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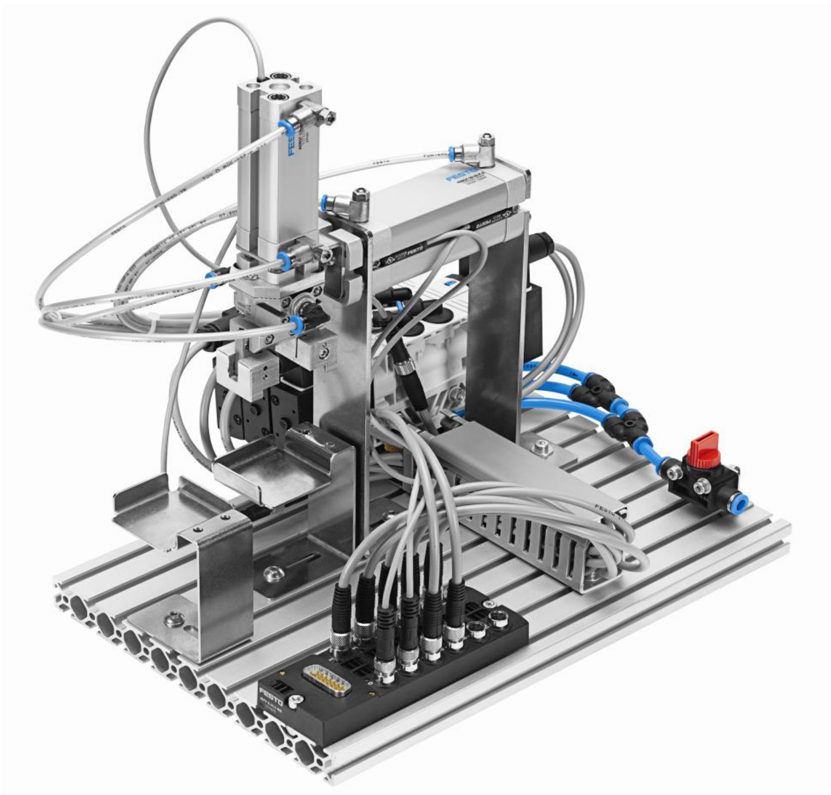

Handling station

GO! onderwijs van de Vlaamse Gemeenschap

Ruggeveldlaan 496
2100 Deurne
tel. 03 328 05 00
info@spectrumschool.be
www.spectrumschool.be

Introduction and didactic background

In the age of knowledge, automation technology is gaining increasing importance as a key division of engineering sciences. As a technical/scientific achievement, it is an expression of creative thoughts and actions of engineers and natural scientists. Automation technology brings about lasting changes to the working and living conditions of people by ensuring high productivity and consistent product quality while at the same time satisfying people's ever-growing need for technological know-how. This applies as much to people's professional as to their private lives.
As a technical area of science, automation technology combines knowledge from virtually all other technical sciences. Such an intensely interdisciplinary field of study could scarcely have developed to the extent it has without scientific fundamentals from electrical engineering, mechanical engineering, process engineering and information technology to name just a few.
People of all age groups come face-to-face with automated technical systems every day. They use escalators, wait for automatic doors to open, see their groceries move along conveyors at the supermarket and operate automated teller machines. Automation technology, in this sense, is everywhere. Everyone, in every aspect of their lives, is regularly confronted, either directly or indirectly, with the purposeful selection and use as well as the evaluation and assessment of automated systems.
The objectives of future-oriented, general technical education must therefore be more strongly geared towards this technology than in the past.
Specific objectives are:

- Promoting implicit and explicit knowledge of automated systems,
- developing skills and promoting abilities in the use of automated systems,
- Consolidating abilities with regard to appropriate selection, operational commissioning and careful maintenance of automated technical systems.

It is precisely the complexity of automation technology that makes determining the educational content for general pre-vocational technology education difficult yet important. Innovations, essential to every economy, first and foremost require the creativity of technically educated people who have a flexible and above all positive approach to constantly evolving technology. This gives rise to special requirements for general education in technology. It must consist of and provide the content that helps students to understand and deal with technology.
People are expected to adapt quickly to the constantly changing conditions of the professional and working world and to acquire the appropriate competencies. For most people, this is only addressed during vocational training. Basic attitudes, however, are created and acquired much earlier. Consequently, general technical studies as well as technological education as part of work studies or interdisciplinary projects is particularly important. Modern didactics always start from the students' current stage of development and ensure they progress from there.
Automation technology is one of the most challenging academically since it forms a very complex subject matter within the technology curriculum of a general school system. It can't be taught and learned solely through lectures by a teacher and multimedia lesson units. Involving experts in class work or going on factory tours as a "bridge to practice" is also insufficient.
Instead, students must be offered the opportunity to get hands-on practice with automated technical systems, to observe and understand how subsystems and components interact and to be able to assemble and disassemble them. It's all about learning through experience with all the senses. Complex models can be used in the lesson to

