Course of Programmable Logic Control (PLC) in Distance Learning

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Abstract

The experience and content of a PLC course developed for distance learning (ODL) is presented. The course aims to introduce the student into the automation world of industrial processes allowing him/her the acquisition of a certain level of PLC programming as well as its internal operation. The background required is: basic knowledge on electricity and computers at user level. A CD-ROM with the theoretical contents, a dossier with written documentation will be delivered to each student. Access to the virtual campus is also facilitated. Each chapter includes a section with practical exercises on its own content. Those exercises that can be self-corrected by the student require the connection to the net.

1 Introduction

The present paper came out at the end of the European Leonardo project entitled *Flexible cell for automated process learning*. At that time, the possibility of connecting of a flexible cell to the web was considered, in order to allow the monitoring of an automatic controlled process from any computer with network connection. At this point, the main goal was to open to the public such automated installations that are not accessible due to their high cost and availability.

The main interest of the on-line course of programmable logic control is that it allows the students interested on the subject to follow the course not necessarily from a classroom, but from anywhere with the only condition of being connected to the web.

The course has been prepared as a basic course addressed to people without any previous knowledge on the subject but that are willing to learn about it. Such people, of both genders, can come from different fields of activity, as employees (continuous education), unemployed (occupational education), handicapped (special education) and so on.

The only educational background needed to be able to follow the course successfully is some basic knowledge on electricity, digital electronics, mechanics, electric engines and some practical technological skills are also required.

The characteristics of the course are that the student that enrolls in the same, alone will have available a connected PC to net. Starting from here he/she will receive a carpet with the guide of the course, a CD with the theoretical contents, the necessary software to be able to publish the PLC programs and the entrance password to the Virtual Campus, where he/she will find, besides the practices to carry out, connections to libraries, companies of the sector, contact with other registered students and also the possibility to consult with the assigned professor-tutor

When the student is prepared to make the practices, he/she publishes them with the PLC software and he/she transmits them to the PLC that will also be connected to net and that in

turn she will have connected the electric and pneumatic actionators, of agreement with the practices proposals, therefore we can assure that the student carries out the same practices that if the course was present in the laboratory, in real time.

The course was divided in four chapters, supplemented with a collection of problems, for self-evaluation. The course was firstly developed in two possibilities: Spanish and English language.

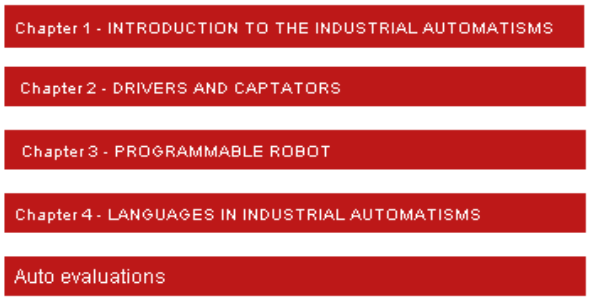
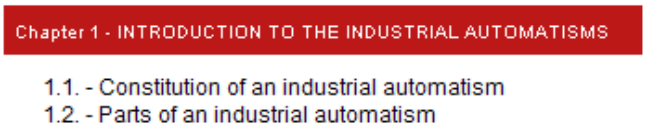


Figure 1. The content of the on-line PLC course.

2 Theoretical content of the CD-ROM

A specific CD-ROM was prepared to assure enough theoretical and practical content to make possible the self-learning on PLC programming.

The first chapter is about the INTRODUCTION TO THE INDUSTRIAL AUTOMATED CONTROL. An example of this chapter is set out bellow.

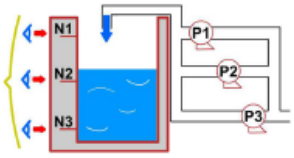


Chapter 1 - Introduction to the industrial automatisms 3/7

1.1 Constitution of an industrial automatism

The three level detectors allow to know the quantity of water contained in the deposit.

The information, given by these sensors, constitutes: THE ACQUISITION OF THESE INPUTS.



