DOI: https://doi.org/10.26552/tech.C.2023.2.20

Programmable model of an automated warehouse

Vladimíra Biňasová, Ing., PhD., DiS.*
Department of Industrial Engineering, Faculty of Mechanical Engineering,
University of Žilina,
Univerzitná 1, 010 26 Žilina, Slovak Republic.
E-mail: vladimira.binasova@fstroj.uniza.sk, Tel.: + 421 41 513 2727

Peter Bubeník, doc. Ing., PhD.
Department of Industrial Engineering, Faculty of Mechanical Engineering,
University of Žilina,
Univerzitná 1, 010 26 Žilina, Slovak Republic.
E-mail: peter,bubenik@fstroj.uniza.sk, Tel.: +421 41 513 2719

Miroslav Rakyta, doc. Ing., PhD.
Department of Industrial Engineering, Faculty of Mechanical Engineering,
University of Žilina,
Univerzitná 1, 010 26 Žilina, Slovak Republic.
E-mail: miroslav.rakyta@fstroj.uniza.sk, Tel.: +421 41 513 2737

Marta Kasajová, Ing., PhD.
Department of Industrial Engineering, Faculty of Mechanical Engineering,
University of Žilina,
Univerzitná 1, 010 26 Žilina, Slovak Republic.
E-mail: marta.kasajova@fstroj.uniza.sk, Tel.: +421 41 513 2707

Katarína Štaffenová, Ing.
Department of Industrial Engineering, Faculty of Mechanical Engineering,
University of Žilina,
Univerzitná 1, 010 26 Žilina, Slovak Republic.
E-mail: katarína.staffenova@fstroj.uniza.sk, Tel.: +421 41 513 2740

Abstract: The paper deals with the multifunctional kit is a robust training model that simulates and demonstrates warehouse automation in the world's most advanced enterprises. Programming takes place in the *Siemens TIA Portal* software, which is then loaded into a *Programmable Logic Automator* which is interconnected with the source *Siemens SITOP PSU*100*S*. The main objective of the paper was to provide an overview of the current state-of-the-art in automated manufacturing and to create an example of an automated warehouse that can be used in teaching as an ideal simulation and demonstration model for training and industrial automation.

Keywords: transport station, programmable model, *PLC Simatic S*7-1200.

INTRODUCTION

The main objective of this paper was to provide an overview of the current state of the art in automated manufacturing and to create an example of an automated warehouse that can be used in *Department of Industrial Engineering* training, simulation and demonstration model for training and industrial automation. The automated warehouse model example offers the opportunity to continue developing and extending the model and creating an experimental manufacturing system in a selected laboratory at the *Department of Industrial Engineering, Faculty of Mechanical Engineering*, at *University of Zilina*.

The vision of *Industry* 4.0 [1-2] is to achieve a highly automated and autonomous manufacturing environment in which decision-making processes are provided by a variety of technologies that rely on the collection and subsequent analysis of input data performed in real time. Newly explored technologies can often transform entire industries. The expansion of the engineering industry increasingly requires the use of state-of-the-art technologies in the field of production in order to achieve significant labour productivity and optimisation of the production in question. At the same time, with the increase in higher demands on the products or services produced, there is a need to speed up the production process as much as possible, but at a cost, that maximises the quality of the product. This is why automation is also being used. [3]

The efficiency of production is constantly conditioned by the work of pre-production components (construction, technology, design). [4] The role of the engineer is to analyse the already used, but also newly created working procedures [5-6], to discover the best method to perform the work (optimal working method). The best working method is generally considered to be is considered to be the one in which the cost of performance is minimised as much as possible [7-8]. An effort is to make each work operation as short and simple as possible, so that it can be more easily learnt and at the same time require a minimum of human effort to perform.

1 METHODS

As an example, a *Programmable Automated Warehouse Model* was created (Fig. 1). This multifunctional kit from *Fischertechnik* [9] is a complete, stable training model that is used to simulate and demonstrate warehouse automation in the world's most advanced companies. A transfer/transport station with conveyor belt, a shelf stacker (3-axis robot) for stacking and retrieving special workpiece carriers, storage rack with nine storage slots.