this end as enactive, i.e. realistic, media. They convey information, represent reality, are communication tools and enable active autonomous and co-operative learning. Models bring every day practice into the classroom.
The MecLab is a learning system developed by Festo Didactic, with its stacking magazine, conveyor and handling subsystems, simulates automation practice; its aim is to familiarise students with automated technical systems. Its focus on learning objectives means it can be called a learning media system. Its three subsystems (stacking magazine, conveyor, handling) are separate but can also be used in combination and can thus be seen as an example of learning media complexes. They combine reproductive learning about a disassembly object with productive learning about a production object.
The modules can be used to design models, where the focus is on synthesis. Models that can be dismantled and adapted to different requirements by the students through conversion and modification, as is the case in the MecLab system, can be used for both analysing the component parts of a technical system and re- integrating those parts and trace them back to a coherent unit.
Linking of theory and practice is an essential aspect of MecLab and its components. Students learn about the practical applications of theories and learn their value as individual statements and statement systems, hypotheses, theses, premises, principles, rules and laws, and therefore will be able to appreciate why they are important. For every theory related to engineering sciences, there is a corresponding application. Generally speaking, practice is the application of technology.
Links between theory and practice can, on the one hand, lead students to practise what they have learned by studying the theory and, on the other, to analyse practical applications to prove the theoretical fundamentals on which they are based. These links can be methodically constructed in a number of ways. What's important is that students don't learn about practice just through descriptions or pictures, but internalise and experience it as genuine practice or its equivalent and in so doing exercise their problem- solving skills.

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Handling station

Technical significance

Movement, orientation and assembly of workpieces are a requisite for all automated assembly systems. These tasks are performed by automated handling machines, the best known and most powerful of which are the industrial robots.
Industrial robots are freely programmable and have at least four axes (i.e. driven joints), making them extremely flexible. Industrial robots are also very fast (over 1 m/s) and accurate (repetition accuracy of better than 50 μm). Simpler handling devices are adequate for many assembly tasks.
One of the most important components in a handling device are the grippers used to establish contact with the workpiece. There are many different designs of grippers:

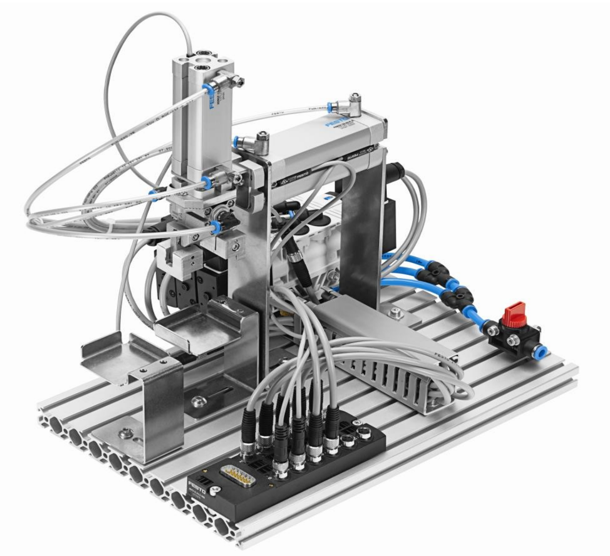
- Mechanical grippers with two or three gripper jaws grip workpieces like a hand. Since these grippers' fingers are not as flexible as the fingers on an actual hand, however, it means that the gripper jaws generally have to be adapted to the workpiece to be gripped.

- Vacuum grippers hold the workpieces by means of vacuum. They are especially suitable for flat workpieces but less suitable for porous ones because no vacuum can be built up.

- Magnetic grippers for magnetisable workpieces.

- Adhesive grippers where the workpieces are held using an adhesive film. These are used less frequently because they are very sensitive to soiling.

Since two-axis automated handling machines are most frequently used to remove (pick) workpieces from a magazine and then deposit or assemble (place) them somewhere else, they are also called pick and place devices.



The handeling station consists of
- Two pneumatic linear axes
- One pneumatic gripper
- Three valves for controlling the pneumatic actuators
- Four magnetic procimity sensors for detecting the position axes and further components

Complete structure of the handling station

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The following table provides an overview of the components, their significance and the corresponding circuit symbol.

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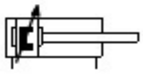
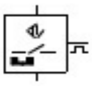
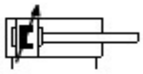
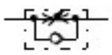
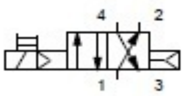
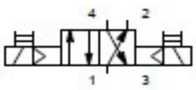
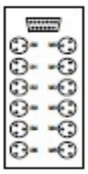
Illustration	Symbol	Description
		Gripper for holding the workpieces.
		Magnetic proximity sensor for detecting the position of the cylinder piston.
		3/2-way stop cock for shutting off the compressed air and exhausting.
		T-distributor for distributing the compressed air.
		Double-acting guided cylinder.
		One-way flow control valve, used to regulate the speed of pneumatic drives.
		4/2-way solenoid valve, with pneumatic spring return.
		4/2-way double solenoid valve.
		Multi-pin plug distributor, interface for connecting all actuators and sensors of the conveyor station to the control PC.