The information that will come from the level detectors will be analyzed by an automaton.
It is THE TREATMENT OF THESE INPUTS.

The automaton clarifies the ranges that are send to the DRIVER that transmit the necessary energy for the motor's operation. It's THE CONTROL POWER

Figure 2. The content of Chapter 1, and an example of its appearance

Chapter 2 deals with actuators and sensors.

Chapter 2 - DRIVERS AND CAPTATORS

2.1. - Electric motors
2.2. - Motor driver
2.3. - Pneumatic cylinders
2.4. - Control and driver of pneumatic cylinders
2.5. - Data acquisition
  2.5.1. - Actuators EVERYTHING or ANYTHING
  2.5.2. - Pushers and pilots
  2.5.3. - Relies
  2.5.4. - Logic types
  2.5.5. - Logical functions
  2.5.6. - Useful of analysis
2.6. - Data handling
2.7. - Dialogue man-machine

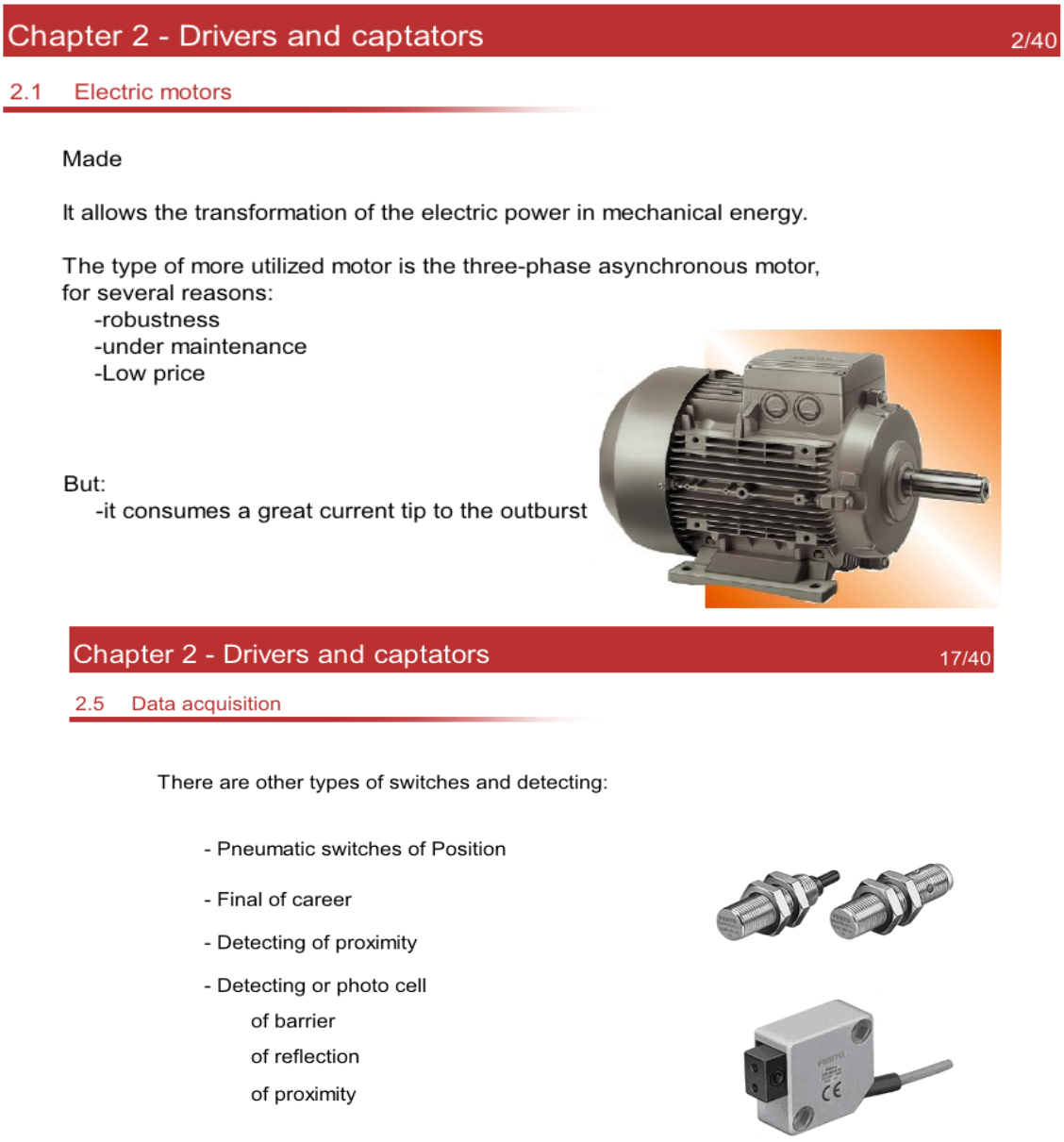


Figure 3. The content of Chapter 2, and two examples of its appearance.

Chapter 3 deals properly with programmable logic control (PLCs) world. Its constitution and internal architecture as well as its election are considered here. This chapter allows to get into a deep knowledge of the PLC hardware architecture and to realise its utilisation possibilities in the heart of an industrial automated system.

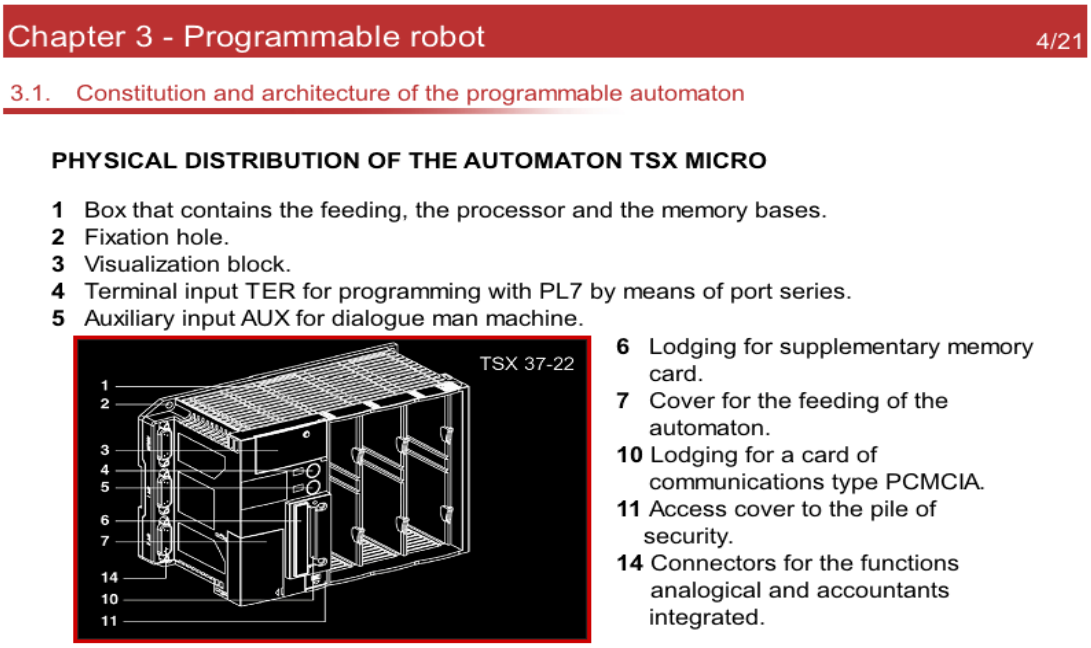


Figure 4. Appearance example of Chapter 3.

