber-physical system”. It will enable you to build intelligent machines now for the world of tomorrow, and ensure your systems are truly ready for Industry 4.0, even in terms of pneumatics.

Disconnected: functions and hardware
With the Festo Motion Terminal pneumatic functions are, for the first time, no longer automatically connected to the mechanical hardware, and can be assigned simply using apps. You now require just a single valve type for an extremely wide range of pneumatic movements and functions. The Festo Motion Terminal makes it possible for the first time ever to have the same hardware for a multitude of functions. No modification, no additional parts, no arduous installation: none of that is needed any more. With the matching motion app, you can change functions at the press of a button, whether for a simple change in the directional control valve functions, Soft Stop, energy saving mode (gentle travel in the end positions, energy-efficient movements), proportional characteristics or a format change. The Festo Motion Terminal thus combines the advantages of electric and pneumatic systems.

Motion apps – the first examples
- Directional control valve functions: over 10 valve functions can be reassigned cyclically
- Proportional directional control valve: two proportional flow control systems in one valve
- Soft Stop: self-adapting algorithm for time-optimised positioning without vibration
- Proportional pressure regulation: for both valve outputs
- Model-based proportional pressure control of the complete application, e.g. cylinder and tubing
- ECO drive: for low loads – energy-saving positioning motion with supply air flow control
- Selectable pressure level (ECO): for high loads – reduced, self-adapting pressure level
- Leakage diagnostics: measuring leakage in the application
- Supply and exhaust air flow control for adjusting the supply and exhaust air between 0% and 100%
- Presetting of travel time: self-learning and adapting system for constant, monitored advancing and retracting

Further apps for even more functions are already being planned.
The Festo Motion Terminal VTEM is opening up radical new dimensions in the world of automation, as it is the world’s first valve to be controlled by apps. It is the first product to truly earn the label “digital pneumatics”. For a multitude of functions which currently require you to order and install more than 50 separate products/positions.

**Central component of the Festo Motion Terminal**

**CPX terminal – electric systems at its most flexible**

With CPX, you have the option of using many different control systems and end user specifications, as well as all the usual digital and analogue I/O modules or decentralised “simple” valve terminals.

CPX is available on request with an integrated CODESYS controller and OPC UA for Industry 4.0.

Find out more at [www.festo.com/motionterminal](http://www.festo.com/motionterminal)

**Controller with motion app – software at its most flexible**

The core of your Motion Terminal. It enables you to conveniently control numerous functions and to assign them to the individual valves via the Ethernet WebConfig interface.

With the Internet of Things, you can adjust parameters efficiently through the intuitive WebConfig user interface, which you access via a web browser on a computer – no additional configuration software is required. Or you can set parameters in the usual way, easily and directly via the PLC machine controller.

**VTEM – pneumatics at its most flexible**

The individual control and freely programmable functions of the individual VTEM valves offer a high degree of flexibility.

The integrated stroke and pressure sensors provide optimal control and transparent condition monitoring.

Each VTEM valve contains:

- Valve electronics with sensors
- 4 innovative piezo pilot valves for minimum energy consumption and maximum service life
- 4 diaphragm poppet valves for reliable functional diversity

**Highlights**

- Many functions in a single component – thanks to apps
- Combines the advantages of electric and pneumatic technologies
- Very high level of standardisation and reduced complexity
- Reduced time to market
- Greater profitability
- Reduced installation effort
- Increased energy efficiency
Detecting states, condition monitoring
All fieldbus/Ethernet, AS-Interface and IO-Link products are suitable for use as “feeders” in terms of Industry 4.0. Festo offers you a comprehensive IO-Link portfolio, for example:

- Various sensor ranges
- Actuators such as proportional pressure regulators VPPM
- Vacuum generator OVEM
- Valve terminals
- Electric actuators with stepper motor/servo controllers CMMP, CMMO, amongst others

Further areas of research include:
- OPC UA TSN – time-sensitive networks
- IO-Link wireless

Vision systems
Identify and control intelligent workpieces and workpiece carriers. Several sensor technologies are used in an Industry 4.0 environment, such as RFID as well as vision systems. This includes our code reader SBSI-B, object sensor SBSI-Q and the compact camera systems SBOx-Q.