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Preparation
The assignment starts by trying to find out which in-and outputs are connected to the Multi-plug in connection. Once these links are found , we are able to generate connections based upon the technical data of the Multi-plug in connection (see attachment) and a custom made addressing table.

After connections have been made we will check all cylinders , sensors and relays via the PLC or FluidSim by steering them.

Learning objective
Upon completing this exercise, you should
- be able to select the components of an electropneumatic circuit
- be able to design electropneumatic circuits
- be able to actuate a double-acting cylinder using FluidSIM
- be familiar with the most important logic operations
- be able to create logic programs in FluidSIM
- be able to solve simple control tasks using logic operations
- be familiar with the mode of operation and fields of application of sequencing
- be able to create simple control systems via sequencing programs
- be familiar with the mode of operation and fields of application of sequencing
- be able to create complex control systems via sequencing programs

Aids
FluidSIM, Handling station,

Tasks

Problem description 1
Workpieces are to be lifted using a pneumatic cylinder. A control system is to be designed for this purpose. A vertically arranged double-acting cylinder equipped with one-way flow control valves is provided for lifting. This cylinder is to be supplied with air by means of a solenoid valve and controlled via PC. The cylinder should advance when a pushbutton is actuated and retract after a second pushbutton is actuated.

Task 1
Design a pneumatic circuit diagram for the components you selected and test its function via simulation.

Complete the electrical circuit diagram with the suitable actuating elements and transfer the solution to FluidSIM. Test its function via simulation.

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Extend the circuit so that the vertically arranged cylinder of the handling station can be controlled and test its operability.

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Problem description 2

Logic operations are an important basis of control technology. In the FluidSIM logic module, inputs and outputs are linked using logic operations. This exercise deals with the most important logic operations.

Task 2

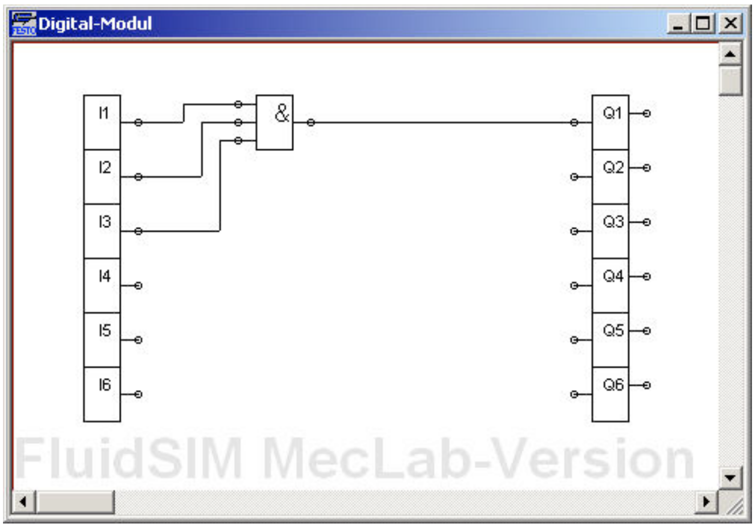
Transfer the following logic circuits to FluidSIM and study the circuit's behaviour by setting the input channels I1 through I3 to the status 'high' by clicking on them. Complete the truth table. In each case specify an example of a control task that can be solved using this logic operation.

Create the logic circuit shown below in FluidSIM, test its behaviour and describe it. What control tasks can this so-called latching element be used for?

Create the circuit shown below in FluidSIM.

Open the logic module and create a program with the following characteristics:

- Lamp P1 should light up when the two pushbuttons T1 and T2 are pressed (and stay on after pushbuttons T1 and T2 have been released).
- The lamp should switch off extinguished when pushbuttons T3 or T4 are actuated.



