Scenario title

Digital visualization for understand the principles of operating mechatronic systems.

Target audience

VET teachers working in the field of mechatronics

Problem to solve - Learning Situation

VET teachers in mechatronic face the situations when the VET students at the beginning of the course struggle in understanding the principles of functioning and operating of the mechatronic system. In seeking to solve this problem it is recommended to apply simulators, microcontrollers and electro-pneumatical control equipment with visualization of the control process.

Overview of scenario

EQF levels 3 and 4

This VET teacher training scenario deals with the didactic problem of how to fill in the gaps of VET students abilities and skills to understand the principles of functioning and operating of the mechatronic system.

Competencies covered from DigCompEdu

Innovating digital strategies for active learning.

Target level of Digital Skills according to DigCompEdu progression levels

02	**Digital resources**		
	2.2 Creating and modifying digital resources	To modify and build on existing openly-licensed resources and other resources where this is permitted. To create or cocreate new digital educational resources. To consider the specific learning objective, context, pedagogical approach, and learner group, when designing digital resources and planning their use.	
	C1 Leader	Creating, co-creating and modifying resources according to the learning context, using a range of advanced strategies.	*I create and modify digital resources and activities adapted to the learning context and the group of trainees, using innovative strategies such as online assessment*

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			sheets, online surveys, thematic games, collaborative platforms.
			I use tools like h5p, Padlet, Mentimeter, Kahoot, and others to create interactive activities for my graduates.

03	**Teaching and Learning**

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	3.1 Teaching	To plan for and implement digital devices and resources in the teaching process, so as to enhance the effectiveness of teaching interventions. To appropriately manage and orchestrate digital teaching interventions. To experiment with and develop new formats and pedagogical methods for instruction.	
	B1 Integrator	Integrating available digital technologies meaningfully into the teaching process	*I can integrate the use of several different digital technologies and tools in the theoretical lesson and in supporting the independent learning of students.*
			I can integrate several different digital technologies and tools in practical training

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			and work based-learning environments.
	3.3 Collaborative Learning	To use digital technologies to foster and enhance learner collaboration. To enable learners to use digital technologies as part of collaborative assignments, as a means of enhancing communication, collaboration and collaborative knowledge creation.	
	B2 Expert	Using digital environments to support collaborative learning	*I can use online (Internet) learning environments to support collaborative learning of the VET students in the classrooms.*

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			I can apply digital environments used for the collaboration and communication in the work processes for the purposes of collaborative learning.

05	**Empowering Learners**

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	5.3 Actively engaging learners	To use digital technologies to foster learners' active and creative engagement with a subject matter. To use digital technologies within pedagogic strategies that foster learners' transversal skills, deep thinking and creative expression. To open up learning to new, real-world contexts, which involve learners themselves in hands-on activities, scientific investigation or complex problem solving, or in other ways increase learners' active involvement in complex subject matters.	
	B2 Expert	Using digital technologies for learners' active engagement with the subject matter.	*I can explain and demonstrate to VET students and apprentices the advantages of using digital technologies for the active and effective acquisition of vocational knowledge, skills and transversal skills in the*

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			classrooms and practical training environments.
			I can initiate and implement the training projects which involve using of digital technologies for the active engagement of the VET students and apprentices in the acquisition of vocational knowledge, skills and competence.
	C2 Pioneer	Innovating digital strategies for active learning.	*I can design the new methodical-organizational approach of active learning for the VET students and apprentices based on the*

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			application of digital technologies.
			I can develop new technological solutions of digital applications for the active learning for the VET students and apprentices.

