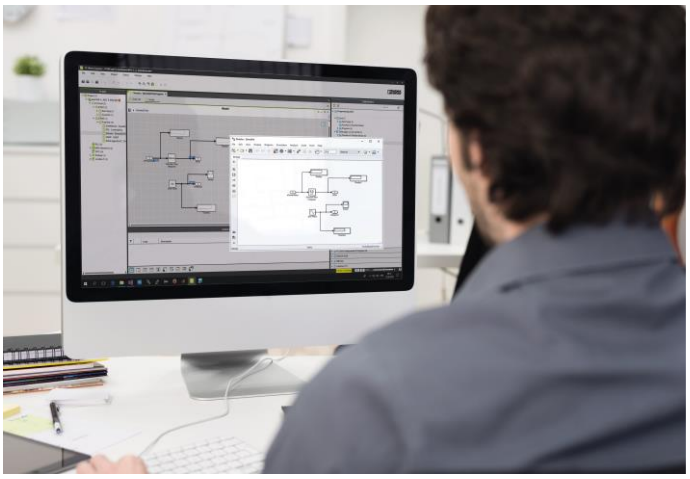
Using Matlab Simulink and PLCnext Technology in the process industry

How to facilitate the implementation of complex functions

In spite of digitalization and Industrie 4.0, the control systems of processing plants remain technically complex even when they are broken down into their smaller elements. For example, the implementation of a fast cascade control system on a small controller proves to be a complex challenge. But the right tools, such as a combination of the tried and trusted Matlab Simulink software and Phoenix Contact's next generation of PLCnext controllers, can help manage the complexity.



There's a considerable number of applications that are hard to implement, for example, cascade control, fast momentum control, and also those said control technology applications baased on the implementation of a complex mathematical formula. Generally, those applications can be programmed for a PLC in IEC 61131 code, which might not be very practical. A difficult formula which a programmer writes in structured text according to IEC 61131 is often unrecognizable. As a result, optimization and debugging become needlessly complicated.

The next step is testing the complex function, which might also be rather difficult when clarity is missing. Furthermore, improving a closed-loop control system already proves to be time-consuming when it involves less complex tasks.

The challenges mentioned above are more or less the classical problems that programmers have been facing ever since; however, additional issues keep emerging. Ever more often, the process industry uses modular automation approaches, particularly since MTP (Module Type Package), a standardized software interface compliant with VDI/VDE/NAMUR 2658, has been introduced to the industry. Today's modules each have their own controller performing closed-loop control, which takes the load off the central control system. But the environment in which programmers implement controls such as the one mentioned above has changed: from central control systems engineering to control engineering in general.

Ready-to-use function modules

Matlab Simulink is the go-to software for programmers in the field of control technology who want to make the implementation of such complex tasks easier and more elegant. It is an advanced tool for developing and testing mathematical as well as control technology solutions, and for turning those into code. Cleve Moler from the U.S. University of New Mexico came up with the idea to Matlab already in the 1970s. In the mid-1980s, the software was turned into a commercially available product. From the year 2000 onwards, Matlab has become widely used, not least because the tool was included into the universities' curricula.

Thanks to the later expansion of Matlab by the Simulink module, the software now enables the simulation of programs as well as the use of blocks in systems modeling. Systems can thus be graphically visualized in a clear manner. A wide variety of "toolboxes", for example, the "Signal Processing Toolbox" or the "Fuzzy Logic Toolbox", which enable the use of preprogrammed function modules, are available to be used with the software. As mentioned above, such solutions have been around since the 1980s. What is new is that users can combine the system with an industry-grade controller in an easy way. This has become possible because the PLC has been added as the "target" for the code, as opposed to before, when microcontrollers had been available as the only option for a runtime environment, and C code was all that could be generated. Now, a complex closed-loop controller can be designed in Simulink, tested over the complete frequency range under influence of

disturbance variables, optimized by means of the Simulink tools and, finally, exported as a program for the PLC.

Export to the target controller

Users thus have a wide variety of options usually not provided by control engineering environments. The testing and improving of closed-loop controllers are particularly tedious processes, during which engineers will appreciate anything that makes their job easier. Matlab Simulink covers all classical methods of control systems engineering, such as Bode diagrams, root locus diagrams, or frequency response plots, which facilitates the process of developing code. Another advantage of the software is that it enables graphical blocks to be used for control design. For example, a gain can simply be added by dragging and dropping it, and designing takes place not in a PLC environment but on a level more suitable for control systems engineering (fig. 1).