Chapter 4 presents the common programming languages used in PLC technologie

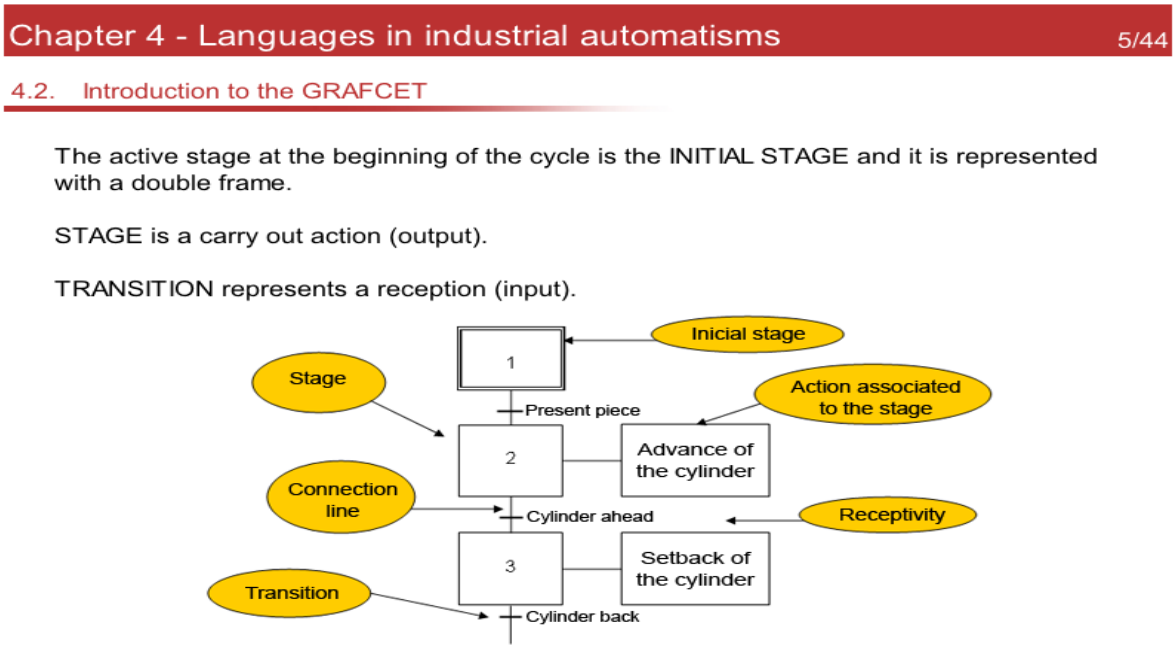


Figure 5. Appearance example of Chapter 4.

Last chapter consist of a series of questions related to the content of the preceding chapters. The objective here is to allow the student for self-check his own degree of assimilation of the theoretical contents of the course.