Industry 4.0 energy management
Reduce energy consumption and control central operating parameters automatically. The energy efficiency module MSE6 prevents compressed air wastage during system downtime (auto-stop function), detects leakages independently, and offers online process monitoring. This is suitable for new and existing systems.

Leakage measurement*
When the compressed air supply is shut down, the E2M checks the system for leaks. Rapidly dropping pressure indicates excessive leakage. A notification is then sent to the system operator. This allows maintenance which, for the first time, is based on actual requirements.

- Zero compressed air consumption in standby mode
- Checks the system for leaks
- Ensures maintenance in the event of leaks
- Monitors relevant process data
- Communication via PROFINET, Ethernet/IP. CODESYS with OPC UA on request

* This function is also available on the Festo Motion Terminal. Thanks to the cloud connection (see page 2/3), both components are fully fledged cyber-physical systems for Industry 4.0
Automation platform 4.0!
Ideal as an automation platform, valve terminal partner or remote I/O – electric, open and direct. CPX – the perfect platform for electrical peripherals. With CPX, you can integrate pneumatic and electrical control chains easily, quickly, flexibly and seamlessly into all automation concepts and company-specific standards – and into Industry 4.0 as well!

Highlights
• Modular and flexible IP65 Remote I/O
• Optimised version for IP20 and potentially explosive atmospheres
• Maximum function integration for complete applications
• Falling installation costs and rising productivity
• Decentralised and small-scale handling systems
• Networked intelligence with embedded CODESYS controller
• Industry 4.0 thanks to OPC UA and CODESYS control V3 and IoT gateway for cloud connection

CPX – the new benchmark for perfect networking thanks to:
• Universal communication via fieldbus/Ethernet
• A choice of pneumatic platforms (valve terminals MPA or VTSA, Festo Motion Terminal VTEM)
• Subordinate, decentralised installation systems CPI, IO-Link or I-Port
• Unrivalled module and application variety

CPX – greater economic efficiency and operational reliability through function integration, such as:
• Front-end control
• A choice of scalable installation concepts
• Comprehensive diagnostics and condition monitoring
• Motion control for electric drives and servo-pneumatic actuators
• Measurement and control
Cyber-physical systems as solution packages

Industry 4.0 and the Internet of Things (IoT) fascinate original equipment manufacturers (OEM) and end users alike. No wonder, as this is where production and the digital world come into direct contact with each other, making factory automation more flexible, increasing energy efficiency, linking logistics processes more closely, and optimising the value chain in both factory and process automation.

The Internet of Things (IoT), smart factories, cyber-physical systems and big data are getting the project “A more productive future” off the ground. Solutions must therefore be ever faster and more diverse, more flexible and more intelligent – down to a batch size of 1. Calls for greater availability, energy efficiency and just-in-time production are on the increase and are likely to be answered.

Intelligent subsystems/solution packages

From the solution package YXMx to the automation platform CPX, Festo provides comprehensive expertise.

Handling systems in the form of linear, planar surface or three-dimensional gantries are available through the Handling Guide Online with the option of individual configuration — or they can be supplied as a predefined, specialised solution package by consulting our experts.

- Planar surface gantry EXCH
- Linear gantry EXCT
- High-speed parallel kinematic system EXPT (tripod)

You will find the most up-to-date overview of all our products, solutions and services on the Internet at

www.festo.com/iot

• Industry 4.0 research project: parallel kinematic system
• CPX/EMCA as robotics without a control cabinet
• Servo press
• Handling systems YXMx

Highlights 2 – products and solution packages for Industry 4.0
Servo-pneumatic drive solution for welding guns
Car body welding requires a high level of precision and robustness. The components from Festo for servo-pneumatically driven welding guns are specially designed to meet this requirement. You decide which is best for you – the X gun or the C gun. Our range of types and designs makes pneumatics for spot welding extremely efficient.