Curriculum Construct(s)

According to Revised Bloom's Taxonomy (Anderson and Krathwohl, 2001)

https://www.researchgate.net/publication/264675976_Transitioning_from_Teaching_Lean_Tools_To_Teaching_Lean_Transformation/figures?lo=1

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Level	Description	Coverage
Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing	FL
Evaluating	Making judgments based on criteria and standards through checking and	FL
Analyzing	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through	FL
Applying	Carrying out or using a procedure through executing or implementing	LP

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Understanding	Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining	LP
Remembering	Retrieving, recognizing, and recalling relevant knowledge from long-term memory	LP
LP = Learning Prerequisites, FL = Focus of the Learning Scenario		
Source: Anderson & Krathwohl (2001)		

Scenario description

Drawing and design of electrical control circuits, control systems and other elements of mechatronic and electronic systems is important part of training in the VET programmes of mechatronics and electronics. Here VET teachers often face the problem of the lack of basic knowledge and skills of VET students in dealing with these tasks. Traditional training methods,

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like lectures, learning from the books and other written resources, are not sufficiently effective and attractive for the students. Here the approach of work-based learning with usage of digital resources can provide optimal solution. This scenario will help VET teachers and trainers in developing the design skills of students by applying:

- task analysis and development of possible algorithm for the operation of the circuit;
- autonomous designing an electrical control circuit by working in teams;
- design of an electronic control system using a microcontroller.

Scenario Objectives

This scenario seeks to develop the subject and methodological competences of vocational teachers needed to teach the design of compact automated plant control systems.

Requirements

Teaching/learning infrastructure and technology: equipped mechatronics laboratory with computers, CAD-CAM or equivalent software, platforms for programming/controlling the microcontroller and monitoring its processes, simulators Festo FluidSIM Pneumatics, CADeSIMU or equivalent.

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Outline plan

Activity	Analysis of the electropneumatic diagram
Timing	3 hours
Methods	Lecturing, presentations, questions-answers, execution of independent/group tasks.
What the tutor is doing	The tutor discusses with the teachers the training strategy on how to explain to the students the basic principles of control and operation of electro-pneumatic and electronic systems.
What the learners are doing	The VET teacher explains the basic principles of control and operation of electro-pneumatic and electronic systems and demonstrates the

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	operation of the systems. He/she analyses with the students different examples of the operation and application of such systems. The students observe the demonstration, ask questions and then start executing the task presented to them. They analyse the electro-pneumatic diagram given in the task, provide written or oral information on the devices shown in the diagram, their purpose and function, and a brief description of the operation of each device.
Equipment and Support	Mechatronics laboratory equipped with computers, CAD-CAM or equivalent software, Festo FluidSIM Pneumatics, CADeSIMU or equivalent simulators, drawings.
Reference to DigCompEdu	02 Digital resources - 2.2 Creating and modifying digital resources 03 Teaching and Learning - 3.1 Teaching

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	03 Teaching and Learning - 3.1 Collaborative Learning 05 Empowering Learners - 5.3 Actively engaging learners
Assessment of/for learning	Observation of the teaching process and communication between the VET teachers and students.
Resources/links/relevant content/Examples	Examples of the electropneumatic diagrams in the printed or digitalized format.

Activity	Independent design of electrical circuits with a simulator
Timing	3 hours
Methods	Demonstration, independent execution of tasks

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What the tutor is doing	Discusses with the teacher the execution of training activity and observes the process of training.
What the learners are doing	The teacher demonstrates the necessary functions of the simulator. The students independently (with the teacher's help/advice if necessary) design the principle electrical control circuit and check its operation in the simulator.
Equipment and Support	Mechatronics laboratory equipped with computers, CAD-CAM or equivalent software, Festo FluidSIM Pneumatics, CADeSIMU or equivalent simulators.
Reference to DigCompEdu	03 Teaching and Learning - 3.1 Teaching 03 Teaching and Learning - 3.1 Collaborative Learning 05 Empowering Learners - 5.3 Actively engaging learners

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Assessment of/for learning	Methods used to assess learning outcomes: - Theoretical testing of knowledge. The assessment of knowledge is based on the assessment of knowledge. - Practical test of knowledge. Computer aided design of the drawing provided and printing of the model.
Resources/links/relevant content/Examples	Tutorials of CAD-CAM and applied simulators.

Activity	Coding of microcontroller and testing the code.
Timing	4 hours
Methods	Demonstration, independent execution of tasks
What the tutor is doing	Discusses with the teacher the execution of training activity and observes the process of training.

