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Results of research project Remote laboratories in distance forms of education focused on practical skills of students

Gabriel Bánesz[1], Viera Tomková[2], Danka Lukáčová[3], Ján Širka[4]

Abstract

The project Kega Remote Laboratories in distance forms of education was aimed at creating remote laboratories for students of the expert university department. Pneumatic systems laboratories were used in the education of students within the project. These laboratories are used to train the wiring of simple and more complex pneumatic connections in various tasks. Students were trained both in distance form and in the form of contact hours in seminars. One of the research goals of the project was to find out what skills the students acquired when working with pneumatic systems. The aim of the paper is to present and summarize the results of the students from the assignments that they solved at practical lessons. These were the basic connections of pneumatic circuits. The paper presents the achieved results from the solved tasks. To evaluate the results, a qualitative method of evaluating individual assignments based on observations was used.

Keywords:	*Schlüsselwörter:*
distance education	Fernstudium
self-study)	Selbststudium
study material)	Studienmaterial
e-learning	e-learning

1 Introduction

One of the goals of the Kega Remote Laboratories project in distance learning was to design a set of tasks to train basic pneumatic systems using Lucas Nule's electro-pneumatic panel. This electro-pneumatic panel enables to practice basic wiring used in technical practice, to understand the application of the basics of Bool algebra in control systems as well as the principles of PLC systems (Lukáčová – Bánesz, 2017, p. 100). The project solvers therefore arranged a set of tasks with which students could acquire new practical skills and knowledge. (Education portal 2016). Work on individual tasks was preceded by home preparation using an e-learning course, which was created just for this purpose. In practical exercises, the students could then try out the basic types of connections and then solve the tasks more complexly. (Paulsen, 2003)
An electropneumatic panel from Lucas-Nule was used to practice the necessary skills, the electrical part of which is shown in picture 1.

[1] Constantine the Philosopher University in Nitra, Faculty of Education Tr. A. Hlinku 1, Slovakia. *E-mail:* gbanesz@ukf.sk
[2] Constantine the Philosopher University in Nitra, Faculty of Education Tr. A. Hlinku 1, Slovakia. E-mail: vtomkova@ukf.sk
[3] Constantine the Philosopher University in Nitra, Faculty of Education Tr. A. Hlinku 1, Slovakia. E-mail: dlukacova@ukf.sk
[4] Constantine the Philosopher University in Nitra, Faculty of Education Tr. A. Hlinku 1, Slovakia. E-mail: jsirka@ukf.sk

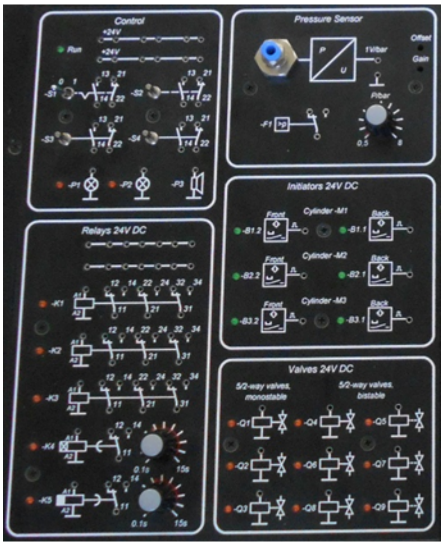

Fig. 1: Electrical part of the pneumatic systems facility (teaching aid) (Lucas – Nule, 2016)

Special attention is paid to its electrical part, through which the pneumatic parts are controlled (power source, functions of switching elements such as cut off switches, change-over switches, electric relay, time-adjustable switching relay etc.). A very important part of the electrical systems are also electrically actuated control pneumatics valves, actuating of which is in the electrical part of the panel board. (Bánesz, 2013)

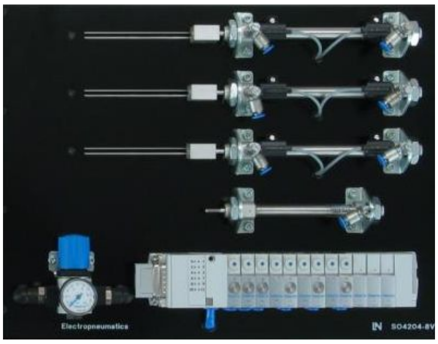

Fig. 2: Pneumatic part of the pneumatic systems facility (teaching aid) (Lucas – Nule, 2016)