- Very short cycle times
- High quality and outstanding reproducibility of the spot welds
- Excellent value for money
- Individual components fit for Industry 4.0

Servo press kit YJKP for electrical press-fitting applications
The modular servo press kit YJKP gives you just the software functions you need for your application. You get an extremely precise press-fitting system with a high level of repetition accuracy and an excellent price/performance ratio. Simple, cost-effective and quick to install.

- Software and hardware from a single source
- Less expensive than conventional press systems
- The controller CECC-X with OPC UA interface makes the system ready for Industry 4.0.

Compact handling system YXMx for desktop applications
The flexible basic platform for a wide variety of desktop applications. Everything from a single source: the coordinated, ready-to-use system kit consists of software, controller and kinematics – and forms the basis for a wide variety of desktop applications such as screwdriving, dispensing, testing, soldering, gripping, opening and closing containers and much more.

- Ready-to-use system kit comprising kinematics
- Controller and software
- Industry-4.0-capable cyber-physical system thanks to motion apps and cloud connection (see page 2/3)
Highlights 3 – products and solution packages for Industry 4.0

Expanding the limits: inter-system cooperation
Multi-Carrier-System: as a transport and logistics system with maximum flexibility, the Multi-Carrier-System offers several highlights in line with Industry 4.0:
• Maximum electromechanical flexibility with Festo linear motors
• Compatible with all intralogistics systems, simple and seamless inward and outward transfer of the carriers, and thus a fully flexible overall concept
• Control concept including virtual commissioning

Simple implementation, optimum combination
• Existing intralogistics are retained
• Seamless integration
• Efficient engineering
• Proven control platform
• Complete synchronisation of transport and motion control for continuous production processes

Maximum function integration, robotics-enabled controller and motor controller in IP65 integrated on site
Robotics is getting ready for Industry 4.0 with the high-speed handling system EXPT with CPX/EMCA.

CPX control technology from Festo for an IP65/67 environment and the numerous functions included in the new “integrated drive” EMCA facilitate robotic functionality which is close to revolutionary, with no need for a control cabinet.

• Robot controller without control cabinet – in IP65/67 thanks to CPX
• All-in-one integrated electric drive EMCA
• Very fast, light and compact
• Maximum economic efficiency
• Virtual commissioning with CIROS by Festo Didactic
• Pioneering: OPC UA interfaces for Industry 4.0, CODESYS V3 SoftMotion transformation models with calibration option.

Multi-Carrier-System in a closed loop
• The closed-loop circulation of carriers is now also an addition to the existing intralogistics solution, making the MCS ideal for long processes and machines or for compact module solutions. The alternative: complete integration or connection.
• Inexpensive servo-controlled toothed-belt solution for the return transport of MCS carriers in a closed loop.

Industry 4.0 functionality
Virtual commissioning (simulation), modular servo controllers, motion controller with optional OPC UA interface and carriers equipped with RFID permit open integration into Industry 4.0 host environments.
Intelligent parallel engine block assembly
Flexible and efficient: engine block, seal, pistons, cylinder head and screws are gripped in parallel and mounted in two steps. This type of parallel engine block assembly is faster and less expensive than sequential production. Furthermore, it can be implemented with either servo-pneumatic or electric axes.

Thanks to decentralised intelligence on the valve terminal CPX/VTSA, the reliable and space-saving grippers are flexible, adaptive and versatile when carrying out different gripping processes. A compact CODESYS controller CPX-CEC with IP65/67 protection controls the gripper unit on-site, and without a control cabinet. The available interfaces include all fieldbuses/Industrial Ethernet as well as Industry 4.0 standard OPC UA.

Flexible loading with end line packaging
We provide you with flexible automation solutions for your loading requirements, whether electric, pneumatic or a combination of both. With all components from a single source, from suction grippers and electric axis systems right up to CODESYS controllers. That allows you to implement dynamic loading processes with fast format changeovers, for example. And we provide you with additional support, from engineering to commissioning and operation.

The application is controlled by a CODESYS controller CPX-CEC with IP65/67 for compact on-site installation – without a control cabinet. The available interfaces include all fieldbuses or Industrial Ethernet as well as Industry 4.0 standard OPC UA.

