An Innovative Controller Concept for Production Machines

Automating a Production Machine – A Challenging Proposition!?

Are you faced with the need to automate a production machine?
Then you have a very challenging task ahead of you!
From the outside, your machine appears simple and straightforward enough.
But when you consider the functional requirements, your machine poses a real challenge.

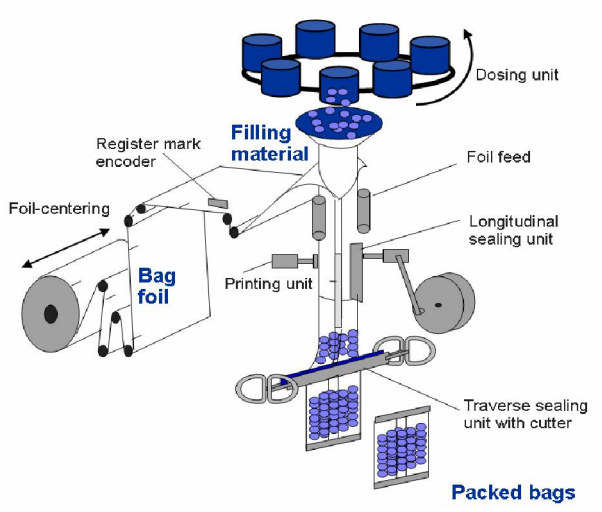
First and foremost, your machine is used to produce, manipulate, transport and/or package products. Everything must be done as fast as possible and with a high degree of accuracy and quality. The more products your machine can produce and the fewer rejects that result, the greater the value of your machine. By value, we are not referring so much to the cost of your machine as to your competitive advantage.

To satisfy these demands, it is essential to supply the machine function requirements, while at the same time, ensuring that the speed and quality aspects of production are optimized to the maximum extent possible.

Example of a Production Machine

Let's take a closer look at the individual machine functions and their requirements. For our example, we will use a "simple" tubular bagging machine.

A bag foil is fed via a loop control to the filling station. Because the foil feed is subject to slippage, the exact position of the foil is constantly updated using a register mark encoder. A forming collar is used to shape the film into a bag, and the length is sealed by the longitudinal sealing unit. A printing unit then creates an individual label. Now, the film bag is filled. The dosing unit is used to drop a measured portion of the fill material into the bag, which is sealed by the traverse sealing unit. A cutter separates the packaged product from the bag foil. The length of the container and the amount of fill material as well as the efficiency of the machine must be set individually so that they correspond to the properties of different products and can produce various packaging sizes having different weights.



Motion Control as the Central Function – and Much More

As you can see from this production machine example, motion control is the central function. Multiple motion axes must be strictly coordinated and operated in concert in order to produce high-quality finished products.

Specifically, the following functions are required:

- Virtual master axis that supplies the machine clock pulse and from which all real axis motions are derived

- Loop control for foil haul-off as well a positioning function for film centering
- Positioning function for dosed quantity
- Electronic cams for film feed, longitudinal sealing, and traverse sealing
- Measuring input function for the register mark encoder and film slip correction
- Electronic output cams for activating the printing unit and cutter
- Temperature control for longitudinal and transverse sealing units

But that is not all. For your machine to also produce something, the various functions must act in combination according to the production process. Of course, it must be possible to influence these functions externally. You need a programmable system to manage and convert the various formats, to track materials, and to support different operating modes (manual operation, automatic operation, etc.). It should be possible to operate everything conveniently from a computer display.

This leads to the following requirements:
- A programmable controller for your individual application
- Interfaces for digital and analog I/O
- Interfaces for digital and/or analog drives
- The option to connect HMI systems

Perhaps this machine operates in conjunction with other machines or is connected to a central computer.
If so, you will require:
- Appropriate communications services
- Interfaces

As you can see, there are a few hidden elements in your “simple” machine.