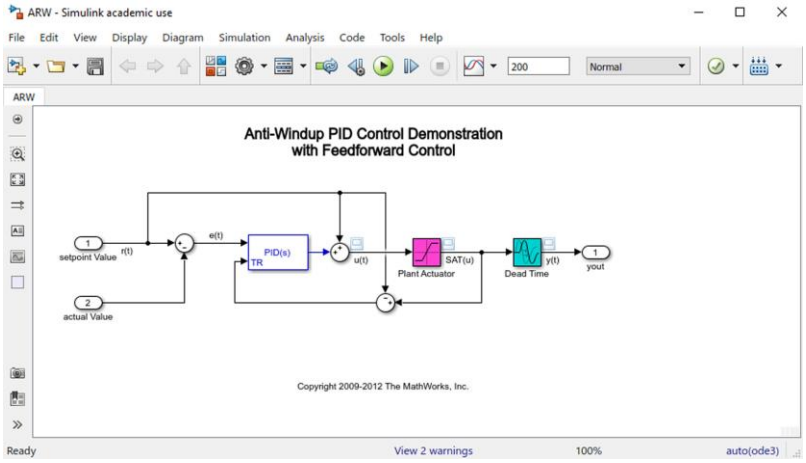


Fig. 1: Closed-loop control circuit representation in Simulink

When programmers are done planning the closed-loop controller in a conventional PLC environment, they face the challenge of testing. In such an environment, input signals can be simulated, however, this proves to be difficult when carried out over the entire frequency range. Thanks to Simulink's wide variety of possibilities, the process of starting up the controller in the field can be shortened significantly because the programmer is able to test the behavior of the closed-loop controller in advance.

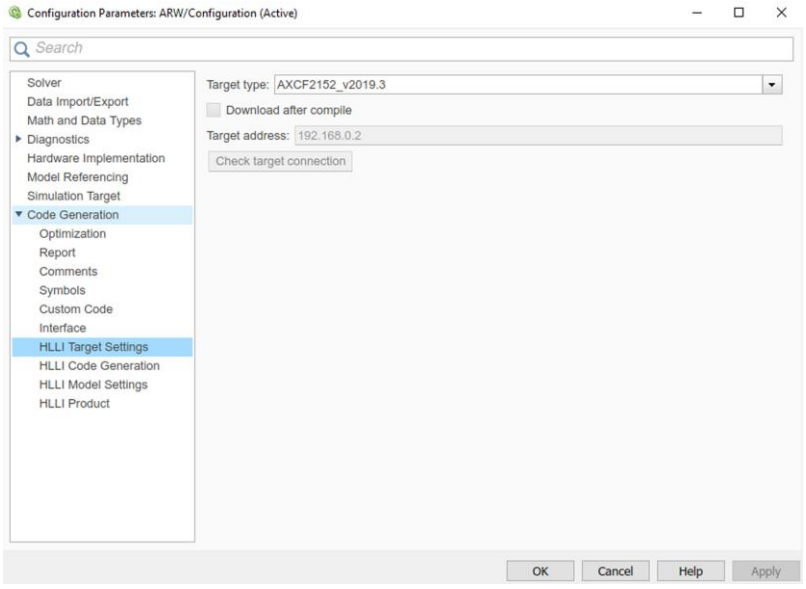


Fig. 2: Selecting the AXC F 2152 PLCnext controller as the target

After the controller has been completely modeled and tested, the new system feature takes effect: the controller that has been configured can be exported to fit the specific PLC system. Targets – also referred to as PLC coders – are available for the TIA portals of Siemens, B&R, Codesys, Phoenix Contact, and some further manufacturers. Connecting to hard real-time systems with all their I/Os and fieldbus systems is now easier. And all in all, Matlab Simulink has evolved into a readily available and useful tool for the field of automation engineering (fig. 2).