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What the learners are doing	The VET teacher explains and demonstrates how to link the microcontroller to the computer, demonstrating the operation of the program, coding and loading the program code into the microcontroller. The students program the system in LD programming language based on the electrical control schematic they have designed.
Equipment and Support	A mechatronics laboratory equipped with computers, CAD-CAM or equivalent software, programming software with LD programming language, microcontroller.
Reference to DigCompEdu	02 Digital resources - 2.2 Creating and modifying digital resources 03 Teaching and Learning - 3.1 Teaching 03 Teaching and Learning - 3.1 Collaborative Learning

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	05 Empowering Learners - 5.3 Actively engaging learners
Assessment of/for learning	Methods used to assess learning outcomes: - Cumulative. Cumulative grading is a convenient way to motivate students by monitoring and recording their motivation, initiative and progress, as well as their independent learning. Cumulative assessment is used throughout the process. - Formal assessment can be used to assess the results achieved. Formal assessment is used at the end of each of the following three stages (one mark for the first two activities and a second mark for the third activity): a mark for describing and testing the operation of the scheme in the simulator and a mark for constructing and testing the real scheme.
Resources/links/relevant content/Examples	Tutorials of CAD-CAM and applied simulators.

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Our notes from practice

The learning scenario consists of three parts (activities):

1 - Task analysis, in which students analyse the devices used in the circuit, learn about the design requirements and develop a possible algorithm for the operation of the circuit.

2 - Designing an electrical control circuit. After familiarising themselves with the requirements of the task, the students design an electrical control circuit (creating a sequence of operation (algorithm) for the devices to be triggered), create the principle electrical control circuit and check its operation using a simulator.

One of the students is responsible for designing the algorithm and the other is responsible for designing the control scheme.

3 - Design of an electronic control system using a microcontroller. One of the students programs the microcontroller (generates the code and loads it into the microcontroller's memory) based on the electrical control scheme designed by the other student and the similarity between the LD language and the principle electrical scheme.

Assessment: students are assessed on their independent work or part of their work according to criteria set by the teacher. The algorithm must be designed to be executed in a consistent and logical manner. The electrical control scheme designed and tested in the simulator must be operational and constructed using a minimum number of components.

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The program code shall be verified and tested.

This scenario encourages students to think analytically, solve problems, communicate and cooperate (students can consult with each other and solve the problems related to the tasks together).

Below there is illustrated an example of the task (Figure 1), an example of the design of the electrical part (Figure 2) and an actual schematic and code element (Figure 3)

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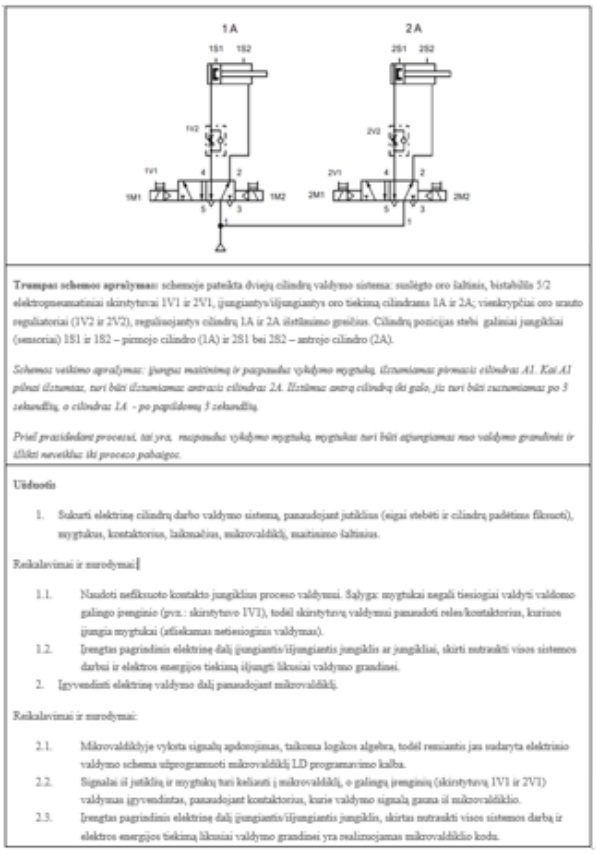

