GD Bildung und Kultur Programm für lebenslanges Lernen / Federal Ministry of Education and Research	Berufsschule für Fertigungstechnik	Module Electro-Pneumatics	goMOVET.eu

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"MODULES FOR VOCATIONAL EDUCATION AND TRAINING FOR COMPETENCES IN EUROPA II"

"MOVET II"

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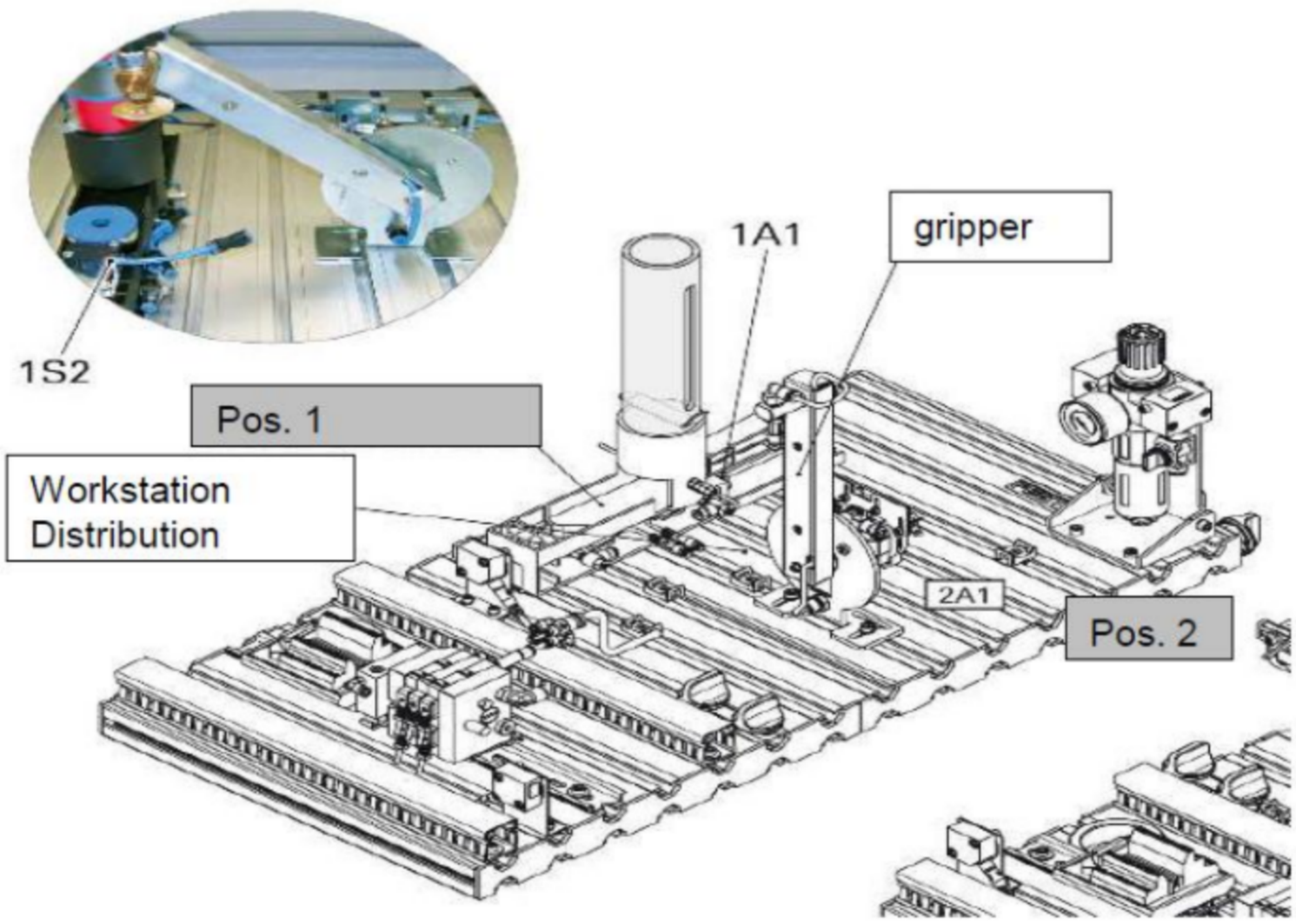
Module Electro-Pneumatics