I1	I2	I3	Q1
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	1	1	
1	1	0	
1	0	1	
1	0	0	

Example of a control task:

___

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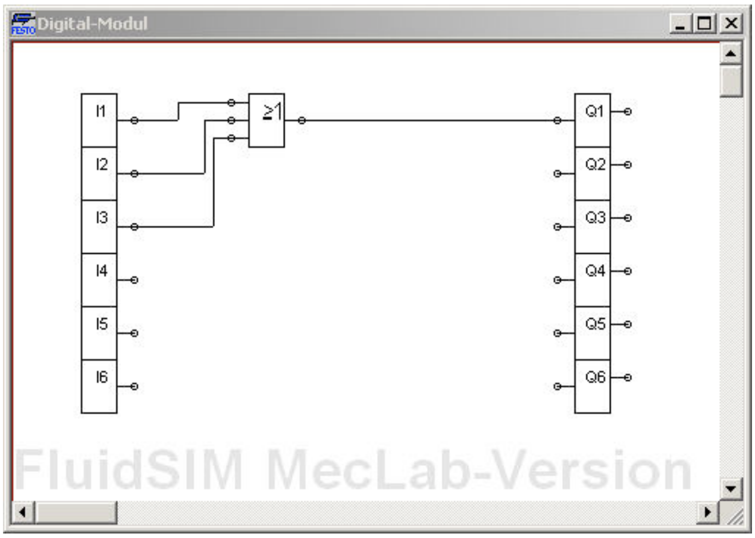
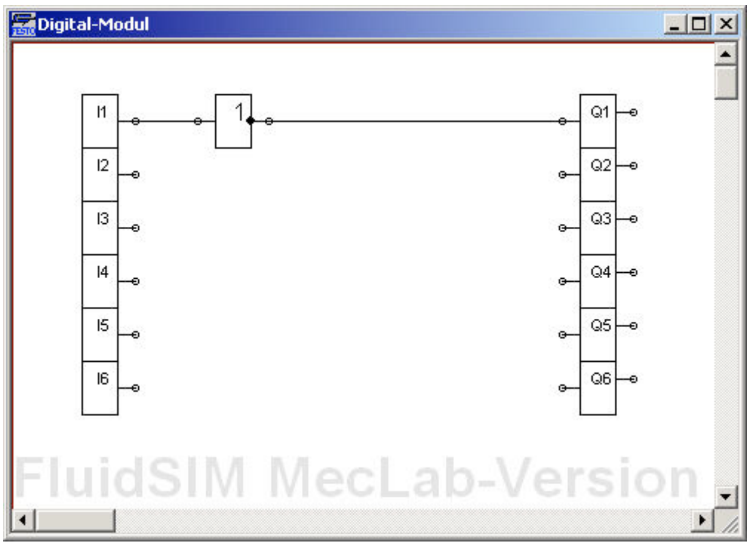


I1	I2	I3	Q1
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	1	1	
1	1	0	
1	0	1	
1	0	0	

Example of a control task:



I1	Q1
0	
1	

Example of a control task:

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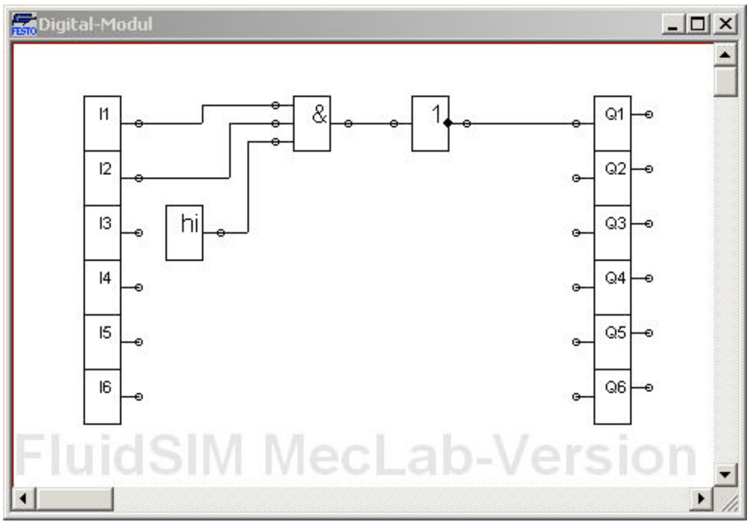
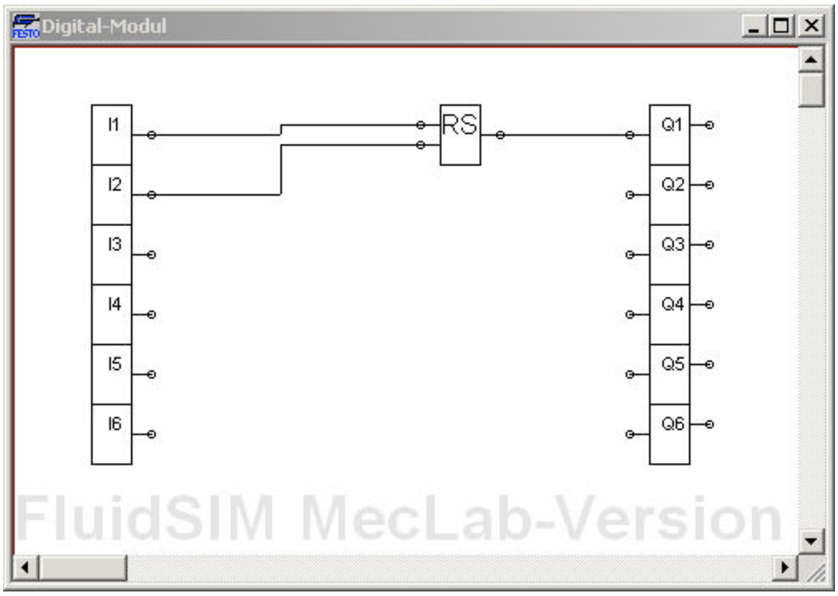


I1	I2	Q1
0	0	
0	1	
1	0	
1	1	

Example of a control task:

Create the logic circuit shown below in FluidSIM, test its behaviour and describe it. What control tasks can this so-called latching element be used for?