Trumpas schemos aprašymas: schemoje pateikta dviejų cilindrų valdymo sistema: suslėgto oro šaltinis, bistabilūs 5/2 elektropneumatiniai skirstytuvai 1V1 ir 2V1, įjungiantys/išjungiantys oro tiekimą cilindrams 1A ir 2A; vienkrypčiai oro srauto reguliatoriai (1V2 ir 2V2), reguliuojantys cilindrų 1A ir 2A išstūmimo greičius. Cilindrų padėtis stebi galiniai jungikliai (sensoriai) 1S1 ir 1S2 – pirmojo cilindro (1A) ir 2S1 bei 2S2 – antrojo cilindro (2A).

Schemos veikimo aprašymas: įjungus maitinimą ir paspaudus valdymo mygtuką, išstumiamas pirmasis cilindras A1. Kai A1 pilnai išstumtas, turi būti išstumiamas antrasis cilindras 2A. Išstūmus antrą cilindrą iki galo, jis turi būti sugrąžinamas po 3 sekundžių, o cilindras 1A - po papildomų 3 sekundžių.

Prieš pradedant procesą, tai yra, paspaudus valdymo mygtuką, mygtukas turi būti atjungiamas nuo valdymo grandinės ir išlikti nevaikšlus iki proceso pabaigos.

Užduotis

1. Sukurti elektrinę cilindrų darbo valdymo sistemą, panaudojant jutiklius (sigai stebėti ir cilindrų padėtims fiksuoti), mygtukus, kontaktorius, šalkmačius, mikrovaldiklį, maitinimo šaltinius.

Reikalavimai ir nurodymai:

1.1. Naudoti nefiksuoto kontakto jungiklius proceso valdymui. Sąlyga: mygtukai negali tiesiogiai valdyti valdomo galingo įrenginio (pvz.: skirstytuvo 1V1), todėl skirstytuvų valdymui panaudoti reles/kontaktorius, kuriuos įjungia mygtukai (atliekamas netiesioginis valdymas).

1.2. Įrengtas pagrindinis elektrinę dalį įjungiantis/išjungiantis jungiklis ar jungikliai, skirti nutraukti visos sistemos darbui ir elektros energijos tiekimą išjungti likusiai valdymo grandinei.

2. Įgyvendinti elektrinę valdymo dalį panaudojant mikrovaldiklį.

Reikalavimai ir nurodymai:

2.1. Mikrovaldiklyje vykdyta signalų apdorojimas, taikoma logikos algebra, todėl remiantis jau sudaryta elektrinio valdymo schema užprogramuoti mikrovaldiklį LD programavimo kalba.

2.2. Signalai iš jutiklių ir mygtukų turi keliauti į mikrovaldiklį, o galingą įrenginį (skirstytuvą 1V1 ir 2V1) valdymas įgyvendintas, panaudojant kontaktorius, kurie valdymo signalą gauna iš mikrovaldiklio.

2.3. Įrengtas pagrindinis elektrinę dalį įjungiantis/išjungiantis jungiklis, skirtas nutraukti visos sistemos darbą ir elektros energijos tiekimą likusiai valdymo grandinei yra realizuojamas mikrovaldiklio kodu.