Application programs from the online store

Phoenix Contact's PLCnext Technology, a new, open generation of controllers based on the Linux operating system, offers various advantages. The economical AXC F 2152 PLCnext controller with its two separate 800 MHz processors offers a well-suited platform for running a Simulink model on one core and processing standard tasks on the other one, for example. The code generated in Simulink easily integrates into the project as a program, and can be processed by one of the two processors with

any task duration. This enables the user to open the generated models in the engineering environment, and to monitor them online during their runtime for extensive transparency. For licensing reasons, changes to the model can only be made in Matlab Simulink (fig. 3).

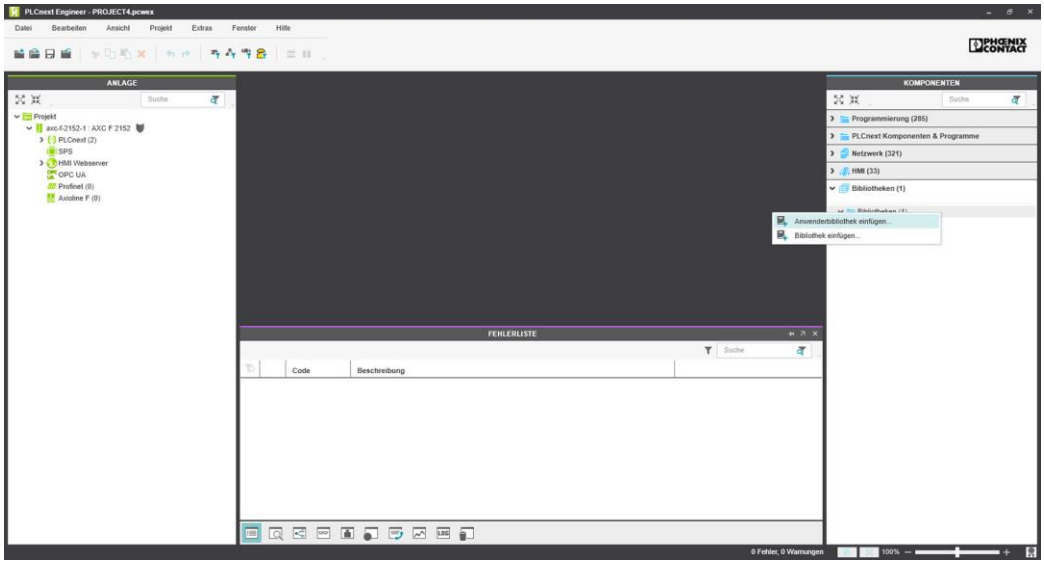


Fig. 3: Adding a Simulink model as a library to the PLCnext Engineer environment

Today's control technology offers even more possibilities. For example, users can download an application program or parts of it from the PLCnext Store to the controller, just like they are used to do it with apps for their smartphones. To this end, the AXC F 2152 is connected to the PLCnext Store via its user ID. Then, the controller is logged in via its UUID (Universally Unique Identifier), and the user selects the application to be installed on the PLCnext controller from the store. Users thus have access to turnkey application programs without the need to use any engineering system or to be proficient in programming according to IEC 61131. Moreover, the PLCnext Store contains libraries and parts of programs. So, an institute could design a complex closed-loop controller and make it available in an easy way via the PLCnext Store – either for free or for a licensing fee. Industrie 4.0 has thus found its way into the process industry (fig. 4).