Optimum food production
Festo provides you with support for optimum food production – with hygienic products and solutions, from valve terminals right up to electric or pneumatic actuators. Also included in our product range: robust, clean-design tubing and fittings. It is the ideal choice for form-fill-seal applications and much more besides.

Industry 4.0 and “big data” using the example of the energy efficiency module MSE6-E2M: evaluate pressure and flow sensors in real time for quick, on-site decisions. Communication via PROFIBUS, PROFINET, EtherNet/IP or Modbus/TCP. OPC UA is available on request.

The application is controlled by a CODESYS controller CPX-CEC. The available interfaces include all fieldbuses or Industrial Ethernet as well as Industry 4.0 standard OPC UA.
Designing an adaptable future in the Scharnhausen Technology Plant

The Scharnhausen Technology Plant is Festo’s main factory for the production of valves, valve terminals and electronics. It will also be a model plant for customers. Designed as a future-ready and adaptable factory, its production systems already embody the first elements of Industry 4.0. In addition, knowledge gained from our research into Industry 4.0 is incorporated into the further development of the Technology Plant.

According to the definitions included in the recommendations made to the German government, there are several action and research areas that constitute a “smart factory” in line with Industry 4.0. These were defined by Acatech within the framework of the working committee on Industry 4.0. A central goal of the smart factory is to have a fully networked factory. Festo is steadily working towards this goal in the Technology Plant. This is an evolutionary process.

Scharnhausen: the production plant of the future for valves, valve terminals and electronics

- Automated and adaptable
- Flexible and continuous production
- Optimised energy consumption
- Learning is a matter of course
- Highly flexible, energy-efficient assembly lines
- An optimised flow of processes, information and materials
- Energy networking of the building and the production processes
- A “training factory” as a practical, integral part of the actual factory
Energy networking of buildings and production processes – RetroFit projects for existing machines

How can you hook your existing machines up to Industry 4.0?

This is a question that many customers/users ask themselves – and we faced the same challenges in our own production.

At Festo, virtually all the machines were retrofitted with a small secondary controller and additional sensors so that key figures (energy consumption, operational data) can be uniformly recorded via OPC UA. A variety of efficiency optimisation measures were analysed and checked to ensure they were economically feasible, and initial measures were implemented.

All the measures taken together reduce the energy used for manufacturing at the new site by a third.

Highly flexible, energy-efficient assembly lines

Millions of units every year, but with flexible batch sizes from 10 to 10,000. These are just a few of the features of our latest assembly lines, which are based on findings from the Industry 4.0 research project “SmartFactoryKL”.

This machine, with standardised mechanical, electrical and software interfaces, points the way forward. It is based on up to 400 decentralised cyber-physical systems (CPS).

Mobile maintenance for greater efficiency and higher availability

As part of a pilot project, all the data for a machine, such as plans and diagrams, bills of materials, spare parts and repair instructions, were ported to mobile devices and linked up to a central computer system – which in our case is SAP.

This allows on-site maintenance technicians to view, analyse and prioritise all the alarms, and to work their way efficiently from one machine to the next. They can also consult experts online, exchange images and photos, view stocks of spare parts, and directly pick or order stock.

The rollout to all other Festo plants is currently underway. Incredibly, the return on investment is less than six months.

Festo Didactic offers consultancy services for optimising production, assessing production plants and processes in accordance with “fit for Industry 4.0”, and the latest service and maintenance concepts. Ask your Festo sales engineer.
Training for Industry 4.0

Industry 4.0 will permanently change how production work is done and thus the demands on skilled workers. Festo is not only focused on technological developments, but also offers an integrated approach and a special training programme to develop the skills required to use and work with the latest digital industry technologies.

With turnkey training factories, laboratory facilities, learning systems with the latest innovative industrial technologies, e-learning and training programmes, Festo Didactic offers the training solutions required for forward-looking and practical training in mechatronics and automation technology.