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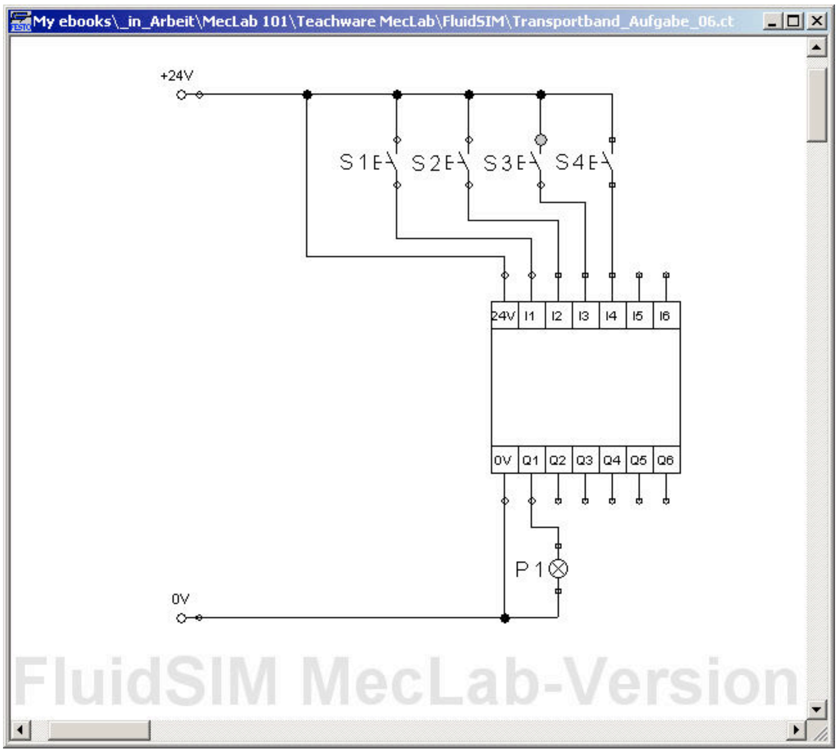
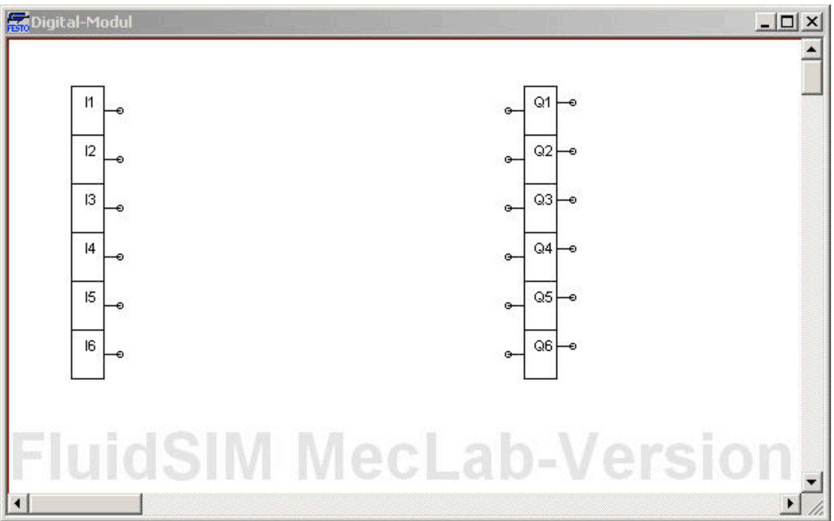
Create the circuit shown below in FluidSIM.



– Open the logic module and create a program with the following characteristics:
  - Lamp P1 should light up when the two pushbuttons T1 and T2 are pressed (and stay on after pushbuttons T1 and T2 have been released).
  - The lamp should switch off when pushbuttons T3 or T4 are actuated.