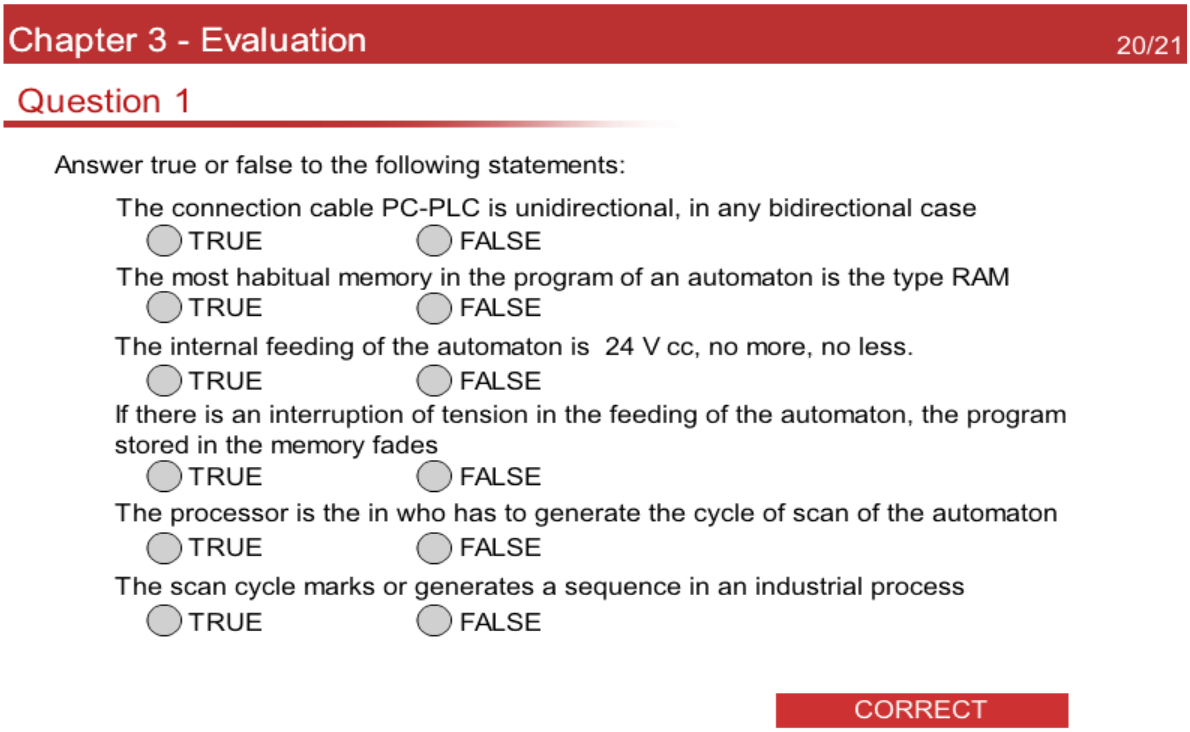


Figure 6. Appearance example of Chapter 5.

3 Creation of a Virtual Campus

The main goal of the work was to create a Virtual Campus. This Campus is understood as an electronic site, which can be accessed by any, previously registered student .

This site will give to the student the following facilities:

- Access to the practical interactive works proposed and the possibility of online correction.
- The PCL program is at disposal of the student so that there is a real online connection with PCL. In the practical work the student not only must elaborate the programs but also check them
- Contacts with other students
- Connections with companies of the sector, libraries, specialised magazines
- Schedule of the course
- Contact with the professor-tutors in order to overcome possible difficulties or solve occasional problems.

4 The proposed practical work

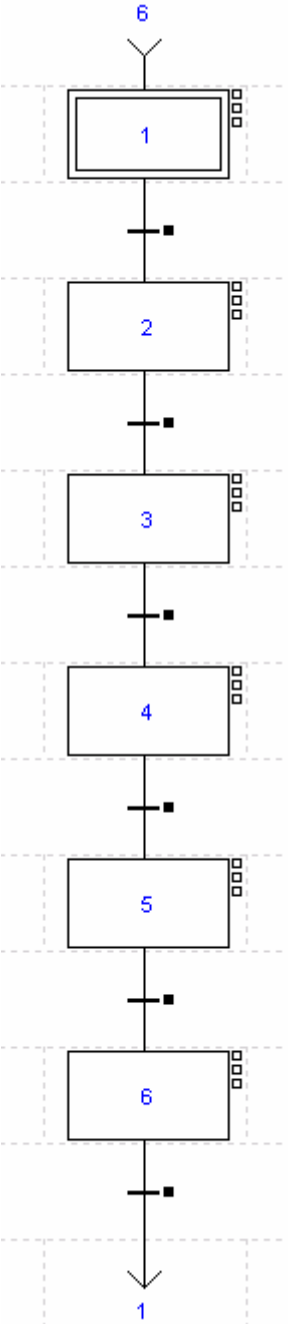
A total of six practical works are proposed. These are: start and stop of a motor, inverting the rotation direction of an asynchronous motor, control the traffic lights of a cross-road, pneumatic sequences and repeated pneumatic sequences. There is a guide for each practical work containing a brief description of the hardware object to be automated. The assignments of the inputs and outputs connected to the PLC are also described there.

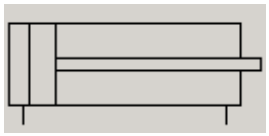
Presenting Grafcet

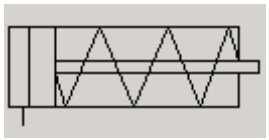
General points The Grafcet language complies with the "Sequence function chart" (SFC) language of the IEC 1131-3 standard.