The second part of the pneumatic system facility comprises pneumatic components of various mechanisms, which may be connected according to given assignments. It relates mainly to a valve block, which comprises 5/2 monostable valves and 5/2 bistable (flip flop) valves, one single-acting cylinder and three double-acting cylinders. Connecting of these pneumatic components is carried out by means of tubes, through which compressed air is supplied.
The aim of the paper is to present the results of students' work, connecting more complex wirings. It was the connection of the electric control of the pneumatic parts and the connection of the pneumatic parts so that they work according to the assignment. (Klement at all, 2012)

2 Characteristics of the assignment

Students were solving the following task:
The door to the room is controlled by a pneumatic single acting cylinder using two switches. Set up the wiring for the electrical controls and the wiring of the pneumatic parts so that the door can be opened with two pushbuttons (control from both sides of the door) and the door will be opened for five seconds.

2.1 Methodology of evaluation

The time for elaboration was set to 20 min. During this time the students solved the assignment based on their own judgment, or they suggested the wiring of the electrical part without the circuit diagram. If they had not been able to solve the assignment by this time, they were given an additional 20 minutes to solve the problem, and they were also provided with a wiring diagram for the electrical controls. They did not receive the scheme for pneumatic wiring.
They were monitored during each time period and the results of their solution were recorded in the observation sheet. Partial solutions and the final wiring was also recorded in the photographs. The task was solved by two independent groups: the first group of three students and the second group of four students. (Gillet et all, 2002)

2.2 Results and evaluation of solutions

The correct electrical wiring diagram is shown in the picture 3.

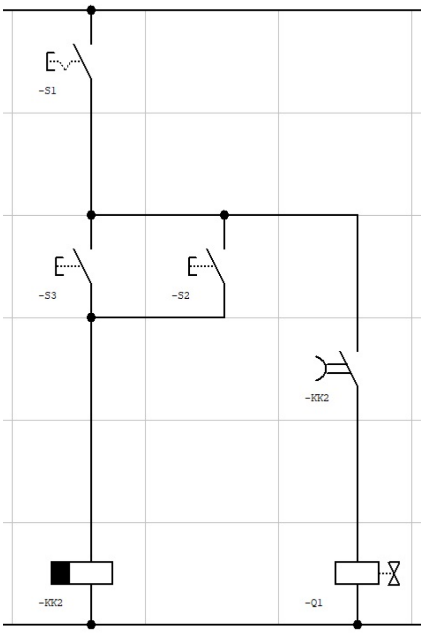

Fig. 3: Electrical wiring diagram (Lucas – Nule, 2016)

In the electrical part of the control is used one main switch of the whole circuit S1 and pushbutton switches S2 and S3 for opening and closing the door. The time 5 seconds at which the door is to be opened is set by the timer relay KK2, which switches the KK2 switch to switch on the 5/2 (5/2 five-way and two-position) monostable valve.
The wiring shown in the picture 4 was used for the pneumatic part of the circuit.

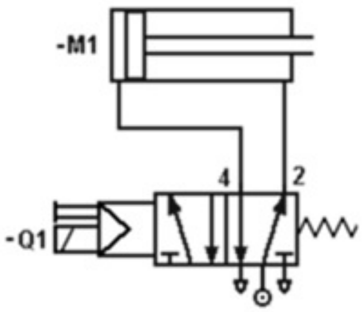

Fig. 4: Diagram of pneumatic part of the circuit (Lucas – Nule, 2016)

The pneumatic part of the circuit consists of a 5/2 monostable electrically operated valve. From the valve outlets 2 and 4, hoses are connected to the double-acting cylinder M1, which opens and closes the door.

2.3 Solution of the first group

At the beginning of the solution the students considered connecting the electric circuit from the 24 V power supply and also connected the main switch S1. Then switches S2 and S3 were connected in parallel in the wiring. Along with the electrical circuits, the group correctly connected the pneumatic part of the circuit, but also considered using a 5/2 bistable control valve. Since the task was set to open the door for 5 s, they began to consider using the KK2 timing relay in the electrical connection. After ten minutes of solution the wiring worked only partially, the doors could only be operated from one side.
Then they resolved the task by using a monostable valve in the pneumatic part 5/2. In the case of electrical control, they used a wiring with a timing relay, but within a set time of 20 minutes they could not solve the task. After receiving the wiring diagram within 5 minutes, the assignment was resolved. The correct connection is shown in the Picture 5.