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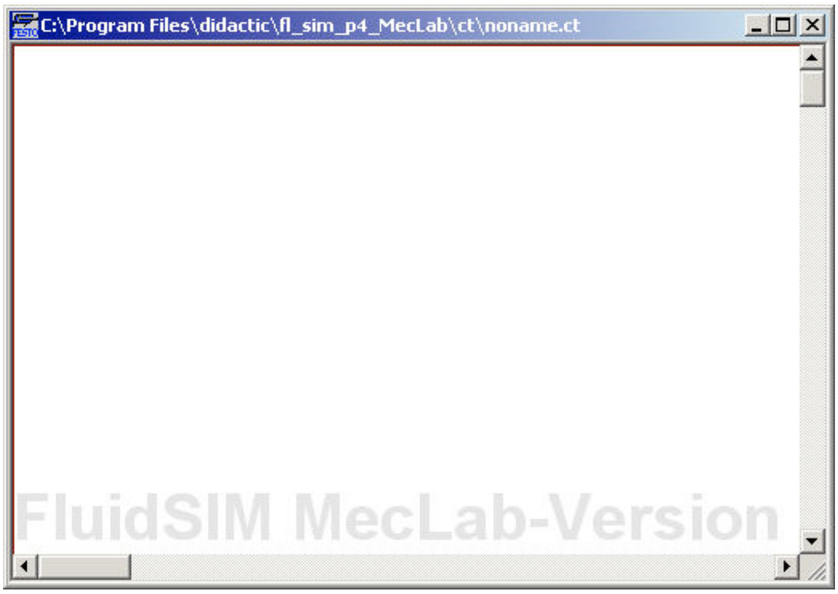
Extend the circuit so that a double-acting cylinder retracts and advances instead of the lamp lighting up.



Problem description 3

Many sequences in automation technology are characterised by one process step having to take place after another. Sensors check whether one step has been successfully completed before the next step starts. This is referred to as sequencing. There is a special programming technique available for user-friendly sequencing.
A simple sequence is to be programmed that lifts a workpiece in the handling station from the holder using the vertically arranged cylinder. The workpiece should then be released again when a pushbutton is actuated.

Task 3

Create a schematic diagram of the setup as well as an allocation list that shows which electrical components are plugged into which slots on the multi-pin plug distributor. Also create the pneumatic and electrical circuit diagrams in FluidSIM (using the logic module, still without a program).

Describe in detail the sequence outlined in the problem description. Use the prepared form on the worksheet.

Open the logic module in FluidSIM by clicking on it with the mouse and create the program to accomplish the sequence described in previous Exercise 3. Test the program via simulation.

Test the program using the handling station. Ensure that the wiring and the tubing correspond to the circuit diagram and assignment list.

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Create a schematic diagram of the setup as well as an allocation list that shows which electrical components are plugged into which slots on the multi-pin plug distributor. Also create the pneumatic and electrical circuit diagrams in FluidSIM (using the logic module, still without a program).

Schematic diagram

Slot	Designation	Explanation
4		
6		
5		
7		

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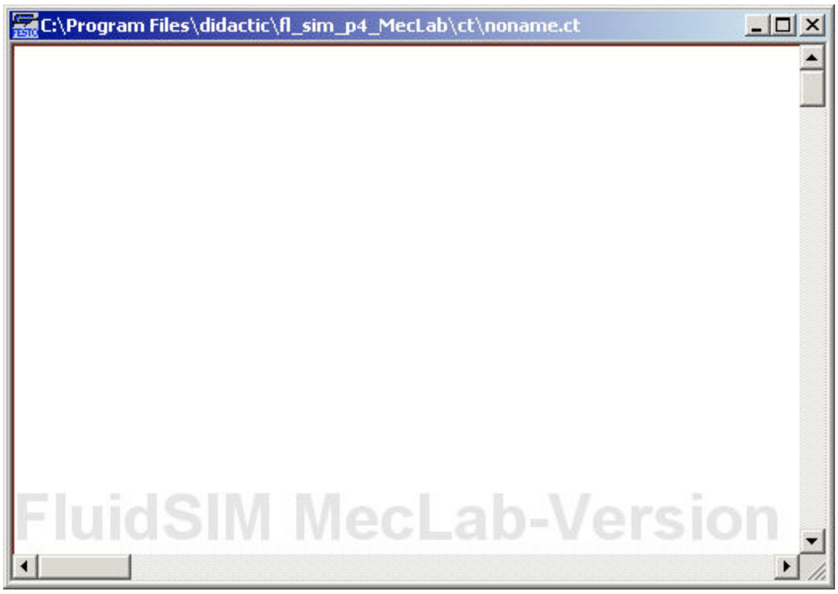
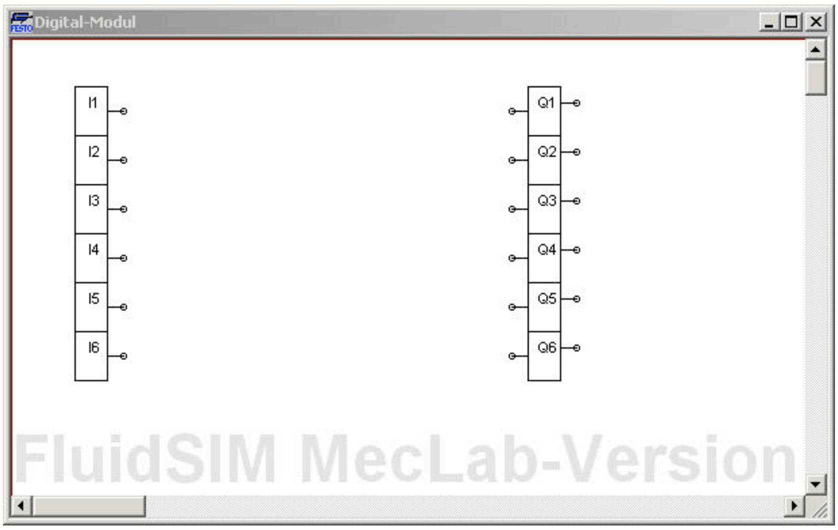


