The modular Mechatronics Training System mMS 4.0: hands-on, flexible, scalable
Highly flexible automation, maximum productivity, Industry 4.0 – the requirements for employees are constantly increasing. The Bosch Group is one of the largest training institutions for technical professions worldwide. Operating more than 270 production sites and with the knowledge of what is needed in everyday industrial practice. As the leading manufacturer of Drive & Control technologies, Rexroth pools this expertise and seamlessly integrates it into, for example, modular mechatronics training systems – meeting the exact qualification levels required by the industry.
Unique knowledge through the Drive & Control Academy
As an all-around service provider for control and movement technologies, Bosch Rexroth has unique technological knowledge. We are happy to pass this knowledge on to trainees and students, as well as to customers and employees. In the Drive & Control Academy, we thereby support customized education and training as well as the certification of technical experts. Hands-on, tailored to the target groups, and using the most modern methods.

From eLearning to “understanding”
The concept of the Drive & Control Academy is based on the four pillars of knowledge transfer:

- Customer-oriented training (in person or e-learning/ e-training)
- Hands-on modular training systems with industrial standard components
- Supporting media from training manuals to 3D animation
- Online access to a knowledge portal comprising accumulated knowledge, data, and facts about the Rexroth learning world

Customized education with training systems
The modular training systems are a particular specialty of Rexroth. They are perfectly matched to the qualification stages of industrial and educational institutions. All industry-relevant technologies and processes concerning hydraulics, pneumatics, and automation can be learned in practice and “understood.”

Hands-on experience with standard components
The mechatronics training systems developed by Rexroth experts impart to beginners and advanced students sound, practical knowledge using standard industrial components instead of simulated models – with original products, internationally standardized programming languages, and open interfaces. Ready for Industry 4.0 by Rexroth technology Open Core Engineering, Completely pre-configured and ready to use. Modular throughout, from individual assemblies to the work station, through to the entire plant. Allowing for industry processes to be experienced hands-on.
From practice for practice: the modular Mechatronics Training System mMS 4.0

The modular Mechatronics System mMS 4.0 consists of three flexible, exchangeable and expandable stations: rack, processing, and storage. For the realization of a complete automation process.
A complete system on a small scale – the new Mechatronics Training System mMS 4.0 in the final stage. The system consisting of three individual stations addresses the assembly of a cube, from the removal out of a rack to processing with a pressing machine, and through to the high-rack warehouse. Completely interconnected and programmable via bus systems and extensively secured. The entire system or its individual stations are shipped fully assembled, installed, and programmed. You can get started right away.

**Your benefits with mMS 4.0:**

**Original standard components from industry**
- DC motors
- Servo motors
- Control technology: relay, PLC, motion control, CNC
- Linear motion technology
- Pneumatic drives
- Hydraulic drive (optional)
- Sensor technology and RFID
- Cartesian robot or 3-axis CNC
- Standard machine control panel
- Fieldbus and Ethernet communication

**Modular, scalable training system – from single module to full plant**

**Industry 4.0 integrated**
- HMI – Human Machine Interface
- RFID – Radio Frequency Identification
- Open Core Engineering from Rexroth – winner of the Hermes Award

**Various programming options**
- PLC programming (according to IEC 61131-3):
  - Instruction List (IL)
  - Structured Text (ST)
  - Sequential Function Chart (SFC)
  - Function Block Diagram (FBD, STL)
  - Ladder Diagram (LD)
  - Continuous Function Chart Editor (CFC)
- **Open Core Engineering**
  offers more ways of programming
  - Java (APP)
  - C/C++
  - C#
  - Microsoft Excel, PowerPoint
  - Matlab/Simulink
  - and more

**Additional advantages**
- Operation with smart devices via Wi-Fi possible, e.g., tablet, smartphone, etc.
- One controller to handle the functions of a PLC and a CNC. Free CNC software support for programming
- Optional expansion with different PLC systems
- Integrated machinery safety and expandable functions

**Plug-and-play concept for immediate use**
- Training content from real industrial applications, suitable for the topics of a German industrial mechatronics education

**Universal learning concept**
- Industry know-how of the Bosch Group from over 270 production sites worldwide
- Rexroth Drive & Control Academy with unique knowledge about technologies, processes, learning methods
Three stations for a complete plant: rack, processing, storage

Station 1: Rack
Just like in "real life", individual, extensive sensory checks are carried out here (capacitive, inductive, and visual) and then forwarded for processing. Incorrect materials can be removed. Easily controlled from the control panel, but also programmable via smart devices and various high-level languages. The most important components:
- Machine control panel
- Conveyor belt
- 2 separating racks
- Sensor technology analog/digital
- Removal unit
- Profibus coupler
- Safety technology (optional)
- Connected Industry 4.0: Open Core Engineering, HMI & RFID (optional)

The features of this station correspond to the EVO 2 expansion stage described on page 9.

Station 2: Processing
The station for processing workpieces with a hydraulic or pneumatic press and for forwarding. Can be operated and programmed flexibly and individually, but can also be linked and expanded with other stations mechanically, pneumatically, or electrically. With emergency stop system for the station or the entire system. This includes, among other things:
- Pinning unit
- Portal
- Pneumatic/hydraulic press (optional)
- Safety technology, two-hand release (optional)
- Profibus, Fieldline
- Connected Industry 4.0:
  - Open Core Engineering, HMI and RFID (optional)

Different cylinder types are available for the pneumatics, while a valve with manual operation can be used for the hydraulics. The extensive safety technology comes fully into play with the use of the press.
Station 3: High rack warehouses
Off to the warehouse: This station provides automatic storage of the processed workpieces in a high rack warehouse: 3 x 5 storage spaces, 2-axis servo robots with pneumatics, light barrier and enclosure with safety switch. Can be extensively controlled and programmed via modern bus technology.