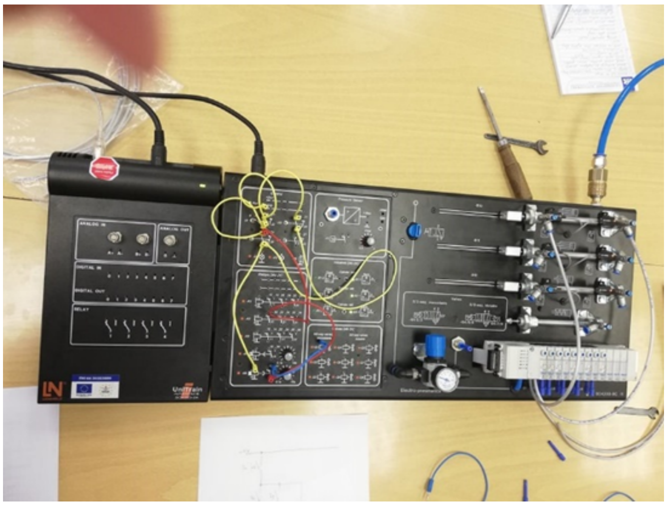

Fig. 5: Circuit connection of students from the first group

2.4 Solution of the second group

This group suggested the first solution to use a time relay to switch the door opening using a 5/2 bistable valve. They snapped the wrong 5/2 bistable valve incorrectly because its left side was incorrectly connected. (The solution could be realized also with this type of valve.) It was necessary to use valve actuators Q4 and Q5 for correct connection. These students even considered using two-way valve limit switches, but the wiring wasn't working. For this reason, the whole wiring was taken apart. At the end of the first 20-minute period, they focused on the use of a 5/2 monostable valve which was incorrectly wired. They did not find a solution within the set time of 20 minutes for the task.

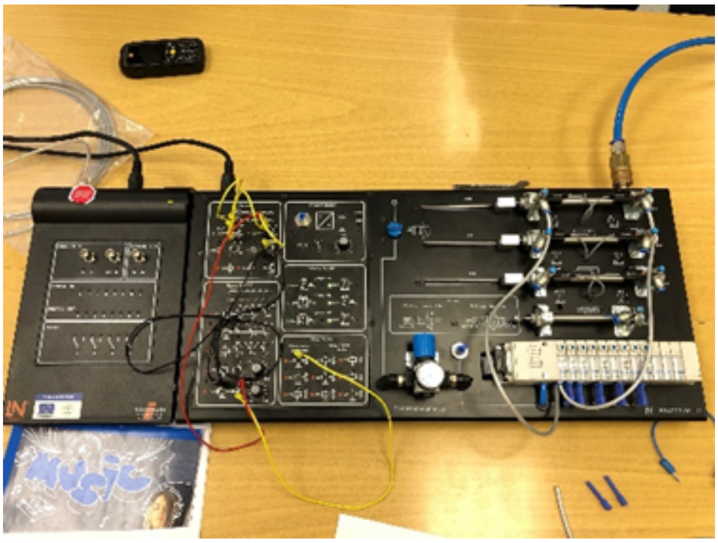

Fig. 6 Circuit connection of students from the second group

After receiving and reading the diagram, they were convinced that a 5/2 monostable valve was sufficient for proper operation. Within five minutes they correctly applied the electrical wiring diagram in the electro-pneumatic panel and the door control functioned according to the task.

2.5 Evaluation of experimental teaching

Strengths of solution:
- Students were able to partially use the theoretical knowledge gained from electronic courses.
- Students could distinguish between 5/2 monostable and bistable valve functionality.
- Students understood the principle of timing relay operation.
- Students were able to apply the schematic to the circuit wiring.

Weaknesses of solutions:
- Students could not apply the results obtained in new situations - non-specific transfer.
- Despite several solutions within the team, they could not solve the given task without a wiring diagram.

3 Conclusion

Presented results show following findings. Students in their theoretical home preparation, using an e-learning course acquired relatively good knowledge, which they tried to apply in practice. The preparation took place within a week, giving them the opportunity to acquire basic knowledge of the physical principles of the tire, the basic connections used to engage monostable and bistable valves, as well as sufficient knowledge of the schematic marks used in the tire.
In solving the task, the students lacked a methodical approach to solving the task, for example to apply the knowledge of Boolean algebra. When wiring, they often used a trial-and-error system to find the right solution.
Although the content of the course offers basic types of wiring of electro-pneumatic circuits, they could not apply their knowledge in a new situation (non-specific transfer).
When solving a task using an electrical diagram, they no longer had a serious problem connecting the correct circuits as required by the assignment.
This way of preparing students using e-learning has proved to be effective and we believe that it is necessary to supplement the course with a methodology of solving technical tasks so that students can better apply their theoretical knowledge in practice. (Bánesz et all, 2017)

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