Modular entry into the world of Industry 4.0: CP Lab
The Cyber-Physical Lab is a professional and compact Industry 4.0 learning system. It includes all the technologies and components needed for the practical and in-depth transfer of Industry 4.0 knowledge. Its modular and flexible structure allows the range of training content to be expanded step-by-step.

The universal Industry 4.0 research and learning platform: CP Factory
The cyber-physical learning platform CP Factory models the stations of a real production system, allowing trainees to learn system programming, networking and many other topics such as energy efficiency and data management. The CP Factory is also used for developing and testing flexible software solutions.

Skills development for Industry 4.0
Employees can be steered successfully through the Industry 4.0 change process with targeted skills development. With customer-specific training programmes, customised content and an integrated approach to consulting, Festo Didactic supports companies in equipping their staff with the skills required for digital production.
The collaborative behaviour of ants, the collective flight behaviour of butterflies, or an extremely versatile gripper modelled on the tongue of a chameleon are revealing new directions for visionary automation technology, exclusively at Festo. Festo’s Bionic Learning Network also studies human learning behaviour and new ways for human-machine interaction, thereby furthering groundbreaking research for Industry 4.0 and the future of production.

**BionicANTS**
The BionicANTS technology carrier has been modelled on the autonomous and cooperative behaviour of ants.

For example, they work together to move loads that a single ant couldn’t manage. Like their role models from the natural world, the BionicANTS work together according to clearly defined rules. They communicate with one another and coordinate their actions and movements.

Each individual ant makes its decisions autonomously but in doing so is always subordinate to the common goal and thereby plays its part in solving the task in hand. The control strategy permits a multi-agent system in which the distributed intelligence of all the BionicANTS together contributes to the process of finding a solution.

**LearningGripper**
Gripping and positioning through autonomous learning

The LearningGripper looks like an abstract form of the human hand. The four fingers of the gripper are driven by twelve pneumatic bellows actuators with low-level pressurisation. Thanks to machine learning, the gripper is able to teach itself to carry out complex actions such as the targeted gripping and positioning of an object. Machine learning reduces the amount of programming required.

The prototype shows how it takes less than an hour for it to learn a mechanical motion strategy, from its first attempt to the reliable execution of the required task. Yet the gripper is only told what it needs to be able to do, not how to do it. The complex strategy required for this is developed independently by the gripper’s learning algorithms – without any further programming.

**BionicCobot**
The way the joints of the BionicCobot are arranged resembles a human arm. With its seven-axis robotic kinematics with pneumatic rotary drives it grips and transports payloads of up to 2 kg quickly and easily, powerfully and precisely. Closed-loop control together with flexibility and adaptability recreate the stretching and bending abilities of human muscles. This inherently safe system that is used for human-robot collaboration, doesn’t require any holding forces.

The modular design allows a variety of gripper systems to be fitted for transporting different loads. The BionicCobot is operated intuitively using a tablet, and can be precisely corrected and adjusted via an infrared tracking system.

The application is controlled by the Festo Motion Terminal with 7x2 chambers and a CODESYS controller CPX-CEC with IP65/67 protection for compact on-site installation – without a control cabinet. The available interfaces include all fieldbuses, Industrial Ethernet and Industry 4.0 standard OPC UA.
As a trendsetter in automation technology, Festo is actively involved in a broad range of areas: our experts advise the German federal government, contribute to the standardisation of communications and software interfaces, and offer basic and further technical training opportunities across the globe. Festo is the only company to offer flexible, decentralised installation concepts and integrated mechatronic solution packages. From mechanical systems to Industry 4.0-compatible controllers – everything comes from a single source.

**Maximum productivity is a question of ambition – both now and for Industry 4.0**

Sometimes there is only a small step between a very good result and market leadership. But that step is the crucial one. Outstanding productivity is part of that step. If that is your goal, we have the right solutions for you – such as the automation platform CPX together with the highly innovative Festo Motion Terminal VTEM. Whether you are looking for a technically sophisticated system solution or a very economical alternative for components, we are here to support you on the road to success. Ambitious and goal-oriented, with vision and awareness of our responsibilities – everything you expect from Festo and everything we are.