

Introduction and Links

The programmable logic controller (PLC) has been used by industry for over 70 years as a primary means of automation. The PLC has been the primary building block for training those interested in a career as either an engineer or technician on the factory floor. The use of the PLC in training the workforce has been a fundamental part of any training in the field of automation.

The courses developed in the attached website use the PLC to train aspiring engineers and technicians. It gives motivation to those who show interest or potentially might show interest in a career in automation. The courses are outlined at the website:

hybridplc.org

The accompanying two texts and 34 videos challenge the student in the area of automation of machinery for the plant floor. The youtube channel was developed during the covid era to help in the dissemination of the lectures if remote learning was to be the standard going forward. These courses had always been strictly hands on and the youtube videos were meant to supplement that effort – of being a hands-on learning environment.

The following video is the introductory video of the series and introduces the student to the courses:

<https://www.youtube.com/watch?v=WhKvy1QSdSw>

The courses' texts and videos are free. They will remain so as long as this author is involved – free for all to use. The videos discuss a number of low-cost programming trainers as well as a group of low-cost lab experiments. The recommended approach is a \$189 Siemens PLC, programming software and cable. All that is needed to complete the training station is a computer with Windows 10 Pro, a power supply and a breadboard with some resistors and jumpers and perhaps a voltmeter – common items many may already have.

Why the name – Hybrid? It was and is felt that the student best learns when comparing two different things and in this case it is two similar but distinct PLCs – Allen-Bradley and Siemens. Why the Siemens' processor - because it is low cost and can accomplish so much. And with some free or low-cost software, the A-B approach may also be implemented with simulators. The idea is hands-on first. That involves wiring, troubleshooting, and making 'it' work. The goal is a complete program with working parts. The underlying goal is to interest the student to pursue work in the area of automation. And this approach works. In the past 15 or so years since the hybrid approach has been implemented, there has never been a student who came back after graduating who couldn't find a job (sometimes with a little encouragement). If a student engaged, studied and learned the material, there was a job somewhere for him (or her). And many of these jobs start out in the \$60K's, \$70K's and even the \$80K range.

And the student who engaged in these courses usually graduated with a BS degree. The PLC has many times been the difference between the student being able to see the end goal and finding the encouragement to reach it.

The second text – Hybrid Lab Text – features a number of labs discussed in the text but expanded here to explain how to succeed in building and programming the labs as well as the bill-of-material to build

the lab. The maker material has been a plus in this effort. Many of the labs in the Hybrid Lab Text cost little or no money in addition to the original investment and demonstrate valuable principles from the factory floor. The labs are designed to teach basic principles of automation and use parts from the maker world (think Arduino). Content of many of the labs is outlined in the paper given at the CIEC conference this past year in Tempe, Ax.

<https://hybridplc.org/wp-content/uploads/CIEC.pdf>

So, what is being proposed is a course for workforce development based on the above material. Almost free with the addition of the \$189 PLC. The student can be remote or in a classroom. Encouragement comes from the videos and texts. The support means would include phone help from the author and perhaps others. The Siemens help line as well as the Rockwell help line is also a means of support. The goal is to train those possibly interested in automation and grow the workforce in Ohio to include as many as possible willing to be challenged by the PLC and learn to automate the process – whatever the process may involve.

The use of Rapids 2.0 money was instrumental in development of some of the labs described here. They include the Tank over Tank lab, the Servo Lab, the Safety Lab and RFID lab. Other labs using the Siemens and A-B PLCs were also purchased using the Rapids 2.0 grant money.

These labs, while low in cost, did represent an investment by the state of Ohio and the chance to expand from a single lab experiment to 8 was appreciated.

While developing these labs, other labs also were found that cost even less. One lab costs only \$26 in addition to the Siemens PLC. This lab demonstrates single axis motion as found in a factory. Applications include milling machines, grinders, indexers and other single axis control.

To get off the ground, the author proposes a method of call-in to his phone number in order for potential students to get started with the programs and videos. Hopefully after a few encouragements, the student can launch out on his/her own and continue the process eventually completing most or all of the Hybrid Text (21 chapters). The student chooses labs that appeal and eventually tries as many of the labs as possible. The number of labs is now in the 40's and constantly growing. The hope is that the student will fully conquer the fear of the blank sheet of paper and begin each lab with anticipation that the lab will add to their skill-set. The answers to most labs varies over a wide range of acceptable answers and hints and partial solutions are given in the videos. Hopefully the encouragement these labs and books give will launch a wide number of would-be automation engineers into the career of their lives.