The aim of the training is to enable the apprentices to develop the skills, knowledge and competence for competence area 7 of the competence Matrix Mechatronics from the VQTS model (cf. Karin Luomi-Messerer & Jörg Markowitsch, Vienna 2006)

7.2 He/She can master the selection of hardware, software and industrial components for mechatronic systems (sensors, actuators, valves, relays, interfaces, communication procedures). He/she can provide and test simple software control programs (SPS) and develop and design simple control programms according to production process requirements (adaption of 7.2)

BSFT Seidenader Group MTU Aero Engines SWM BMW Technische Universität München

Allocation in the competence Matrix “Mechatronics”

Competence area	Steps of competence development							
1. Maintaining and assuring the reliability of mechatronic systems	He/She can perform the basic scheduled maintenance on mechatronic machines and systems and adhere to the equipment maintenance plans.		He/She can master the maintenance procedures for mechatronic systems such as the use of service documents and maintenance plans and, if faced with new challenges, can make the necessary adaptations.		He/She can use preventive maintenance to assure the trouble-free operation of mechatronic systems. In addition, he/she can modify operational sequences to implement quality-assurance measures		He/She can develop the necessary procedures for maintenance of mechatronic devices and systems, and can schedule the maintenance and quality-assurance procedures.	
2. Installing and dismantling mechatronic systems and facilities	He/She can use written instructions to install and dismantle individual components (sensors, actuators, drives, motors, transport systems, racks) that form a functional group of mechatronic systems.		He/She can master the installation and dismantling of mechatronic systems that use several technologies (mechanics, hydraulics, pneumatics, electricalmechanics, electronics), set up the connexion technology, and check the efficiency of the overall system.		He/She can provide independent mechatronic solutions for the construction of production lines, assure their overall ability to function, and, in addition, can use both existing and modifi ed standard components.			
3. Installing and adjusting mechatronic components in systems and production lines	He/She is able to install and adjust standardized mechatronic components, e.g. individual electro-pneumatic valves, sensor and actuator units.		He/She can install and adjust components of mechatronic subsystems (e.g., linear drives, measuring systems, transport systems).		He/She can install and adjust complex mechatronic facilities that include diverse technologies and instrumentation and control (I&C) equipment, adjust the associated parameters, test the facilities overall functions, and assure their reliability			
4. Designing, adapting, and building mechatronic systems and facilities on the basis of client needs and site plans	He/She can use machine tools controlled either manually or via computer-program to fabricate (according to production designs and customer requirements) the individual components for mechatronic systems. He/she can provide simple designs and descriptions of mechatronic subsystems and can use basic CAD applications.	He/She can build simple mechatronic subsystems by using eineering drawing and can install he devices according to specific production needs. He/She can act on extensive knowledge of standards and regulations (e.g. on surface treatments) and is able to use CAD's more advanced functions (e.g. interference check).	He/She can build mechatronic systems by using both original construction techniques and previously designed parts. He/She fully understands CAD functions and can document system developments (parts lists, descriptions of function, operating instructions).	He/She can design and build autonomous mechatronic subsystems and, with suitable measuring and testing facilities, can assess the necessary production accuracy. He/She can document the results with quality-control systems.	He/She can make independent adaptations to the various devices (including selection of drives, sensors, SPS) and can use CNC programs for building the system. He/She can, through a digital mock up, assemble and simulate the functioning system and use computeraided computations (e.g. FEM). He/She can perform cost-benefi t analyses (e.g. as a basis for deciding whether components should be bought or individually constructed.)	He/She can independently develop complex mechatronic systems and can calculate the economic usefulness of the system. He/She can optimise CNC programs for the manufacturing of complex mechatronic devices and systems and monitor the automated quantity of an open loop control system.	