The Traditional Approach: Multiple Components Pose a Real Challenge
Now, let’s turn to the question: What *could* the control system for your machine look like? No doubt, you have already asked yourself this question, and you may have come up with the following answer:
The solution to your problem would contain the following:
- A programmable logic controller
- Hardware module for motion control that supports the software and hardware for control of electrical or hydraulic axes
- Hardware modules for high-precision detection of measuring interrupts
- Hardware modules for high-precision output of switching signals
- Hardware modules for temperature control
- Interfaces for purposes of interfacing to higher-level control and computer systems or an HMI
- A visualization system for machine operation
- And perhaps other features as well …

This solution might present the following problem. Depending on how well the individual components are tuned to each other, your engineering effort could increase significantly, to say nothing of the issue of performance and precision with so many interfaces.

There Is a Simpler Way

Now, let's turn to the key question: How would you like to have a control system that contains all of the required functionality and that can be optimally adapted to your machine through a powerful, but easy-to-use engineering tool?

Such a controller is available. It is called SIMOTION and SIEMENS makes it.

SIMOTION was specially developed for automation of production machines by merging the innovative system approach for PLC, motion control, and technology tasks into one controller.

Two Available Hardware Platforms Maximize Flexibility

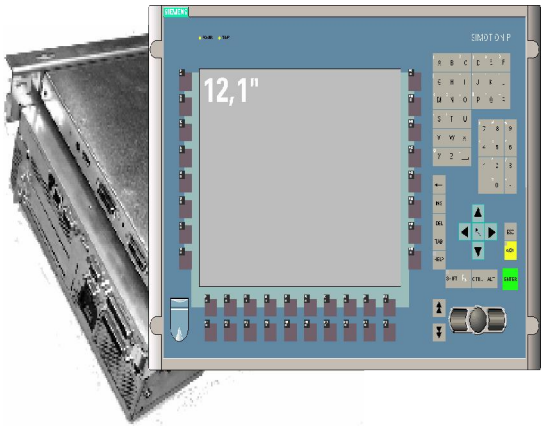
In order to optimally respond to our customer's needs, two different hardware platforms are offered, albeit with an identical controller concept.

For customers that prefer a modular PLC design, there is the controller-based hardware variant SIMOTION C

Interfaces onboard:

- Two 12 MBaud Profibus interfaces
- One 100 MBaud Ethernet interface
- Interface for four analog drives
- 18 high speed inputs
- 8 high speed outputs
- Local and distributed interfaces (via Profibus) can be expanded using the extensive I/O range of the SIMATIC S7-300
- Interfacing of digital drives via Profibus

For customers that prefer the openness of the PC world, there is the PC-based hardware variant SIMOTION P, which combines the SIMOTION controller and a Windows PC in one hardware.



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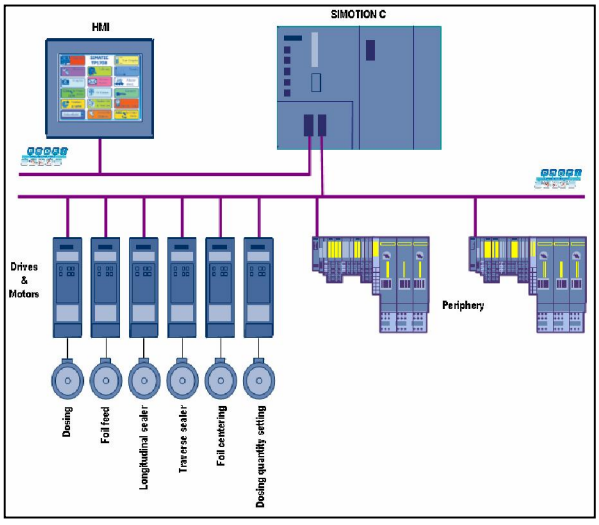
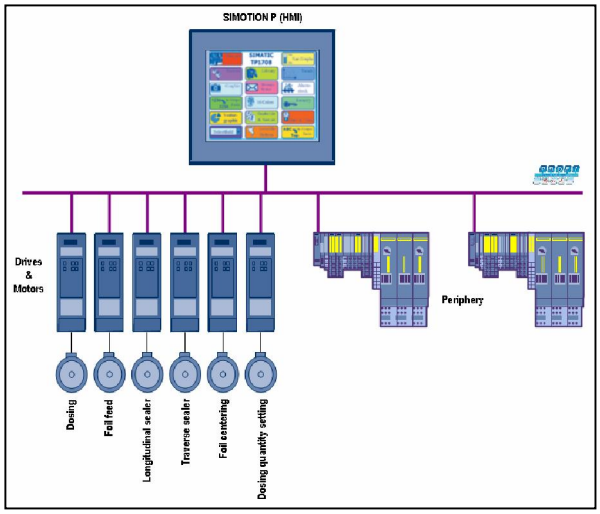
Now, this is how your machine solution could look!



