



WORKSHOP
Introduction to PLCs
Energy Solution Centre – Schneider Electric – BMIP – Bethlehem
January, 15th - 19th, 2012

Final Report

Jean DEPREZ

1- Context

- IUT of Cachan – Paris-Sud 11 University has been involved since 1993 in cooperation with Palestinian Universities and Technical Colleges in the field of technology. Since 2004, as a response to the requests of the French Consulate in Jerusalem and to the Palestinian Ministry of Higher Education, the cooperation has dealt with the set up of 5 years programs in "Industrial Automation and Control" and "Electronics for Telecommunications"

- One of the activities of this cooperation, which is now organized under the umbrella of the French Association MedLink, is the organization of workshops, strongly oriented toward practice, gathering together professors and engineers from 7 universities and technical colleges (Al Quds, An Najah, Bir Zeit, Palestine Polytechnic University - PPU, Kadoorie (PTC then PTU), PTC Al Aroub, Hijjawi College). The current situation does not allow instructors from PTC Deir El Balah and Khan Yunis (Gaza Strip) to reach those workshops.

Bir Zeit University welcomed 2 workshops, 4 were organized in PTC-PTU Kadoorie Tulkarm, 2 in PPU and 1 in An Najah University.

- One other activity of MedLink concerns helping the set up of one IUT in Balamand University (Lebanon) in the field of industrial automation. For this, laboratory equipment has been selected, shipped and installed with the help of the French Schneider Didactic Activities Department (Matthieu LAURAS) (Schneider PLCs and interfaces, electro-mechanical and pneumatic operative part) and a training workshop related to this equipment has been performed by Jean DEPREZ in May 2011.

- Schneider Electric is the first company opening an agency in the Bethlehem Municipality Interdisciplinary Park (BIMP). To establish or re-enforce links with the Palestinian Universities, the organization in BIMP of seminars and/or training workshops has been decided by the Israeli/Palestinian Schneider team (Philippe BRAMI – Country President, Avner BARAK – Vice President and Rifat SHARAWI – Office Manager). The French Schneider Didactic Activities Department initiated the link between this team and MedLink (Jean DEPREZ) to help organizing the first workshop "Introduction to PLCs". The first meeting was held in Jerusalem in November 2011.

2- Preparation of the mission

- The content of the training workshop's program and the specifications for the needed equipment have been proposed by Jean DEPREZ in November 2011. As example, the material (lectures and practice) used in Balamand has been sent.

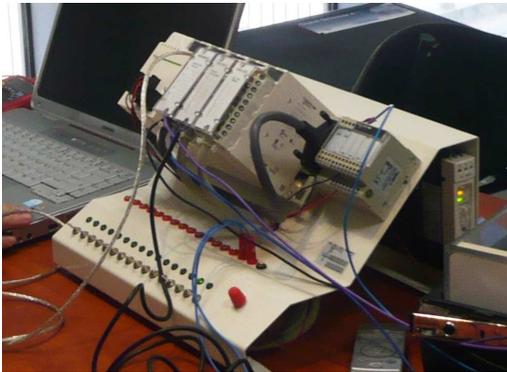
- At the end of December, after some exchanges, the content was accepted like it was, with Modicon 340 PLC's and interfaces. The date of the mission was fixed to January 13th – 20th.

- The mission of Jean DEPREZ (January 13th to January 20th) was supported by Schneider Electric (airline tickets, local expenses and indemnity for the training). A formal technical and commercial offer has been sent by MedLink the 1st of January, 2012.

- In order to reduce the starting time of the workshop, the documents to be printed for the 3 first days has been sent on January 9th.
- Hotel reservation and purchase of airline tickets were made by Jean DEPREZ.

3- Training sessions

The workshop took place in the laboratories/offices of Schneider in the BMIP building.