5. Putting mechatronic systems into operation and providing clients with technical and economic support	He/She can, according to specifications and blueprints, put mechatronic devices into operation and provide support to the client in the handover phase.	He/She, after considering the enterprise's needs and basic conditions, can put the mechatronic systems into operation, create the necessary documentation, advise the customer on safe operations of the devices, and advise on future technology selection.	He/She, after considering all basic conditions, can master the start-up of interconnected mechatronic systems and machines, and can provide the necessary documentation including a manual. He/She can review client needs and confi gure machines that provide solutions. He/She can train the customer where necessary and provide support for safe operating procedures.	He/She can evaluate customer requirements for mechatronic facilities, develop solutions, and can plan the system's implementation and operation.	He/She can direct, including scheduling and time management, the start-up of the project from the creation of a proposal to the client's acceptance.
6. Supervising and evaluating both the process sequences of mechatronic systems and facilities and the operational sequence (including quality assurance	He/She can supervise process sequences according to specifi cations as well as implement any requested quality-control measures.	He/She can independently supervise the process sequences, evaluate the results, operate an accompanying statistic process control (SPC) for the quality control plan, and prepare simple work schedules, including production schedule and time management.	He/She can operate and supervise mechatronic facilities, choose testing and monitoring plans, set up the accompanying SPC, seek the optimal results of the production line according to material-flow, and provide work schedules including standard production times.	He/She can master the monitoring of complex mechatronic systems using virtual instruments and PPS systems as well as open loop control for the optimisation of machinery arrangement, material fl ow analysis, and scheduling.	He/She can optimise the process cycles of mechatronic production lines, provide instructions on modifying the PPS systems (e.g. adjustment to SAP systems) and introduce quality systems for continuous improvement processes (CIP/KVP).
7. Installing, configuring, programming and testing hardware and software components for control and regulation of mechatronic systems and facilities	He/She is able to install and configure programs for hardware and software components as well as set up simple software control programs (SPS).	He/She can master the selection of hardware and software for mechatronic systems (sensors, actuators, interfaces, communication procedures) and can provide and test simple software control programs (SPS) according to production process requirements.	He/She can integrate and confi gure program-, control-, and regulation-mechanisms in mechatronic systems, program simple devices (in co-operation with developers), and simulate the program sequence before start-up.		He/She can develop, test, and configure hardware and software solutions for networked mechatronic systems; and can monitor system conditions with suitable measuring and visualisation tools.
8. Preparing and distributing the technical information for adjustment of each enterprise's mechatronic systems	He/She can provide descriptions and designs of mechatronic subsystems and is familiar with the basic CAD applications.	He/She can fully understand the management of technical information documents for mechatronic systems and can prepare and adapt these documents according to an enterprise's specific operating requirements.		He/She is able to analyse complex operational sequences separately in order to understand the connections and draw up maintenance and production procedures. He/She can understand that the system parameters are important for the equipments' functions and can independently assess and document the wear and general conditions of the mechatronic equipment.	
9. Diagnosing and repairing malfunctions with mechatronic systems and facilities, advising clients on avoiding malfunctions, and modifying and expanding mechatronic systems	He/She can diagnose and repair errors and malfunctions on the simple components and devices in the mechatronic systems. He/She can use the necessary checking, measuring, and diagnostic tools.	He/She can independently correct problems in mechatronic production equipment with the help of (computer- aided) diagnostic systems and the use of expert systems, databases, and error documentations.	He/She can diagnose and repair errors and disturbances in complex mechatronic equipment and is able to advise clients on how to avoid sources of malfunctions through changes or upgrades in the equipment and system.		He/She can diagnose and repair errors and disturbances in complex mechatronic equipment and is able to advise clients on how to avoid sources of malfunctions through changes or upgrades in the equipment and system.