It is also possible to move individual axes, use axis-interpolation when using robotics, or to use it as a CNC application.
- Bus technology: decentralized field line I/O, PROFIBUS, Sercos
- Safety technology
- Drive technology: servo motor, axes with drive and belt transmission
- 2-axes commissioning: travel cycles (PLCopen), robotics, CNC
- Pneumatics: rotary module, cylinder, and grabber
- 3 learning topics in one station: PLC programming (high rack warehouse), cartesian robot, CNC

Profile cart with electrical system
The profile cart shown in the picture below is the control center of the individual stations. The parent control systems that are used here are the proven, original industrial controllers IndraLogic L25 and L45 from Rexroth with communication via Profibus DP. But the cart also serves as a connection point to the other stations. This means that only one single feed of electrical power and compressed air is necessary.
From assembly to station to plant: The evolution of mechatronics

The modular concept of mMS 4.0 is consistently aligned with the educational path of the mechatronics training. Study courses build on one another step by step, from already wired individual modules (e.g., rack, sensor technology ...) on an aluminum profile plate to an expansion with the profile cart, additional control, processing, and communication components, through to Industry 4.0-enabled work stations or plants.

**Step by step to Industry 4.0**

Using the original industrial components of the modules and stations guarantees a reliable and robust training system for everyday use. Even the table set-up (EVO 1) alone teaches about the interactions of actuators and sensors. In the output stage (EVO 3), one station covers the majority of mechatronic topics and can be expanded to an entire plant.

Because students are guided through consecutive steps that build on each other, from single modules to mastering the overall functionality, their motivation remains high thanks to continuous small accomplishments. Thanks to the extensive range of topics, in addition to the education the training is also a useful tool for your employees to get certified. These multiple uses mean your plant can be continuously utilized. With the learning methods and contents being at industry level, the gained knowledge can be applied in everyday work immediately.

**EVO 1 – Course contents**
- Wiring, measurement, troubleshooting
- Sensors for workpiece recognition
- Relay control of digital signals via industrial relay or optional circuit board
- DC motor control
- Integrating pneumatic cylinders and valves

**EVO 1 – Configuration**
- Aluminum section plate
- Control panel
- Conveyor belt
- 1 separating rack
- Sensor technology: reed contact, roller, capacitive, inductive, optical, light barrier
- Removal unit
- Relay switching
EVO 2 – Course contents
Course contents same as EVO 1, plus:
- bus systems, decentralized I/O
- Processing of analog and digital signals via PLC
- Emergency stop circuit
- Machine control panel
- Control cabinet
- PLC programming
- Open Core Engineering

EVO 3 – Course contents
Course contents same as EVO 1 and 2, plus:
- Machine safety: wiring, measuring, integration, and troubleshooting for safety components
- Programming a safety control
- Integration of an HMI system
- Integration of an RFID system

EVO 2 – Configuration
same as EVO 1, plus:
- Profile cart with electrical system
- Machine control panel
- 1 additional separating rack
- Sensor technology: Contour cylinder (analog signals)
- Profibus coupler
- PLC XLC L25

EVO 3 – Configuration
same as EVO 2, plus:
- HMI: VCP 25 touchpad
- Safety: SafeLogic Compact safety control, light grid, safety door
- RFID equipment set
- PLC XLC L25
Always on the right track: With the right equipment and tools – and full support worldwide

The hands-on philosophy of the Rexroth Drive & Control Academy is also tangible in every detail of the modular Mechatronics System mMS 4.0: in the previously described device components, the didactic learning approach, the corresponding project and training handbooks, through to the online tools. Everything from a single source.

Benefit from practical experience

Technical knowledge and the employees' expertise can give a company a decisive advantage in the global, competitive marketplace. Under the umbrella of the Drive & Control Academy, technology leader Rexroth offers a systematically practice-oriented portfolio of knowledge products in the areas of drive and control technologies.

Key:

- Study topics - Equipment
- additional study topics

Basic knowledge

- Sensor technology
- Control technology
- Drive technology
  - pneumatic
  - hydraulic
  - electrical
- Mechanical components
- Safety technology

Sensor technology and measurement technology
- Programming PLC controllers
- How drives work, EVO 1, conveyor belt
- Basics of hydraulics
- Basics of pneumatics
- Basics of linear technology
- eLearning safety technology
The Mechatronics Training System mMS 4.0 harnesses all of the experience gained by Rexroth specialists in global manufacturing and the knowledge required through application-oriented, tailored training. Use the modules to put together your own training system and an individual learning path for your students. And benefit from an integrated teaching approach that doesn’t stop at technical devices, but instead begins there.

Train the trainer
Further training at one of the world’s leading educators – modular and certified trainer training from Bosch Rexroth refreshes knowledge and guarantees high-quality, sustainable teacher training in soft skills and technical subjects, such as mechatronics. This allows even experienced trainers to keep up to date with the technological and methodical state of the art.

Handbooks and textbooks, supplementary material
Project and training manuals, and supplementary materials are developed at Rexroth by experts with experience in global manufacturing and are prepared pedagogically. Always up to date, with extensive exercises (and solutions for teachers) and above all: practical.

With access to the Rexroth learning world
The Rexroth learning world, which has proven itself over many years, is your access point to unique training knowledge consisting of manuals, animations, and much more. Take a look under www.boschrexroth.com/learnworld

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