

Application Detail

Virtual versions of scalable distributed control systems (DCS) are now available that support the development of control-system configuration, logic checkout, and operator training using a single PC or multi-node PC environment. These packages are designed to be used on a laptop or office PC. Using this capability, it is possible to configure all of the features that the control system supports (for example, continuous control, batch control, advanced control, and their associated workstation displays, alarms, and historian data collection) without purchasing system hardware.

Using this capability, the execution is simulated for the operator interface and selected control modules defined for the plant control system. This capability is used for control logic checkout. And, using the control and I/O block and Fieldbus block simulation capability, field measurement values and status are manually supplied to the simulation—or provided by blocks used to simulate the process.

The full range of OPC features in the control system are available and may be used for the development and testing of OPC interfaces. Plus, before your plant is even constructed, the OPC-compliant process simulation package is used for process and control design checkout. Thus, most of the features of a complete control system are made available on the PC.

Using the virtual plant, it is possible to accomplish the following:

- **Engineer systems anywhere** – Engineering work is done without the constraints of working at a dedicated configuration station. The virtual plant is installed on a home or office computer or on a laptop. The work done on this computer is easily exported and quickly imported to the actual control system.
- **Verify control logic and display implementation** – Software modules configured for your plant control are executed in your computer for control and display checkout. Using the simulate capability of the controller blocks and Fieldbus I/O blocks, the measurement value and status are examined during the checkout of control logic, operator displays, alarms, and trending.
- **Test OPC interfaces**– The simulation environment fully supports OPC. Executing modules in the computer allows an OPC interface to be checked out completely. This feature is used to develop applications that can execute in the control system.
- **Support control system training** – Dynamic process simulations are created to support operator and engineering training one controller at a time. Function blocks can be used to create a process model or a process simulation package can be incorporated in the

virtual plant to create a training tool.

The control system provides an integrated development environment in which the continuous, sequential, and batch control for a plant are engineered. Using drag-and-drop techniques, the configuration of control is relatively easy, as shown in Figure 10-5.

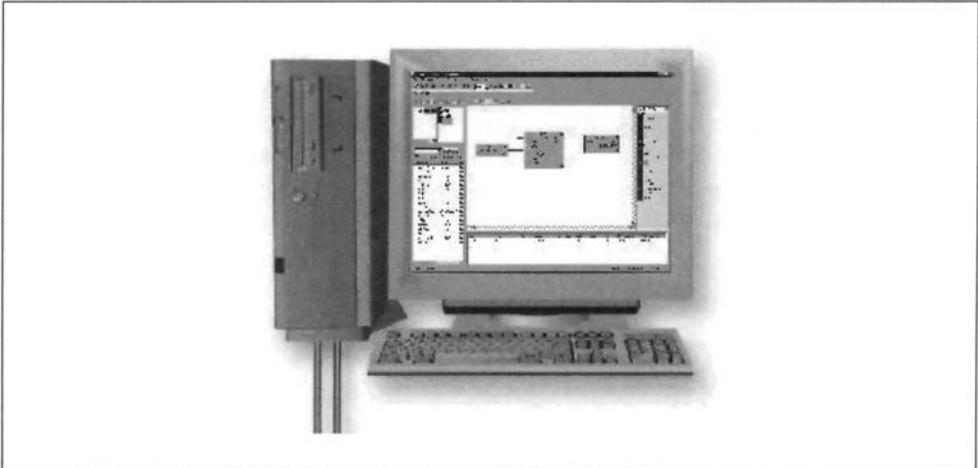


Figure 10-5. Integrated Development Environment

The Fieldbus Foundation architecture has been adopted by the control system. The control functionality that is assigned to a controller or Fieldbus device in the control system is executed in the PC and the results displayed in the configured operator interface, without any change in the control or operator interface configuration. Using the simulate capability of the control system and Fieldbus input-output function blocks, field measurement values are available for control-system and operator-interface checkout as shown in Figure 10-6.

Using the SIMULATE parameter of the controller and Fieldbus I/O blocks, it is possible to manually inject field measurement values and status to check out control logic, alarming, displays, etc. By changing the status or value associated with a measurement, the action taken by control logic execution of the control system in the virtual plant environment may be examined. Also, this capability is used to test whether block parameter values and status are displayed correctly in the screens designed for the operator interface. By changing the measurement value through the SIMULATE parameter, it is possible to force an alarm condition to verify assigned alarm priority and the manner in which alarms become visible to the operator; e.g., alarm banner in the operator interface.