Three kits has been prepared for Schneider by Jafar SHARABATI (Company ADVANtech) :

- BMX P34 20302 Modicon M340 CPU
- BDX DDI 1602 Discrete Inputs Module (x16)
- BDX DRA 1605 Relay Outputs Module (x16)
- BMX AMM 0600 Analog Inputs(x4) Outputs(x2) Module
- Switches connected to the Digital inputs
- LEDs and sockets connected to the Digital outputs
- Potentiometer or adaptor connected to the Analog inputs

Two oscilloscopes and two wave generators were brought from PPU.

All participants used their laptop for software development (Unity Pro, version 5, M or XL)

The schedule and the program of the workshop are given in **annexe 1**.

The Workshop was designed to let the trainees progressively discover the hardware and the software necessary to control basic applications in industrial automation.

For the first 3 days, the program was very close to the provisional one. Modifications have been introduced for the days 4 and 5 according to the available equipment.

Because of the lack of one electromechanical system, I decided to focus on the 4th day to the start and stop procedures (hierarchical SFCs). During the 5th day, we have only experiment the basic control of an induction motor drive (ATV31).

The pedagogical approach used was the usual one for this kind of technical subject:

For each topic, a short presentation (1 to 2 hours) is followed by a practice session (3 to 4 hours). The text of the practice is fully detailed in order to allow all the participants to progress according to their individual skills. During lecture or practice, specific points are chosen to introduce methodology (or pedagogical techniques because of the majority of professors as trainees).

13 participants have followed the sessions (see the list in **annexe 2**)

- 5 from Palestine Polytechnic University (Hebron)
- 2 from Palestine Technical University (Kadoorie – Tulkarem)
- 2 from Bir Zeit Universty
- 1 from An Najah University (Naplouse)
- 3 engineers from Schneider Electric, Advantec and Altakamul Engineering

From my point of view, three trainees have perfectly followed the totality of the topics, seven have understood the main parts, and three have only reached the minimum level of competence which enables them to start the topic by themselves. At the end of the workshop, the trainees filled in, anonymously, an evaluation questionnaire (**annexe 3**).

Printed documents were distributed for the 3 first topics. All the lectures files (.pdf and .pps), practices files (.pdf) and some Unity Pro files (.stu) were given to the participants.



4- Comments

- First of all, it is important to highlight that it is the first time (to my knowledge) that a workshop is organized by a company affiliated with a French group to train teachers from Palestinian universities on technical equipment. Thanks to Schneider Electric for this initiative allowing Palestinian lecturers and engineers to have a practical approach of up to date hardware and software.
- The objective of the seminar was reached: the schedule has been performed in good conditions. Generally speaking, the trainees (who had the required pre-requisite) have reached the skill level that allows them to deepen the subject by themselves and to improve their teaching activities in that field. As in previous seminars, the applicative approach of learning (learning by doing) has shown its effectiveness.
- The questionnaire completed at the end of the session (see **Annexe 3**) attests to the satisfaction of participants and the interests represented by this kind of action for our Palestinian colleagues. However, some trainees had some difficulties that penalized their progressions, although most of them (9/13) indicate in the questionnaire having a good practice with PLC before the workshop...
- I appreciate the quality of reception of Schneider Electric for the workshop. Although Schneider's Office in Bethlehem is a new entity and that it is now in the installation stage, all was successfully done by Rifat SHARAWI to facilitate the teaching activities. The three PLC kits, designed in a very convenient way, were well adapted for the discovery of hardware and software. I appreciate the presence of the system integrator Jafar SHARABATI (Company ADVANtech), who was able, in real time, to introduce some hardware modifications and to suggest software solutions.

After these positive comments, two slightly negative points:

- I mentioned several times during the preparation of the workshop the need of one mechanical system including sensors and electro and/or pneumatic actuators to connect to the PLC (see the Schneider didactic catalogue). Such device is fundamental to motivate the trainees, to show them the physical results of their program and to introduce some basic aspects of industrial automation (inertia, synchronization, response time, defaults), which are transparent when switches and LED are used to simulate inputs and outputs. I think that the lack of such equipment has reduced the impact of the workshop.
- I have never received any official reply from Schneider Electric to the formal technical and commercial offer sent by MedLink before the workshop, nor to the invoice sent after the workshop. Without any document, I had to advance from my pocket the money for the flying tickets and the expenses in Bethlehem. One week after the end of the mission, less than 40% of the invoice amount has been received by MedLink. It is not a real problem, because I guess that we can work on the basis of a mutual trust, but for the future – if necessary – it would be better to have a more standardized administrative procedure.