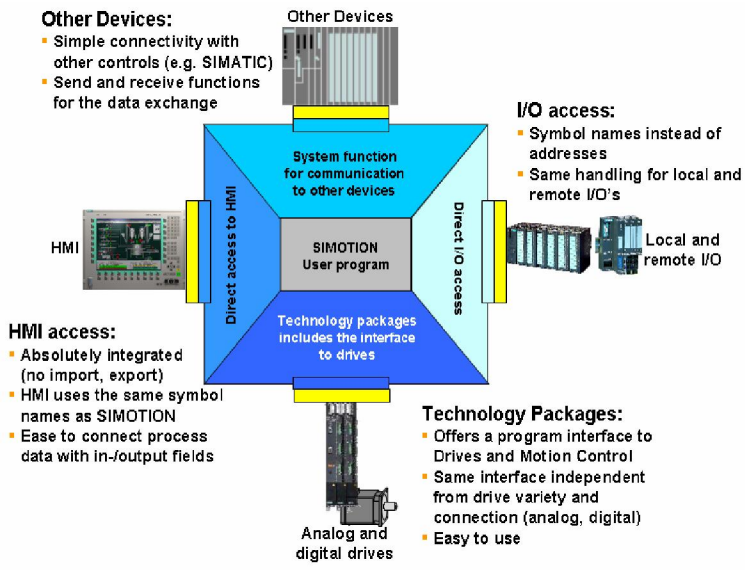


The two solutions differ only in the SIMOTION hardware platform that is used. While SIMOTION C has a separate HMI panel connected for visualization purposes, SIMOTION P has visualization integrated in the SIMOTION PC hardware. It's up to you to decide whether you prefer the open PC-based solution or the modular, compact controller solution. On a purely functional basis, both solutions are optimally suited for automating your machine. You can also change the SIMOTION platform at any time because your application programs can run on either platform without any changes.
All peripheral components such as drives and I/O's are connected to the central SIMOTION controller by means of the powerful Profibus bus system. As a result, you obtain a clean configuration with all of the performance features of Profibus, such as simple configuration, time-synchronous communication, and powerful diagnostic capabilities.

Engineering for a Total System: SIMOTION SCOUT

The engineering should be as clean as the hardware design you have implemented.

The SIMOTION SCOUT engineering system comes into play here. With this engineering system, new ground has also been broken, fully accommodating the innovative approach of SIMOTION.
If the traditional boundaries between PLC, motion controller, and drives are removed, the engineering system must also provide the best possible support for all aspects of configuration and parameter assignment across programming, commissioning, testing and diagnostics, applied equally to all system components.
Engineering no longer focuses on individual components and the creation of multiple interfaces but rather on the actual task – development and commissioning of machine applications.