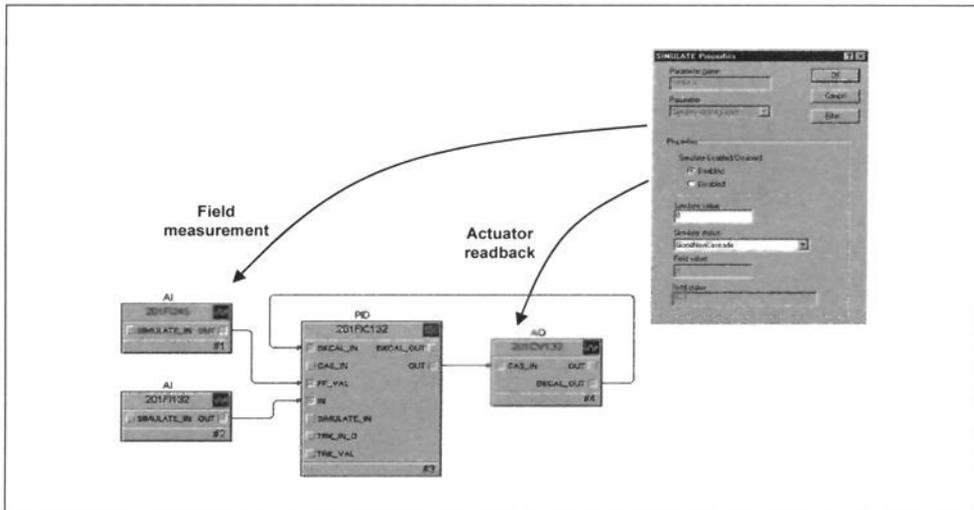


Figure 10-6. Standard Support for I/O Simulation

Dynamic process simulations are created to support process design and operator and engineering training. Using the standard function block available in the control system, it is easy to create a simple dynamic model based on the process design.

The standard calculation and dynamic blocks provided in the Analog Control and Math palette in control-system configuration tools may be used to construct a simple dynamic process model for testing control strategies and operator training. As shown in Figure 10-7, the process is simulated using function blocks that are wired to simulate inputs and outputs of I/O function blocks.

Application packages that support an OPC interface are compatible with the virtual scalable DCS. For example, as shown in Figure 10-8, this OPC capability allows the high-fidelity dynamic process simulation software to be used with the control-system configuration for plant and control design as well as for control checkout and operator training. Many process-simulation packages support checkout and operator training by the use of enhanced tieback simulations. These process-simulation applications utilize the simulate capability of the control system and Fieldbus I/O blocks, as illustrated in Figure 10-8.

An application and interface are provided in the simulation environment to allow the simulated control-system execution to be coordinated with the process-simulation execution. Using this application, it is possible to examine the state of the control simulation and whether I/O and control blocks are correctly set for simulation. Also, from this interface, it is possible to change the simulated control execution to be faster or slower than