Allocation in the competence Matrix “Mechanics in industry”

Competence area	Steps of competence development				
1. Maintaining tools, equipment and technical systems	He/she can perform the basic scheduled maintenance on tools and equipment. (e.g. checking the quality of used cooling liquids, checking the oil-level in the milling machine, checking the cutting edges of tools,…).	He/she can master the maintenance procedures for technical systems using service documents and maintenance plans. He/she performs the correct mounting method for machine elements (e.g. shafts, axles, bearings and shaft seals).	He/she understands the function of technical systems, can perform trouble shooting including locating defects and analysing causes for damage. He/she plans, performs and documents necessary maintenance work.		
2. Installing and dismantling of assemblies, machinery and systems	He/she can apply written instructions to install and dismantle individual components (e.g. to single parts to an assembly by using machine elements like screw joints or pin connections)	He/she can install/dismantle complex assembly groups and machinery, which could include different technologies. He/she positions and fixes the components by performing detachable and permanent joining processes (e.g. mount bearings to gearboxes, weld frames …).	He/she understands the function of complex machines or systems. He/she can build up a system (consisting of e.g. gear drives, chain drives, belt drives, pneumatic or hydraulic components…). He/she can adjust the associated parameters and analyse/evaluate the overall function of the system.		
3. Installing and bringing into service of control technology	He/she can use written instructions to install and adjust pneumatic or hydraulic or electrical components according to safety rules.	He/she can use written instructions to install E-pneumatic or E-hydraulic or electrical components according to safety rules.	He/she can apply an E-pneumatic or E-hydraulic solution for simple tasks.	He/she can apply an E-pneumatic or E-hydraulic solution for complex tasks.	He/she can install and configure programs for hardware and software components as well as set up simple PLCs.
4. Preparing and using technical information	He/she can read and manually draft simple sketches or technical drawings of single components. He/she knows the ISO standards for drafts, surface symbols and dimensioning.	He/she can correctly apply basic CAD functions for the construction of technical components.	He/she can correctly apply advanced CAD-functions for the construction of components and assembly groups. (Including screw joints, pin connections…).	He/she develops technical constructions according to the needs of the customer. He/she can check the functions of complex assembly groups via CAD.	
5. Producing single parts and assemblies	He/she can produce simple components by performing manual production tasks, (e.g. filing, sawing, bending…).	He/she can correctly apply conventional machines for the production of components. He/she knows the parameters for calculating cutting speed, feed rate…	He/she can develop the necessary CNCprogram using DIN/ISO programming, and simulate the functionality. He/she can set up the machines and the tools. He/she can produce single parts using CNC machines (e.g. lathes and milling machines), test and optimize production.	He/she can produce parts on CNC machines using CAD/CAM technology up to 3 axes.	He/she can produce parts on CNC machines using CAD/CAM technology in complex settings with more than 3 (4) axes.
6. Working according to QM principals/ standards (documenting, measuring, supervising work	He/she is familiar with methods of testing. He/she can select the necessary test equipment and check it (e.g. micrometre). He/she can work according to inspection plans. He/she can apply inspection equipment correctly.	He/she can develop criteria for functional tests. He/she can prepare inspection plans and documentation. He/she can evaluate inspection results and identify the cause of quality problems.	He/she can develop inspection plans based on QM regulations (also in respect of mass and serial production). He/she is familiar with tools/methods to support continuous improvement processes in order to optimize the production process.	He/she can control product and process quality. He/she can carry out inspection of machine and process capability on demand. He/she can plan the process as well as document and evaluate process data. He/she can make suggestions for optimizing the quality of process.	
7. Planning, carrying out and optimising technical systems	He/she can plan production processes for typical single parts. He/she can perform and optimize these processes.	He/she can plan production and mounting processes for typical assemblies. He/she can perform and optimize these processes.	He/she can provide independent technical solutions for the construction e.g. of production lines. He/she can assure the functionality of the overall system by using existing and modified standard components. He/she can check failure-free working systems and production processes concerning their potential for optimization. He/she can work out suggestions for optimization regarding technical development. He/she can evaluate and estimate the economic advantage. He/she can carry out the proposal.		

