OE & Digital Transformation

ETAT Workshop

Developing IEC 61131-3 code for Industry 4.0

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Workshop goal

The new challenges of Industry 4.0 require PLC programming methodologies that allow for a greater degree of adaptability, data integration capacity, maintainability and advanced features.

Many automation engineers remain anchored in structured programming, with highly facility-dependent application development and not reusable code.

Object-oriented programming (OOP) allows overcoming these constrains. The IEC 61131-3 Ed.3 standard supports OOP, however, no manufacturer supports this feature of the standard directly. Some manufacturers do allow OOP using third-party tools such as Microsoft Visual Studio (C++) and-high performance controllers.

On the other hand, the reference architecture model for Industry 4.0 (RAMI4.0), and methodologies such as ISA-88 and ISA-95, provide a solid basis for configuring scalable automation systems, with data integration capabilities in all their levels.

This workshop tries to address the importance and details of the merge of these two approaches, OOP and ISA methodologies within the scope of the IEC 61131-3 standard, for the design and development of automation systems, using illustrative examples applied to a real installation..

To whom is the workshop addressed

Basic knowledge of automation systems, PLCs and IEC 61131-3 programming.

The Methodology

It is common at low levels of training, where disciplines related to automation engineering are taught, specifically with the use of PLCs, to focus efforts on knowing the hardware and software characteristics of this equipment - preferably based on the IEC 61131 standard. In these cases, the operating mode, signal connection, variables and data types, programming in different languages and the implementation of simple examples are studied.

The systems can be expanded by handling more complex operating modes, mainly attending to the production process logic, including basic safety aspects and connecting user interfaces (HMI) with higher performance. Issues related to signal interfaces (on-off, analog, PWM, etc.) and industrial communication networks that allow to decentralize the periphery (Profibus, Profinet, Device Net, etc) are also taught.

The methodologies that allow addressing more comprehensive solutions focus on the use of structured programming, which solve specific functionalities of the system, and state diagrams that command the

operation sequences (GEMMA, GRAFCET,…). The price to be paid is that variable declarations and POUs' calls structure tend to become messy, and the possibilities of encapsulating code and its reuse in the project -or in other projects- is often not feasible without hard work, and with the necessary intervention, in many cases, of the human team that participated in its development.

Object-oriented programming comes to solve these problems, allowing the engineer to face in advance the integral design of the solution. Each component of the system has defined characteristics (attributes) and a set of operations (methods), which can be invoked from other objects. This paradigm allows a more precise and simple approach to the design, development, maintenance, modification and validation of automation systems, especially when they are of a certain complexity. Besides, using the OOP paradigm facilitates the vertical integration of different types of systems in within the production process.

However, even today, most conventional programmable controllers do not support object-oriented programming based on the IEC 61131-3 standard. Other equipment that does support it, do not have the robustness and real-time characteristics appropriate for the industrial environment where they are to be applied. The good news is that it is possible to implement OO PLC programs using conventional PLCs based on the IEC 6113-3 standard, by declaring data structures and implementing functional blocks to resemble the "objects" defined in the system.

The challenge then is how to identify and characterized the objects (components) that represent and allow the operation of the system. To do so, it is proposed to use the RAMI4.0 model that suggests using ISA-88 (and ISA-95) for plant architecture. These standards provide a very interesting framework to use, not only for programming as mentioned before, but also in SCADA applications, communications via OPC UA, manufacturing execution systems (MES), and production management (ERP) levels. They are also appropriate methodologies to upload information to the Cloud promoting big data and data analytics. Thus achieving higher levels of production, traceability, security, quality, predictive diagnosis, energy efficiency, etc., which are benefits related to the objectives of Industry 4.0.

The workshop will deal with these aspects of design and implementation of OOP solutions using conventional PLCs and the IEC 61131-3 standard, showing application examples and analyzing their advantages and disadvantages. CoDeSys v3.5 can be used for development, and also some real controller (Simatic, PLCnext, Raspberry Pi) with the appropriate programming tools and real processes for its validation will be presented.

The Workshop duration

2 hours.