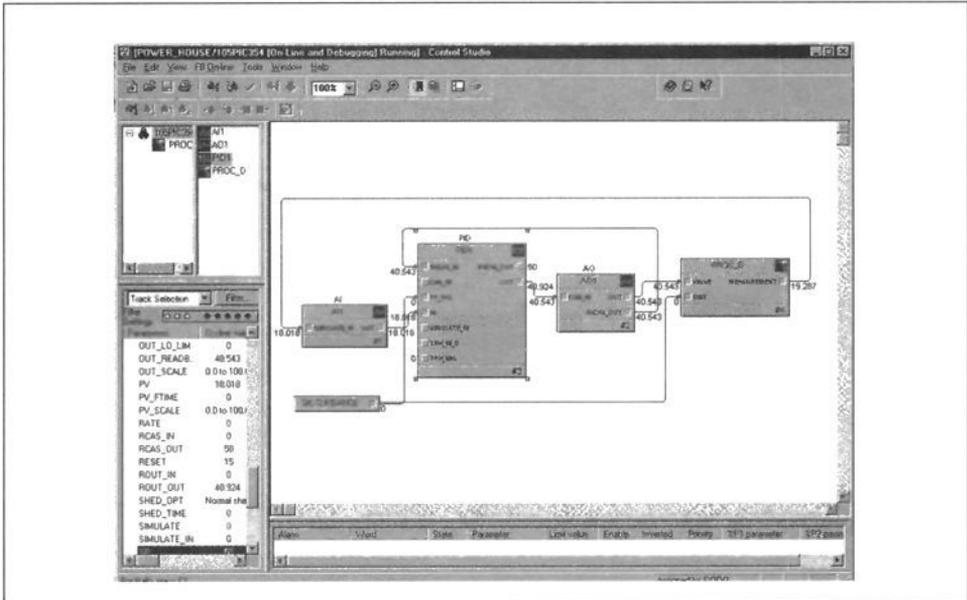


Figure 10-7. Process Models Constructed from Function Blocks

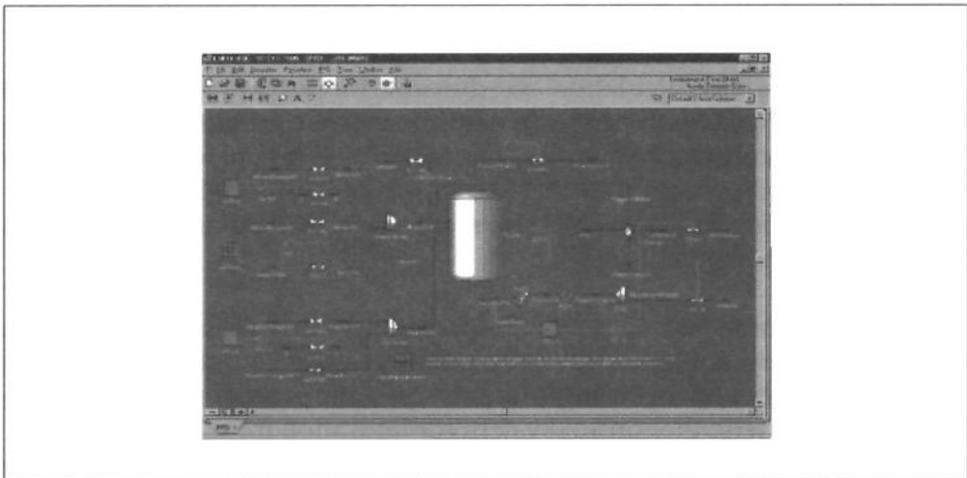


Figure 10-8. High-Fidelity Process Simulation

real time and to pause the execution. Common requirements such as the initialization of the simulation, block mode, and block dynamics are addressed. An OPC interface is provided to allow process-simulation packages to also invoke the same requests that are made through this user interface to the control simulation.

Rules of Thumb

Rule 10.1.— *The actual control system configuration and displays must be imported and exported from the virtual plant.* The use of a reconstructed or emulated control system and operator interface is fundamentally unsound. The actual configuration and displays and all the features of the actual system must be used.

Rule 10.2.— *The use of actual hardware instead of a virtual plant is costly, delays and restricts the access, and decreases the utility of a simulation for training and testing.* If an engineer needs something he can touch, give him last year's obsolete controller.

Rule 10.3.— *The process simulation must use an OPC interface to the control-system configuration and software tools.* This will facilitate the connection of the system to other advanced diagnostic, data-analysis, and control tools.

Rule 10.4.— *The definition of the information flow between the control system and the process simulation should be configurable and easily done without requiring programming knowledge.* The connection should be as simple as browsing and dragging and dropping tags in an interface table.

Rule 10.5.— *The process simulation and control system should support execution fast or slower than real time.* Also, the ability should be provided to freeze both.

Rule 10.6.— *The virtual plant should support single commands to initiate setup of the process simulation and control system to a known state.* There should be an ability to easily capture and restore the state of the process and control system.

Rule 10.7.— *It should be possible to run the virtual plant in a single PC or be distributed between multiple PC's.* No change in control-system configuration should be required to relocate where the process simulation and control system is executed.

Rule 10.8.— *The process-simulation software must be graphical and have high-level and a wide variety of physical property packages, state equations, and configurable functional blocks and unit operations.* Custom simulations that require the setup and numerical integration of differential equations are too complex to construct and maintain and do not have all the physical properties and their dynamic interaction with process conditions. If you spent the millions of dollars to create a custom simulation of an entire plant, only the programmers who created the custom model could debug and modify it.

Rule 10.9.— *To verify that the configuration matches the control definition and to teach operators how to use the interface, an enhanced tieback simulation is sufficient.* Configuration engineers prefer to use a tieback simulation to test their work so they don't have to get involved in the process or learn how to start and stop a process simulation. Also, these tieback models have an input and output file card channel (FCC) screen that lets the configuration engineer conveniently set and monitor input and output signals.