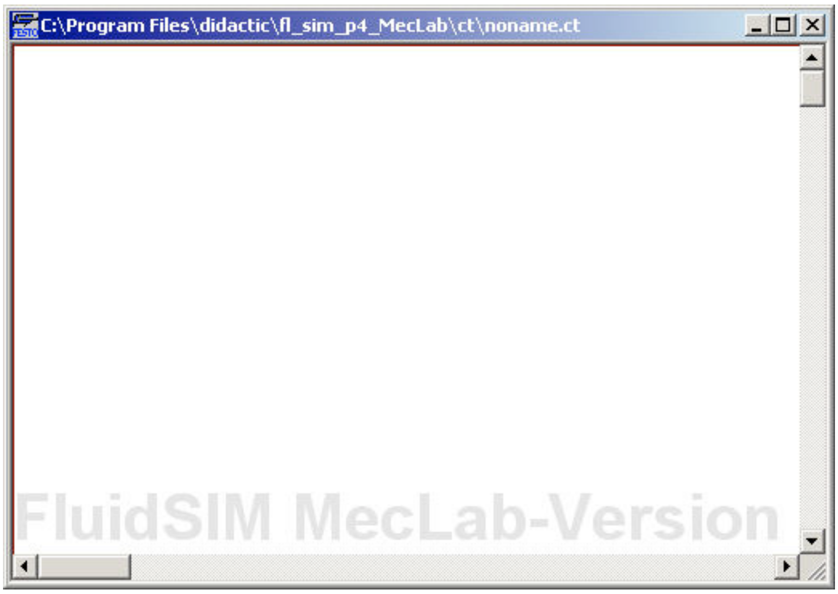
Describe in detail the sequence outlined in the problem description. Use the prepared form on the worksheet.

Step	Action	Output	Condition
0			
1			
2			
3			

Open the logic module in FluidSIM by clicking on it with the mouse and create the program to accomplish the sequence described in Exercise 3. Test the program via simulation.



Test the program using the handling station. Ensure that the wiring and the tubing correspond to the circuit diagram and allocation list.



Problem description 4

Handling tasks are frequently encountered in production. Not all of these tasks require industrial robots;
so-called 2-axis handling systems are used for simple motion sequences. Handling scenarios where a workpiece is moved from one location to another are frequently called pick and place tasks. Examples of these include

- retrieving a workpiece from a conveyor
- placing one workpiece in another (assembly)
- placing a workpiece in packaging
- this exercise deals with a pick and place task using the handling station.

Task 4

Create a schematic diagram, an allocation list and an electropneumatic circuit diagram for the handling station. The logic module is to serve as the controller.

The handling system is to move a workpiece from the rear tray to the front tray. Describe this sequence in detail. Use the prepared worksheet. Specify which input and output signals have to be received and transmitted. The program should start when a pushbutton is pressed.

Open the logic module in FluidSIM by clicking on it with the mouse and create the program to accomplish the sequence. Test the program via simulation.

Test the program using the handling station. Ensure that the wiring and the tubing correspond to the circuit diagram and allocation list. Adjust the holders so the gripper can securely grip the workpiece.

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Create a schematic diagram, an allocation list and an electropneumatic circuit diagram for the handling station. The logic module is to serve as the controller.