Also in the website are a number of other courses taught by this author. They vary from term to term but include at present EET 1010, EET 1020, EET 4450 and ENGT 3050. These courses include syllabi and some material necessary for teaching the course. The ENGT 3050 course has a free book used as a text for the course. ENGT 3050 is the Electrical for Non-Majors course for Engineering Technology students at the University of Toledo. The EET 1010 and EET 1020 courses use the free text and lab texts from James Fiore from MVCC (Mohawk Valley Community College). These represent some of the collection from Jim and are a great resource.

For students wishing to get credit from the University of Toledo for EET 2410, EET 4550, or EECS 4220, contact Prof. Evans about enrolling in the University and applying for credit by examination. These

courses are ABET accredited and offer 4 hrs credit/ea for the EET courses and 3 hrs credit for the EECS course. The EECS course covers the entire 21 chapters of the Hybrid Text. Contact information for Dr. Evans can be found at the top of the website. Whether taking some or all of this material, for personal interest or for potential credit, the objective is the same – to learn to program the PLC and automate industrial processes. The experience is well worth the effort!

Sincerely,

Wm Ted Evans

Links

Siemens Easy Book

<https://support.industry.siemens.com/cs/document/39710145/simatic-s7-1200-easy-book?dti=0&lc=en-EG>

Weighing Technology

https://cache.industry.siemens.com/dl/files/659/109764659/att_976036/v1/WT10_US.pdf

Siwarex WP231 Siemens

file:///C:/Users/willi/AppData/Local/Temp/A5E31238908A-03en_SIWAREX_WP231_M_en-US.pdf

Introduction to SCL

<https://www.pccweb.com/wp-content/uploads/2019/11/S17-SCL.pdf>

Siemens RFID

https://cache.industry.siemens.com/dl/files/810/109805810/att_1091308/v1/BA_RF200-IO-Link_76_en-US.pdf

Siemens Simatic Step 7 and WinCC Engineering V 17 (20236 pgs)

file:///C:/Users/willi/AppData/Local/Temp/STEP_7_WinCC_V17_enUS_en-US.pdf

SIMATIC Industrial Software SIMATIC Safety - Configuring and Programming

<https://support.industry.siemens.com/cs/mdm/54110126?c=143837355531&lc=en-YE#>

Allen-Bradley General

<https://www.rockwellautomation.com/en-us/support/documentation/technical/factorytalk-software/studio-5000-design-software.html>

Here's a link to TIA Portal V16:

<https://support.industry.siemens.com/cs/us/en/view/109772803>

And here's a link to TIA Portal V17:

<https://support.industry.siemens.com/cs/us/en/view/109784440>

Here's a link to download the software TIA Portal V15.1:

<https://support.industry.siemens.com/cs/us/en/view/109761045>

Subject: RSLogix500 free tutorial link

The technote the tutorial says to go to isn't there when you search for it but if you click "downloads" and then "view all downloads" and then "find drivers and firmware" you will be at the product search page the technote would bring you to.

<https://onlineplcsupport.com/free-rslogix-500-download-micro-starter>

To purchase a trainer unit from Siemens, please call one of the distributors listed below. These trainer prices may have moved up but have been selling for \$189 including PLC and software. You will get a key for the software as well as the cd's. If you look at the various links above, you can choose the software version you are interested in using and download it directly from the web and bypass the cd hassle.

Derek Bolton – Electromatic Products – 248-722-4283

Chris Seigneur – C & E Advanced Technologies – 419-779-8082

To talk to an Allen-Bradley Salesman to purchase the \$100 simulator package for RS Logix 5000, contact:

Derek Lajiness – Mac & Mac – Maumee – 419-482-7839

You may also be interested in the A-B PLC's but should talk to Derek directly to purchase what you need. The RSLogix 500 software above is free. If you buy a SLC processor from Ebay, you can use it with the software and move through many of the labs. Purchase a 24 V unit if possible.

If you purchase a trainer, you may also be encouraged to purchase a power supply from the vendor. While this is your choice, several other 24 V power supplies that work can be purchased for much less. The chapter 3 video gives some information concerning the choices.

The Siemens processor will be used more in the later labs because of the interface in the unit for PWM and Pulse Counting as well as analog capabilities. If possible, spend the \$189 and get the Siemens hardware. This is the least expensive way to get hands-on experience on a major PLC platform. You can purchase the Allen-Bradley simulator for \$100 for RSLogix 5000 or download the RSLogix 500 simulator for free. This will give you enough experience on A-B to see what is discussed in the text and get some good A-B experience.

Credit by Exam is possible through the University of Toledo's College of Engineering. If you want to apply for this credit, please contact William T Evans – william.evans@utoledo.edu for information for either credit for EET 2410, EET 4550 or EECS 4220.



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