Content learning outcome

Learning Outcomes After completing this work order the student is able to…		Taxonomy Table
1. Safety precautions		
SP 1	name and memorize (1F) the safety precautions and work instructions.	1F
SP 2	formulate (5Ca) further safety precautions.	5Ca
SP 3	identify (4Ca) hazardous situations	4Ca
2. Production of compressed air		
CA 1	tabulate and describe (1F) the components.	1F
CA 2	summarize (2Ca) the production of compressed air	2Ca
CA 3	understand (2F) the flow diagram.	2F
CA 4	describe (2Ca) the valve settings.	2Ca
3. Work orders		
3.1 Pneumatic Basics WO 1		
WO 1.1	develop (3F) electro - pneumatic circuits by means of standard components.	3F
WO 1.2	differentiate (2F) single and double acting cylinder, standard way valves, direct and indirect control of cylinders.	2F
WO 1.3	use (3F) the item designation systematically.	3F
3.2 Sliding door WO 2		
WO 2.1	describe (1F) the function of the magnetic proximity sensor.	1F
WO 2.2	differentiate (2C) between AND and OR logic operations.	2Ca
WO 2.3	analyse (4P) the result of the loss of air for your circuit.	4P
WO 2.4	carry out (3P) the development and simulation of the circuit for the task.	3P
WO 2.5	check and evaluate (5Ca, 5P) your circuit.	5Ca, 5P

3.3 roller conveyor WO 3		
WO 3.1	carry out (3P) the correct connection of a proximity sensor in an electric circuit.	3P
WO 3.2	understand (2F) the function of the different proximity sensors	2F
WO 3.3	recognize (1F) and apply (3P) the appropriate proximity sensor for the task.	1F, 3P
WO 3.4	carry out (3P) the development and simulation of the circuit for the task.	3P
WO 3.5	check and evaluate (5Ca, 5P) your circuit.	5Ca, 5P
3.4 Vaccum WO 4		
WO 4.1	describe (1F) the function and principle of the vacuum generator.	1F
WO 4.2	describe (1F) the function of a pneumatic semi rotary drive.	1F
WO 4.3	analyse (4P) the result of the loss of electric power for your circuit.	4P
WO 4.4	carry out (3P) the development and simulation of the circuit for the task.	3P
WO 4.5	check and evaluate (5Ca, 5P) your circuit.	5Ca, 5P
3.5 Sawing fixture WO 5		
WO 5.1	describe (1F) the function of the pressure switch.	1F
WO 5.2	calculate and select (3Ca) the appropriate cylinder.	3Ca
WO 5.3	calculate and analyze (4Ca) the air consumption.	4Ca
WO 5.4	carry out (3P) the development and simulation of the circuit for the task.	3P
WO 5.5	check and evaluate (5Ca, 5P) your circuit.	5Ca, 5P
3.6 Stamping device WO 6		
WO 6.1	use (3Ca) the correct item designation.	3Ca
WO 6.2	choose (3Ca; 3P) a suitable proximity sensor	3Ca, 3P
WO 6.3	understand (2Ca) and develop (3P) a sequence chain.	2Ca, 3P
WO 6.4	carry out (3P) the development and simulation of the circuit for the task.	3P
WO 6.5	check and evaluate (5Ca, 5P) your circuit.	5Ca, 5P

5. Test		
Test 1	describe (1F) the function of the magnetic proximity sensor.	1F
Test 2	understand (2F) the funktion of the different proximity sensors.	2F
Test 3	understand (2F) the difference between a 5/2-way single solenoid valve and a 5/2-way double solenoid valve.	2F
Test 4	describe (1F) the function and principle of the vacuum generator.	1F
Test 5	calculate and select (3Ca) the appropriate cylinder	3Ca
Test 6	calculate and analyze (4Ca) the air consumption	4Ca
Test 7	argue (5Ca) economical aspects	5Ca