In conclusion, I think that we have reached the objectives of the workshop "Introduction to PLCs". In the questionnaire, most of the participants from Universities estimate that they have got or reinforced from the workshop the capabilities to teach the topics to their students. I think that they can now build applications with their students around M340 hardware and UnityPro software.

Concerning future workshops in Energy and Industrial Automation, related with the Schneider equipment, the topics mainly suggested by the trainees are dealing with communication: Industrial networks, SCADA, HMI.

MedLink can help to the organisation of such workshop; it is up to Schneider Electric to initiate this new partnership...

PARIS, January 26th, 2012



Jean DEPREZ

Annexes

- 1- Program of the workshop*
- 2- List of trainees*
- 3- Evaluation questionnaire*

Workshop



Introduction to PLCs
January 15th – 19th 2012



OBJECTIVES:

- Learn how to program (LD, ST, FBD and SFC languages) a classic PLC with Digital and Analogue I/O expansions

EQUIPMENT:

- Schneider M340 experimental kit with:

- BMX P34 20302 Modicon M340 CPU
- BDX DDI 1602 Discrete Inputs Module (x16)
- BDX DRA 1605 Relay Outputs Module (x16)
- BMX AMM 0600 Analogue Inputs (x4) Outputs (x2) Module
- Simulator (switches) for the Digital inputs
- Safety sockets connected to the inputs/outputs

- Mechanical system including sensors and electro and pneumatic actuators

- Schneider Unity Pro V5.0 Development Software

INSTRUCTOR:

Pr. Jean DEPREZ, retired from Paris-Sud 11 University, (IUT Cachan, Polytec' Paris Sud).

MedLink, <http://AssociationMedLink.com>

PROGRAM: (35 hours)

1. PLC Overview

- 1.1. The PLC in an automated industrial system
- 1.2. Processor overview
- 1.3. PLC market
- 1.4. PLC : CPU and expansions
- 1.5. PLC functional analysis
- 1.6. PLC physical structure
- 1.7. The PLC processing cycle
- 1.8. Life time of the inputs
- 1.9. Schneider MODICON M340 PLC and I/O
- 1.10. PLC software : IEC 1131 Standard
- 1.11. Unity Pro Software
- 1.12. Methodology
- 1.13. *Practice 1: Getting started with M340 PLC and Unity Pro Software*

2. Combinatorial systems : LD, FBD, ST

- 2.1. BDX DDI 1602 Discrete Inputs Module
- 2.2. BDX DRA 1605 Relay Outputs Module
- 2.3. IEC 61131 Combinatorial Ladder
- 2.4. Combinatorial Ladder Operators
- 2.5. Unity Pro Ladder Editor
- 2.6. IEC 61131 Function Block Diagram
- 2.7. Basic Function Blocks
- 2.8. Unity Pro FBD Editor

- 2.9. Using Function Blocks in LD Sections
- 2.10. IEC 61131 Structured Text
- 2.11. Basic ST Operators and Instructions
- 2.12. Unity Pro ST Editor
- 2.13. Using Function Blocks in ST Sections
- 2.14. Using ST in LD Sections
- 2.15. *Practice 2: Combinatorial systems, LD, ST and FBD*

3. Sequential systems : SFC

- 3.1. SFC Sequential Function Chart
- 3.2. Definitions
- 3.3. The 5 Main Rules
- 3.4. Exclusive Sequences
- 3.5. Parallel Sequences
- Exercises*
- 3.6. Macro Step
- 3.7. Hierarchical Graphs
- 3.8. Unity Pro SFC Editor
- 3.9. *Practice 3: Sequential systems, SFC, Timers*