Rule 10.10.— *To test whether the control definition is correct, to learn how the process and control system behave for upsets, startups, and failures, and to prototype advanced control solutions, a high-fidelity dynamic process simulation is needed.* While the configuration engineer is too busy and will move on to the next project too quickly to take advantage of a high-fidelity virtual plant, it is a valuable ongoing resource for operators and engineers at the plant and can lead to real-time optimization. While this method does not check the I/O file card channels, these assignments are verified anyway as a part of the normal course of the checkout of the field wiring.

Guided Tour

This tour illustrates the potential ease of use and convenience of an integrated interface that is possible for control simulation embedded in an industrial control system. The following areas are addressed:

- Control Simulation Setup
- Coordination of Process and Control Simulation
- Viewing Simulation State

Modern control systems allow modules for control, monitoring and calculate applications to be engineered independent of where they are executed. Thus, a module is assigned to execute on controller hardware or a PC platform with no change in its configuration. Such capability makes it possible to take a control system configuration and quickly use this to construct engineering and operator training system based on PC platforms i.e. no controller hardware.

Modules that have been engineered for the plant control and normally execute in hardware controllers are re-assigned to run in the PCs that have the control system software installed, as shown below. When these modules are loading in the module folder on the PC as shown in Figure 10-9, the assigned modules automatically begin to execute at their configured rate of execution. Late binding of module information in the communications between the PC stations allows the operator and engineering interface to access the inputs, alarms, and calculate values associated with these modules without any change in system configuration.

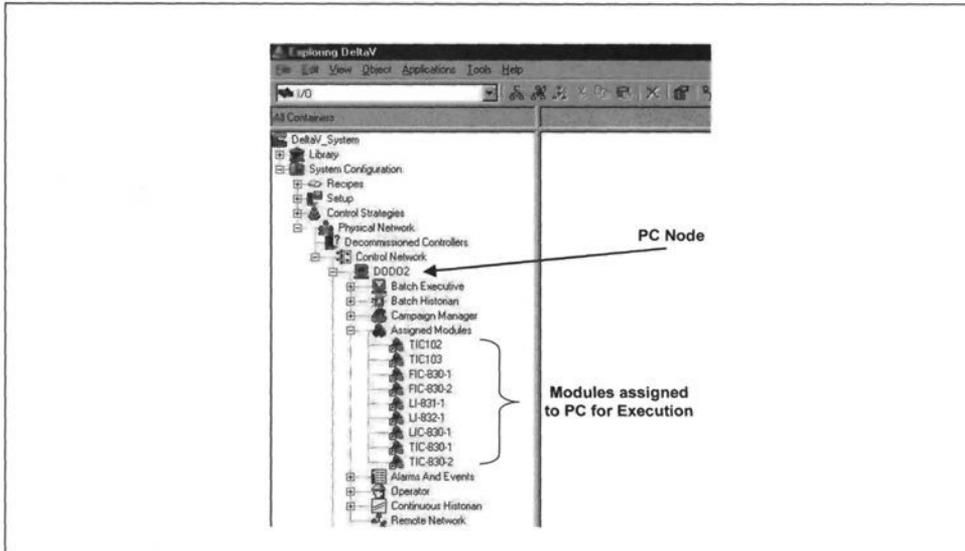


Figure 10-9. Module Assignment for Execution

Within the PC nodes that make up the virtual plant environment, an application may be added to provide process simulation. The process-simulation application may use OPC to read the actuator positions from the I/O blocks within the modules. Based on these values, the process-simulation package may calculate the process inputs and writing these values to the simulate parameter of the input blocks. Thus, within the accuracy of the process simulation, the measurement and control response will duplicate what is seen in the actual installation.

To provide an effective engineering or training system, it is necessary to coordinate the process-simulation package execution with the control-module execution. A simulate interface is provided in the control system for this coordination as illustrated in Figure 10-10.

Through the selection provided in the Setup, it is possible to:

- Enable or Disable the Simulate function of I/O blocks.
- Change Control and Output blocks to their setup mode so the process-simulation application may change these outputs to a known starting point in the simulation.
- Initialize the dynamic blocks in all modules assigned to the node so that they are at steady-state solution.
- Allow the operating state of all modules to be saved or restored at any point in time. This allows the simulation to be restarted at different conditions.