Schematic diagram

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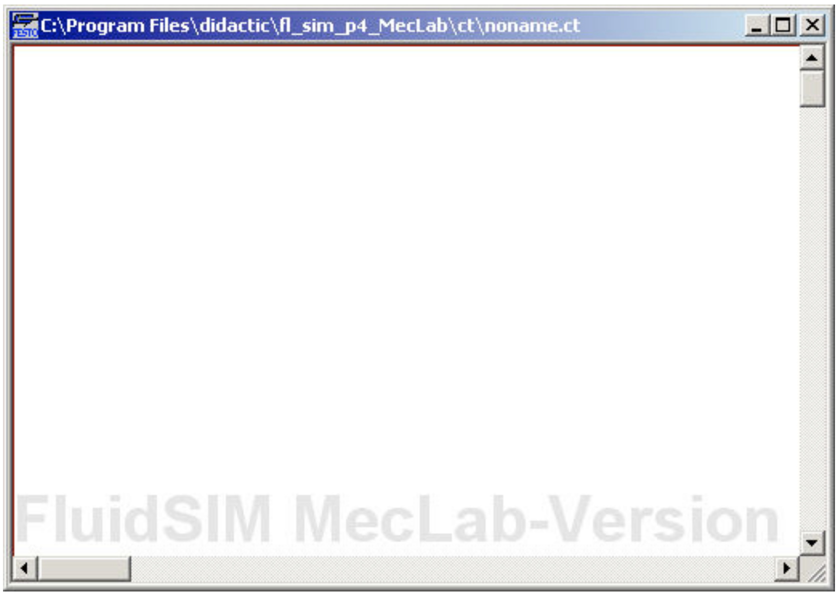
Slot	Designation	Explanation
0		
1		
2		
3		
4		
5		
6		
7		
9		

Allocation list



Electro-pneumatic circuit diagram

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The handling system is to move a workpiece from the rear tray to the front tray. Describe this sequence in detail. Use the prepared worksheet. Specify which input and output signals have to be received and transmitted. The program should start when a pushbutton is pressed.

Step	Action	Output	Condition
1			
2			
3			
4			
5			
6			
7			
8			

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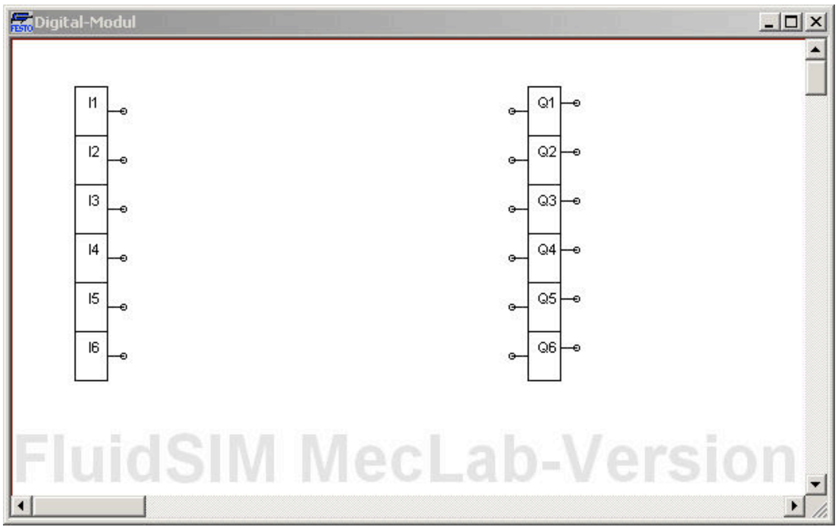
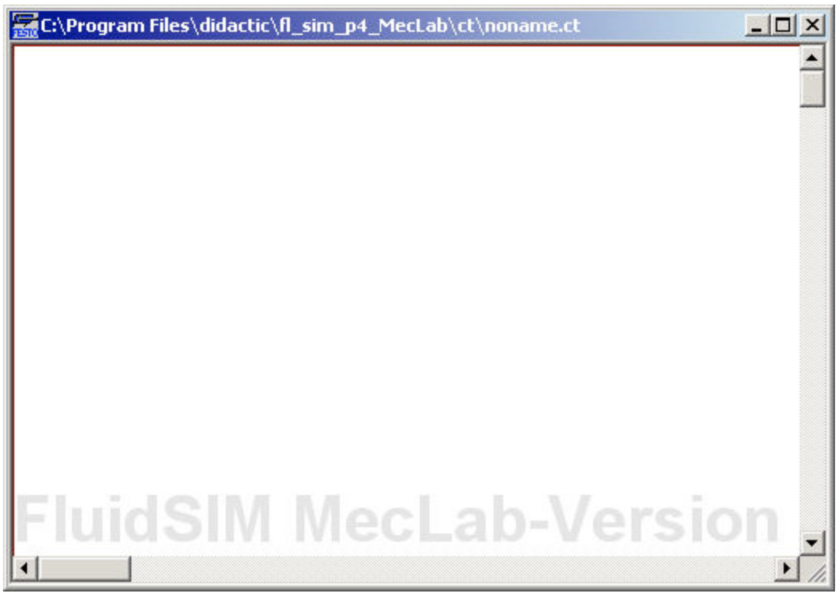
Open the logic module in FluidSIM by clicking on it with the mouse and create the program to accomplish the sequence. Test the program via simulation.



Test the program using the handling station. Ensure that the wiring and the tubing correspond to the circuit diagram and allocation list.



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