4. Analogue Inputs/Outputs, operator screen

- 4.1. General structure of Analogue Inputs
- 4.2. General structure of Analogue Outputs
- 4.3. The BMX AMM 600 Module
- 4.4. BMX AMM 600 configuration with Unity Pro
- 4.5. Analogue I/O in LD, ST, FBD and SFC
- 4.6. *Practice 4: Analogue I/O, Operator Screen*

5. Start and Stop Modes, Hierarchical SFCs

- 5.1. What has to be taken into account?
- 5.2. An example : a filling machine
- 5.3. The start and stop mode diagram
- 5.4. The hierarchical SFCs
- 5.5. Hierarchical SFCs using Unity Pro
- 5.6. *Practice 5 : Hierarchical SFCs*

6. Command of an industrial automated system

- 6.1. Presentation of the ATV31 Induction Motor Drive
- 6.2. *Practice 6: Association M340 – ATV31.*

Annexe 2: list of the participants

First Name	Name	University / Company	e-mail
Jean	Deprez	Paris-Sud 11 University / MedLink	jean.deprez@orange.fr
Hussein	Amro	Palestine Polytechnic University	huseina@ppu.edu
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Kareem	Juneidi	Palestine Polytechnic University	kareem@ppu.edu
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Annexe 3 : Evaluation Questionnaire

Number of questionnaires distributed: 13

Number of questionnaires filled: 13



Introduction to PLCs WORKSHOP EVALUATION



My knowledge in practice concerning PLCs before the workshop was		Good	Low	Very low	
		9	2	1	
I think that I had the technical prerequisite to follow the subject		Yes	More or less	No	12 answers
	concerning the lectures	7	5	0	
	concerning the practices	5	5	2	
For an introduction to PLCs, generally speaking, I think that the technical level of the workshop was		Too high	Correct	Too low	11 answers
	according to my skills	2	11	0	
	according to the needs of my university	2	8	1	
	according to the needs of the industrial market	4	7	2	
Taking into account that the limited time of the workshop I think that the following items should be		more developed	not modified	less developed	12 answers
	Session 1 : overview on PLCs	2	11	0	
	Session 2 : combinatorial LD, FBD, ST	0	10	3	
	Session 3 : Sequential SFC	3	8	2	
	Session 4 : Analog I/O	8	3	1	
	Session 5 : Stop & Start Modes, hierarchical graphs	7	4	2	
	Session 6 : Application to motor drive	3	4	1	
I think that I have got (or reinforce) from the workshop the capabilities to teach to my students:		yes	no	11 answers	
	Session 1 : overview on PLCs	10	1		
	Session 2 : combinatorial LD, FBD, ST	10	1		
	Session 3 : Sequential SFC	9	2		
	Session 4 : Analog I/O	9	2		
	Session 5 : Stop & Start Modes, hierarchical graphs	6	5		
Generally speaking, the teaching technics of the instructors was		Good	Medium	Bad	
		13	0	0	
The organization of the workshop by Schneider (facilities, coffe break, lunch, opening time of the laboratory) was		Excellent	Good	Medium	12 answers
		6	6	0	
Globally speaking, taken into account all the previous aspects, over a range from 0 (very bad) to 20 (very excellent), I attribute the following mark to this workshop:				16/20	min=15 max = 17
For future similar workshops, I would like to express the following recommandations :					
<i>Sort attendee's knowledge (?)</i>					
<i>Slower in presenting the topics</i>					
<i>Print all the handouts (2 times)</i>					
<i>More involvement with trainees (check more their program during practice)</i>					
<i>Insist more in practice on Analog I/O (2 times) and hierarchical graphs (2 times), AC drives, PID controller, PWM inverters</i>					
<i>Work with real automation system (3 times)</i>					
<i>Provide more equipment for practice</i>					
<i>Start workshop on time</i>					
For future workshops in Energy, Industrial Automation, I am interested by the following topics:					
<i>Industrial networks (8 times), SCADA (5 times), HMI (4 times), Analog devices (2 times), Motion drives, Energy management, Methodology</i>					