Figure 1. Example of a task

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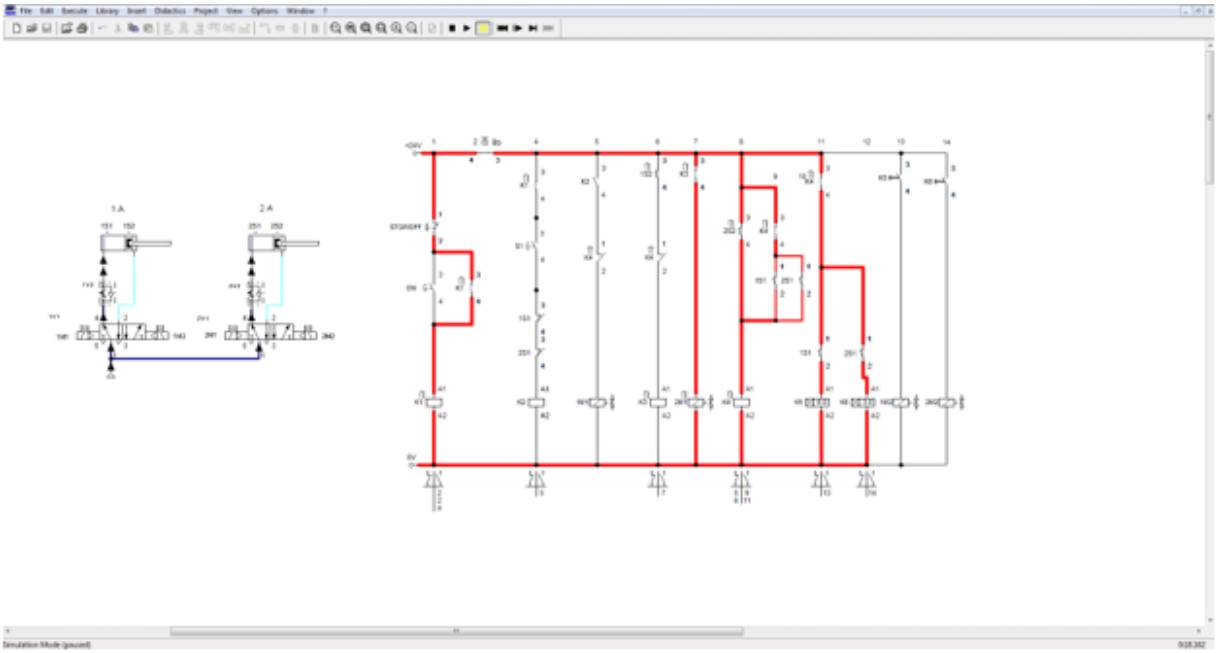

Figure 2. Example of the electric scheme design

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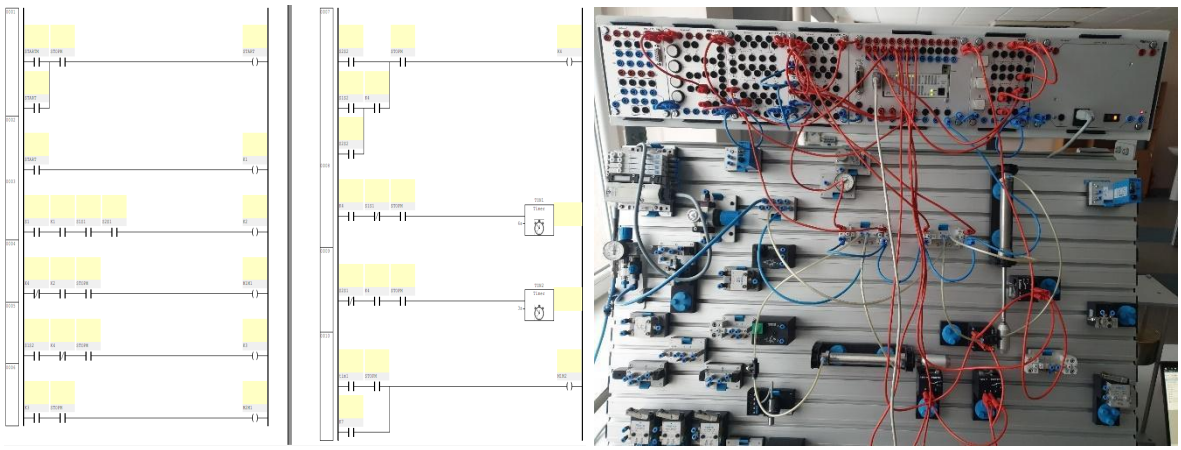

Figure 3. Fragment of code (left side) and the view of a real control system (right side)

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