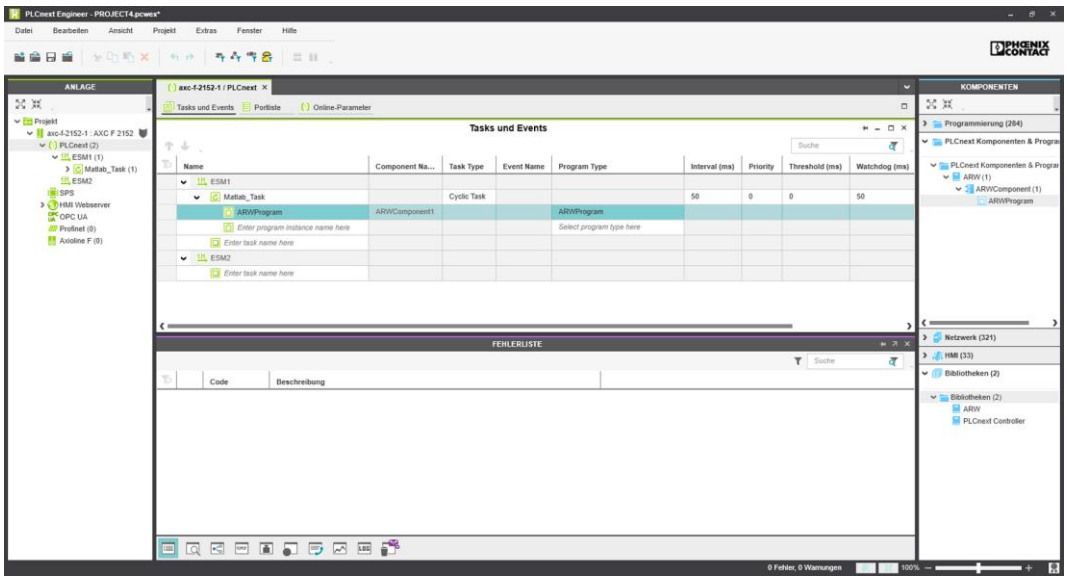


Fig. 4: Adding the Simulink model as an independent task

Combining different programming languages in real time

The NOA concept enables open, secure, and scalable systems, such as PLCnext Technology, to be used in the process industry. The ecosystem makes it possible to combine program sequences written

in different programming languages in real time. The patent-pending task handling system enables program routines to run as classic IEC 61131 code. High-level language programs that have, for example, been created in C/C++ or C# therefore run simultaneously with the IEC 61131 programs (fig. 5).

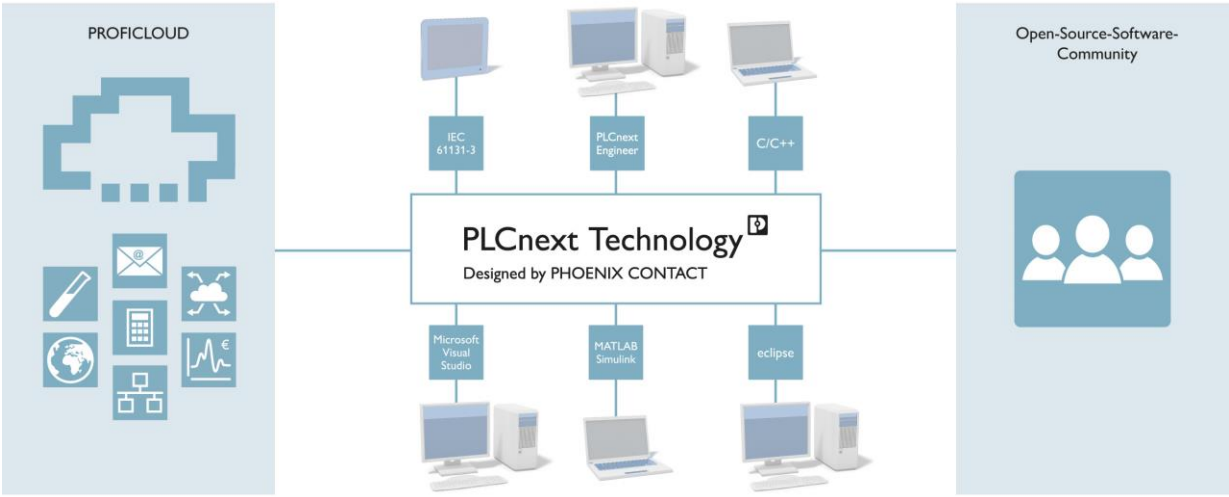


Fig. 5: PLCnext Technology enables developers to program independently of one another in the language they prefer

PLCnext Technology ensures consistent data exchange as well as the synchronous execution of the program code, and makes high-level language programs deterministic automatically. Developers can therefore work efficiently on individual parts of a complex application at the same time and independently from one another, and in their preferred programming language. Thus, the experience of the IEC 61131 experts can be coupled with new ideas and program blocks from the high-level language worlds, as well as with the knowledge of young developers from the IT environment.

Author: Dipl.-Ing. (FH) Thilo Glas, Senior Specialist Engineering in the Industry Management Process, Phoenix Contact Electronics GmbH, Bad Pyrmont, Germany

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