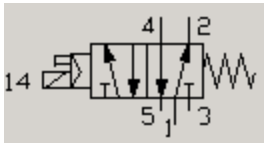
Grafcet is used to represent the operation of a sequential automatic system in a structured and graphic form.

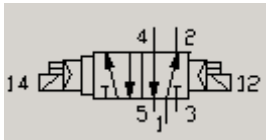
Presentation This graphic description of the sequential behavior of the automatic system and of the various situations that emanate from it is done with the help of simple graphic symbols.











PRACTICAL WORK Nº 1

To realise using GRAFCET the following control sequence of the two double-effect pneumatic cylinders:

(A+, B+, A-, B-)

1.1. Inputs, Outputs and Markers

INPUTS		OUTPUTS		
a_0 =	I 1.1	A+	=	Q 2.1
a_1 =	I 1.2	A-	=	Q 2.2
b_0 =	I 1.3	B+	=	Q 2.3
b_1 =	I 1.4	B-	=	Q 2.4

MARKER "M1" = I 1.7

Figure 7. Example of a practical work (control of pneumatic cylinders).

5 PLC Editor

PL7 Micro/Junior/Pro are programming and debugging tools for TSX Micro and TSX Premium PLCs.

There are three software variants:

- the software suite that is used to install PL7 software,
- the software update suite that is used to update a previous version to a new version (Pl7 Micro V1.0 to P17 Micro V4.3),
- the software upgrade suite that is used to upgrade a previous version to a new version with a higher level of functionality (PL7 Micro V1.0 to P17 Junior V4.3, or PL7 Junior V1.0 to PL7 Pro V4.3).

A PL7 software suite comprises:

- a PL7 software installation CD-ROM,
- a CD-ROM containing the previous version of the TSX37 and TSX57 processor operating systems,
- a TSX07/37/57 PC UNI-TE terminal port cable (reference TSX PCX 1031, not supplied with updates or upgrades),
- an installation and start up guide for PL7,
- a product identification number. A record of this number should be kept because it is needed each time the corresponding software is installed,
- a CD containing documentation in French/English/German/Italian/Spanish

How to perform a first installation of PL7

Introduction The procedure for a first-time installation simply involves installing PL7 without searching for a version already installed on the terminal.

How to install PL7

This procedure describes the different steps for installing the PL7 software.

Enter the product installation code (*) then confirm with **Ok** (a maximum of 3 entry attempts are allowed)

Possibility of modifying information provided by clicking **Previous** common to all installations

Standard Customized

Insert CD-ROM

Open the **Setup.exe** file

Confirm at the welcome screen with **Next**

Choose the software language then confirm with **Next**

Define an installation path then confirm with **Next**

Confirm the information provided by clicking **Next**

Select the components that you wish to install then confirm with **Next**

Define different installation paths then confirm with **Next**

Confirm the information provided by clicking **Next**

Exit the installation program by clicking

Return to Windows

Register your details then confirm with **Next**

Select the type of installation

(*) The installation code is located on the adhesive label on the back of the PL7

6 Monitoring and evaluation

It would be convenient that tutors who are at the same time responsible for traditional courses on the subject would carry out the monitoring of the students work. The process of learning is progressive and sometimes it will be necessary for the student to accomplish several repetitions before he/she gets to make the automat correctly operate. The creation of new hardware application is even possible for the advanced students. The student will be evaluated

through his/her practical works. The student will deliver to the tutor a dossier containing the power schemes, the control schemes, the inputs and outputs assignations.. He/she must also include the elaborated and documented program (software) in order that its philosophy can be analysed. The practical works are essential to obtain the degree.

The students will be asked to fill in a questionnaire and their opinions and suggestions will be taken into account in order to improve the course on its future editions.

7 Future work

- Organize a second level course, including studying of counters, timers, analogue inputs and outputs and other peripherals to which the control could be extended at the level of a flexible cell.
- Extend the knowledge to controllers made by other different producers. The present course was designed for SCHNEIDER PLCs.

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Schneider manual

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