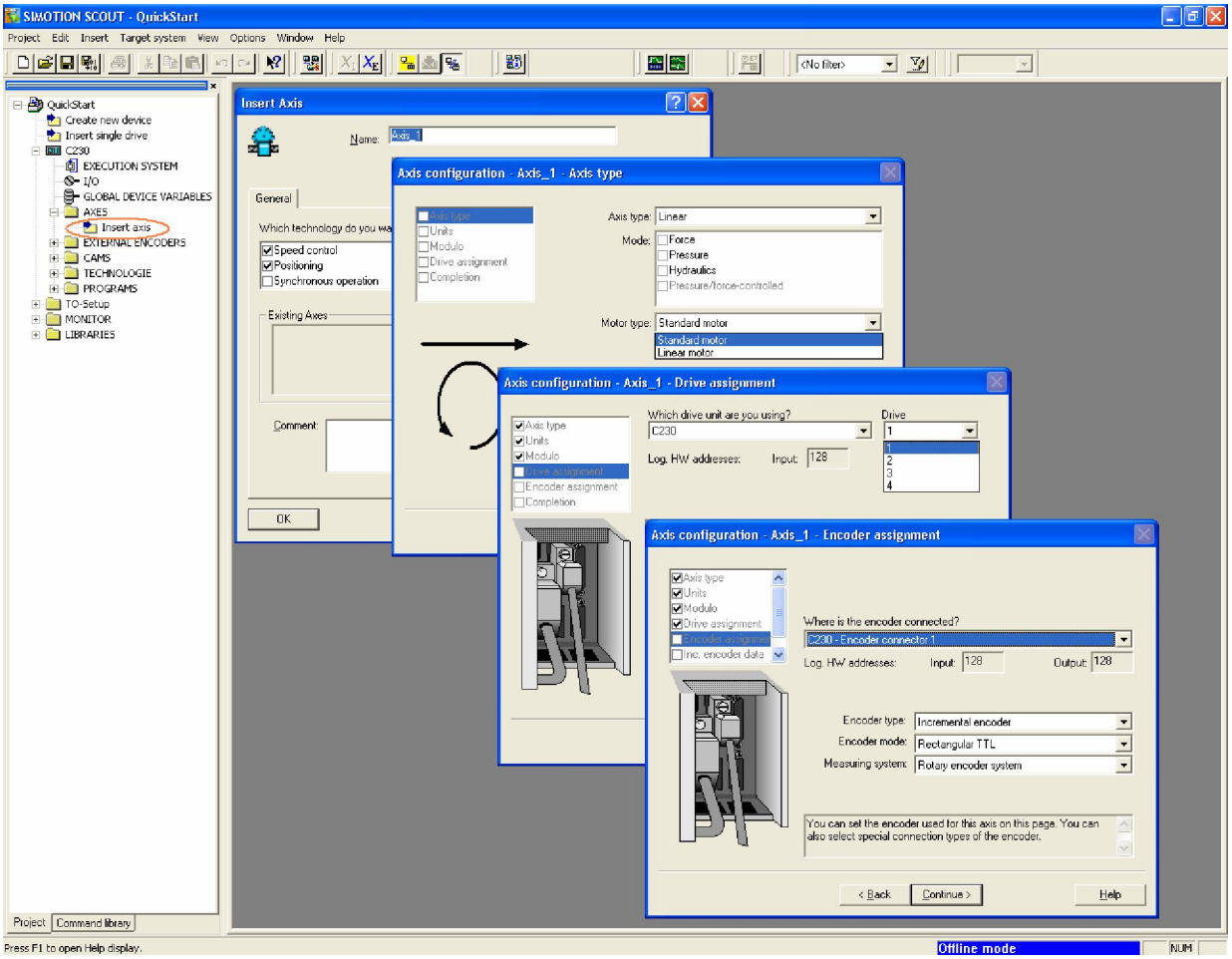


What does this mean specifically? Interfaces and communication between the controller and connected devices no longer have to undergo time-consuming configuration or programming. Using wizards, software objects are prepared with connections to actuators (drives, I/O, HMI, etc.) on the outside and a neutral external view on the inside (user program). As a result of this approach, it is now irrelevant to the user program which type of drive (digital, analog, electrical, hydraulic, etc), I/O (local, remote) or HMI is connected. Your user program communicates exclusively with software object that have been tested on their part for successful interaction with a wide range of devices.

Now, it's time to introduce some motion into our application.

<u>A Rotating or Positioning Axis in 10 Minutes.</u>

No problem with SIMOTION:



To accomplish this, you only need to perform a couple of steps:

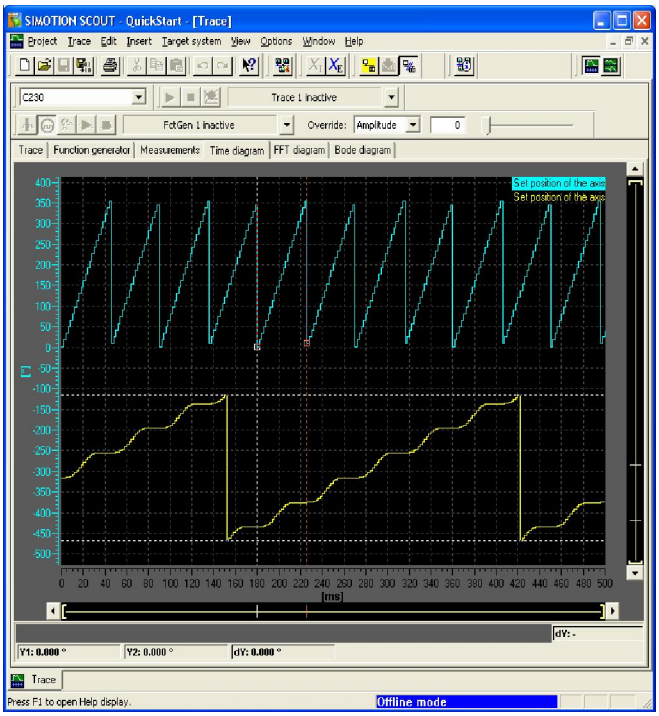
- Call the axis configuration wizard with “Insert axis.” Assign a name for the axis and define the axis functionality (drive axis, position axis, or gear axis)
- Define the axis type (linear or rotary, electrical or hydraulic, position or force-controlled)
- Specify how the drive is connected (analog or via bus)
- Specify how the position encoder is connected (direct or via bus) and the type of encoder involved (absolute, incremental).

You have just created an axis object that supplies the defined functionality and ensures the required interaction with the hardware object (drive, encoder).
Using the same simple method, you can create software objects for measuring inputs, cams, etc. In this way, you create the appropriate number and type of software objects representing your actual circumstances (i.e., actuators and sensors).

Now, back to the 10 minutes. Once you have created an axis object, you only have to download it to the controller. Then, as soon as the so-called Control Panel has been opened, you can instruct the axis to rotate, reference, or position. And this is possible without having to write a single program statement.

This is perhaps a good time to point out the impressive diagnostic, testing, and optimization tools of SIMOTION.

Optimization Tools Are an Integral Component of SIMOTION



It is without question that successful motion control has a lot to do with optimization. To ensure that output requirements are achieved along with homogeneous machine operation, the machine dynamics must be optimally tuned to the machine mechanics.

In the past, you often needed to use external tools to accomplish these optimization tasks. For example, you may have needed a battery box for applying setpoint step changes on the controller input and an oscilloscope for determining the controller behavior.
With SIMOTION, these tasks are much simpler because the functions are directly integrated in the system. An available function generator permits any signal inputs, and the integrated Real Time Trace provides signal sequences for further evaluation.

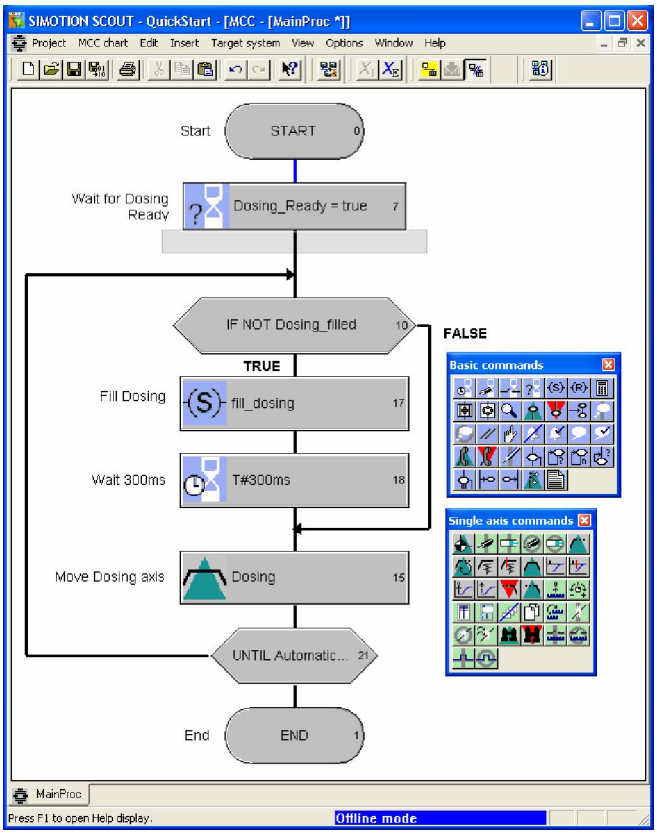
Programming with SIMOTION Is No Longer a Task for Experts.