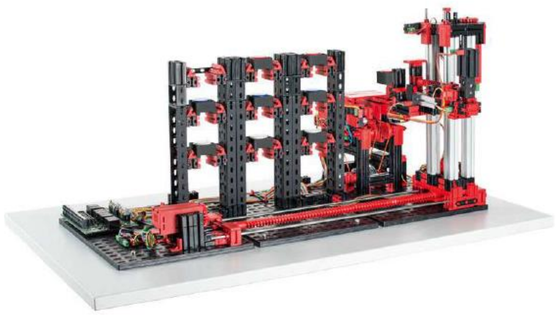

Fig. 1. Transport station with conveyor belt

The procedure for running the automated model:

- acquisition of the kit and subsequent repair of components that have been damaged repairing the components damaged during transport,
- installing the *Siemens TIA Portal* software to verify the functionality individual components,
- connecting the power supply to the network,
- connect the commissioned power supply to the *PLC*,
- interconnect the *PLC* to the kit, via the circuit board with the change relay direction of rotation of the motors,
- checking the wiring and subsequent rewiring to make the individual components work correctly,
- familiarization with the programming language, the individual parts of the block programming,
- programming a particular part of the model, using individual inputs and outputs,
- loading a given program into a *Programmable Logic Automata*,
- subsequently running the program and monitoring the individual components in motion,
- redesign/Improvement of programmed block,
- printed circuit board with relay,
- connecting the *PLC* to the kit and the power supply.

In order to be able to work with the automated warehouse model further it is it is necessary to connect it with a *PLC Programmable logic controller* (*Programmable logic automation*) + *Siemens SITOP PSU*100*S* 24 V/5 A power supply for mounting rail (*DIN* rail) 24 V/DC 5 A 120 W.

A programmable logic controller or *PLC* can be described as a relatively small industrial computer used to control a variety of industrial processes. The control takes place in real time. A *PLC* is also typical in that the program that controls it is loaded in cycles, unlike everyday computers, *PLCs* are designed to be directly integrated into the manufacturing process and because of this have customized peripherals. Such computers have a standardized construction, according to the *IEC*-1131-(*x*) standard. In terms of design, *PLC*s can be divided into the following groups:

- compact,
- modular.

The compact *PLC* has a fixed and immutable structure that cannot be modified or extended. Everything that the *PLC* needs to function, such as the *CPU* and other input/output peripherals, is combined in one unit.

A modular *PLC* is a *PLC* that can be modified or expanded. Such a design allows almost unlimited modification of the input-output peripherals [6]. The program processed by the *PLC* is mostly subject to the *IEC* 1131-3 standard, which defines programming languages such as:

- *Instruction List IL*,
- *Structured Text ST*,
- *Contact Diagram Language* (*Ladder Diagram LD*),
- *Function Block Diagram* (*FBD*) [10-11].

Connection to *PLC* control: The model has a relay to change the direction of rotation of the motors. All inputs and outputs can be connected to a jack connector (26-pin, 2.54 mm pitch) or to serial terminals with socket clamps.

The *Simatic S*7-1200 *Basic Controller PLC* product is shown in Fig. 2. This product is described as The *Simatic S*7-1200 *Siemens PLC Basic Controller* is a high-performance system with a compact and space-saving design. This *CPU PLC* has 2 integrated analog inputs, 6 integrated digital inputs and 4 integrated digital transistor outputs. It comes with integrated *IO* and communication interfaces to meet the highest industrial requirements. This is also made possible by a range of powerful integrated technology features that make this controller an integral part of a complete automation solution. The controller is at the heart of a new offering for simple but high-precision automation tasks.

It is the ideal choice when it comes to performing automation tasks for a range of applications in the low to medium power range with maximum flexibility and efficiency [12-14].

Thanks to standardized remote control protocols, you can connect the controller directly to your control to your control centre without any programming. The *Siemens SITOP PSU*100*S* 24 V/5 A *DIN* rail mount power supply 24 V/DC 5 A 120 W.

Fig. 2. ***PLC Simatic S*****7-1200**

The *SITOP* smart power supply is one-third smaller but has more power is one of the narrowest *DIN* rail power supplies and has excellent overload behavior. Even high loads can be switched on without problems. Rated outputs of 120% consistently make the power supplies the most reliable of their kind. Numerous certifications facilitate universal and worldwide use as well as use in potentially explosive areas. Overview of benefits:

- rounded power range from 60 to 960 W for universal use,
- compact design from 32.5 to 150 mm wide for small mounting area,
- easy *DIN* rail mounting,
- extra power: 150% of rated power for 5 seconds as reliable protection against,
- overload protection - for trouble-free switching of *DC/DC* converters, motors and loads with high surge currents,
- more power through sustained 120% of rated output up to 45°C,
- large output voltage adjustment range up to 28 V, easily accessible from the front by potentiometer,
- parallel connection to increase power output is possible,
- input voltage 120 V (85 - 132 V) / 230 V (170 - 264 V).

2 RESULTS

SIEMENS TIA Portal (*Totally Integrated Automation*) gives the possibility to write a program for control elements such as *PLCs* but also *HMI* panels, essentially integrating all design processes for automation in 1 software. Historically this has been divided into 2 non-core software but today *TIA Portal* allows programming of *PLCs*, *HMI* panels but also different peripherals. This makes the work easier but mostly saves time and money in the programming stations or different industrial machines.

Programming takes place in the *Siemens TIA Portal* program, as the 1200 series module is used in the work, moreover, the *TIA Portal* is used not only for programming *PLCs*, *HMI* panels but also various other peripherals provided by *Siemens*. Therefore it can be defined in 2 big groups namely *PLC* programming and programming resp. Animation of the *HMI* interface for the user. The *TIA Portal* program has these two groups integrated in one program and hence it makes the job of the programmer easier. Since some projects may involve many inputs, outputs or different variables that may not only be input/output but also in a version processed internally by the *PLC* processor.

PLC programming is carried out in the following way and that is that the programmer has to clarify the subsequent sequence of steps that lead to the solution of the problem and when the next step should occur. Subsequently, the task, i.e. if it is complex and large, has to be divided into smaller subgroups and chronologically these subgroups have to be set up in such a way that they are correct. We can make such a division by assigning all the action members to one group but in principle, the division is a matter of the programmer and his habits.

The program is uploaded to the *PLC* via the *TIAPORTAL program* (*TIA Portal V*17) as follows. It is necessary to select the *PLC* in my case (*PLC*_1 [*CPU* 1214*C DC*/*DC*/*R*ly]), right click and select the option (Download to device) and then (Hardware and software). The next step is to check if the program has been loaded correctly, you need to mark *Go* online in the top bar and check if there are green balls everywhere in the (*Project tree*). This indicates whether the program in the *PLC* matches the program that is currently loaded in *TIAPORTAL*. If the color orange is present, this indicates that the block at which the orange ball is located is different. If the ball happens to be red, an error has occurred, but this condition usually only occurs on the physical *PLC*.

CONCLUSIONS

The work focused on new trends in the field of automated production. Automation nowadays is an essential part of a mature enterprise on an international level. The introduction includes a study dealing with the current state of automation in the world, and then the advantages and disadvantages of automation are mentioned, with the advantages outweighing the disadvantages.

The third chapter provides a graphical representation of the importance of mechanization and automation, followed by an example of automation technology on a programmable model of an automated warehouse, along with the various points of how I went about running the model. The programming is done in the *Siemens TIA Portal* software, which is then uploaded to the Programmable Logic Automat or, which is interconnected with the Siemens *SITOP PSU*100*S* power supply. The main objective of the paper was to provide an overview of the current state of the art in automated manufacturing and to create an example of an automated warehouse that can be used in teaching in the *Department of Industrial Engineering* as a training, simulation and demonstration model for training and industrial automation. The automated warehouse model example offers the opportunity to continue to develop and extend the model and create an experimental manufacturing system in a selected laboratory.

Acknowledgement

This work was supported by the Slovak Research and Development Agency under contract No. APVV-19-0305.

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