In addition to the available functionality just described, your machine has its own individual behavior and must execute its own individual processes. Or, in other words: You have to develop an automation program describing the properties, operating modes, and process sequences of your machine.

In this way, the complete capability of the system is brought to bear. Although the system provides a high degree of flexibility, programming remains simple.

First, let's examine the matter of flexibility.
We noted at the outset that SIMOTION provides complete coverage of all functions required for total automation of your machine, thus minimizing the total number of interfaces needed. SIMOTION goes one critical step further. The traditional boundaries between motion control and PLC functionality are completely removed. From the programming perspective, you do not have to distinguish between PLC and motion control programs. Everything can be merged into one program. The resulting elimination of interfaces produces a system with unprecedented flexibility that can be optimally adapted to your individual machine.

High Degree of Flexibility Does Not Mean Complicated Programming and Poor Usability



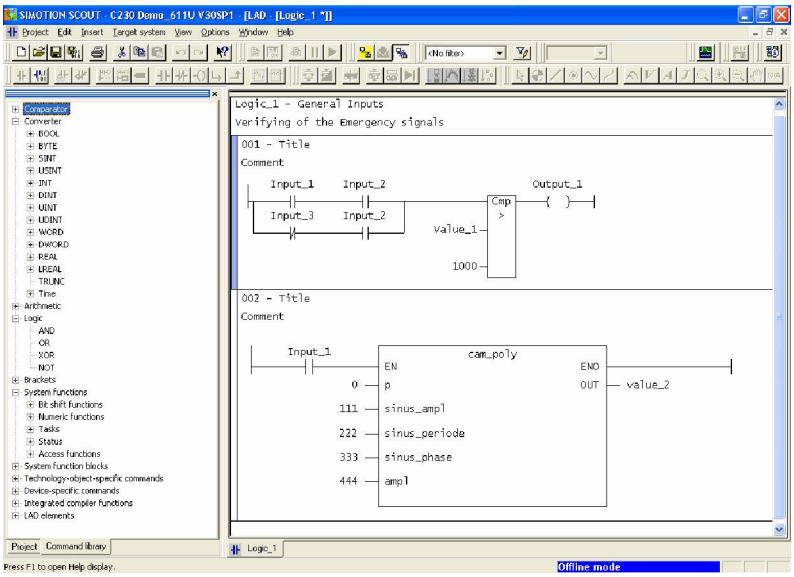
Motion Control Chart (MCC) enables you to prepare demanding application programs quickly and easily.

This graphical editor supports process flow-oriented thought processes. It consists of control elements that describe the process (e.g., IF, CASE, GOTO), scan for conditions (WAIT FOR …), and control the motion control functions (e.g., START POSITIONING, ENGAGE CAM), and also offers everything needed for I/O handling and data manipulation. All functions are displayed in a Toolbox, and the integrated structure functions permit a high degree of transparency and readability.

It is less of a programming activity and more of a process of graphically designing how your machine works.

Of course, you have access to all conceivable functions for documentation, testing, and diagnostics.

Although the performance, ease of use, and impressive documentation capabilities of MCC are unbeatable, SIMOTION also offers the traditional programming tools.



If you want to use LAD or FBD (IEC61131 languages) to program your application or a portion of your application, integrated editors for these programming languages are available. The option of using the high-level ST language for programming is also available. Of course, you can combine these languages, thereby enabling you to use the language that is most suitable for the task at hand.

SIMOTION – The Optimal System for Your Production Machine

As you can see, SIMOTION more than satisfies the requirements for a powerful complete control system for your production machine.

1. All technical functional requirements are satisfied by a single controller. As a result, you do not have to grapple with all of the disadvantages of a combination system.
2. You can choose the platform. You do not have to adapt your machine to the available hardware. Rather, you decide whether a PC-based or Controller-based platform best suits your machine. By the way, we should mention that a drive-based platform will be available shortly.
3. The question is no longer whether your machine runs but rather how long it takes to get it running. The powerful engineering system, streamlined to maximize ease of use, significantly reduces the upfront effort and the time required for engineering.
4. By selecting SIMOTION, you can experience the Totally Integrated Automation concept of Siemens – the concept in which all automation products, including drives and motors, are harmonized and work together, utilizing the same mechanisms for communication, engineering, and data management.