WinMOD®

Mewes & Partner

Process Installations: Factory Acceptance Test - FAT

Close to reality testing of automation systems with the simulation of the installation:

- **Assured Quality**
- **Shorter Commissioning and Start-up of Installations**
- **Coupling with the real PLC-, IPC-, HMI- and Bus-Systems**

The increasing complexity of automation systems and automation software tightens the requirements for functional testing before commissioning. Therefore, customers and suppliers are both seeking for means to minimize involved risks. This includes software testing, as well as early detecting specification errors. At the real installation, however, the available time does not suffice to achieve the required depth of testing. Consequently, testing environments with a simulated installation are a worthwhile alternative.

The Testing Problem

The quality of automation software to a great extend affects the availability of installations for production and the safety of operation. This is intensified by the increasing complexity of automation systems.

Quality assurance concerns three major areas: The applied hardware, the firmware, and the technological software project. The latter is structured into visualization, communication and control functions.

The software project is developed in a customer/ supplier relation and the development is completed with the acceptance of the software by the customer. For this purpose the software is tested during the Factory Acceptance Test (FAT) for if it fulfills the specified functionality. Today, three typical proceedings are common for the FAT:

FAT at the Real Installation: With this proceeding, errors in the software are detected late, what delays commissioning and start-up. Creating test-cases is tedious, detecting and repairing errors occupies the installation and time and costs pressure lead to a limited depth of testing.

FAT in a Special Test Lab: The controller hardware and software are installed in the lab. The controller I/Os are manipulated and observed, e.g. by switches and displays. The reactions of the installation and the process are imitated by the testing personnel. This proceeding is tedious and difficult to reproduce. As a result, personnel tends to test only situations that are simple and easy to survey. Testing complete process sequences or reactions to faults and hazardous situations is possible only in a limited way.

FAT with the Visualization System: The tests are performed without I/O-modules and process signals. The I/Os are marshaled to the visualization system and feedback loops are closed there. But in this way, actions are only caused by the control system and not by an independent process, as it is the case in reality. Consequently, only nominal behavior is tested and faults and special operating situations arising from the installation are rarely covered. In addition, the modifications of the control software are an additional cause for faults and errors.

This listing of testing situations does not claim for completeness or rating, but shows that conventional methods of acceptance testing and quality assurance are not satisfying, neither for customers, nor for suppliers. Hence a considerable need for improvement exists, and a profound potential for advances.

Software Testing with Simulated Installations

The simulation of an installation is a key requisite for improved acceptance testing. With this approach, the controller software and possibly also the controller hardware are tested in the original version, without any modifications. It is connected to a testing environment, formed by the simulation of the real installations (figure 1).

For this purpose, real components and simulated components are

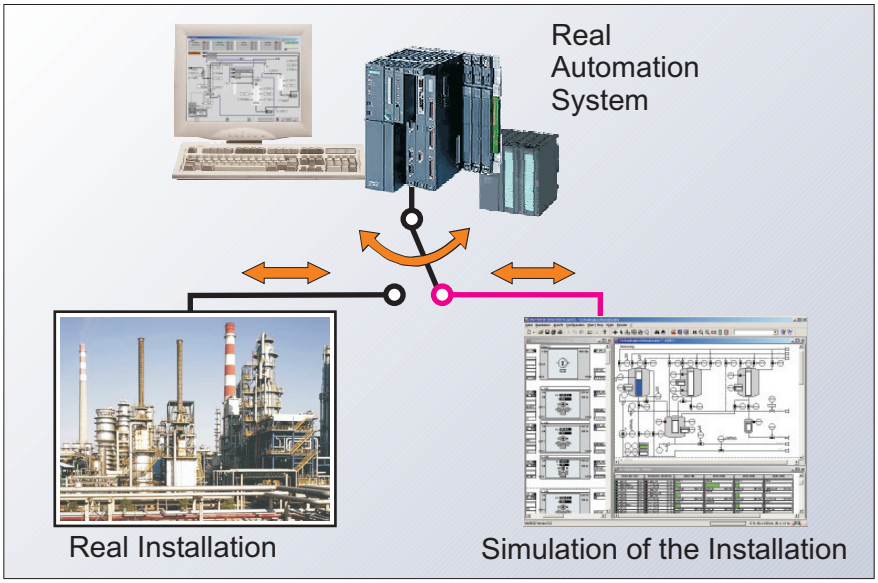

Figure 1: For the automation system, the simulated installation behaves as the real one.

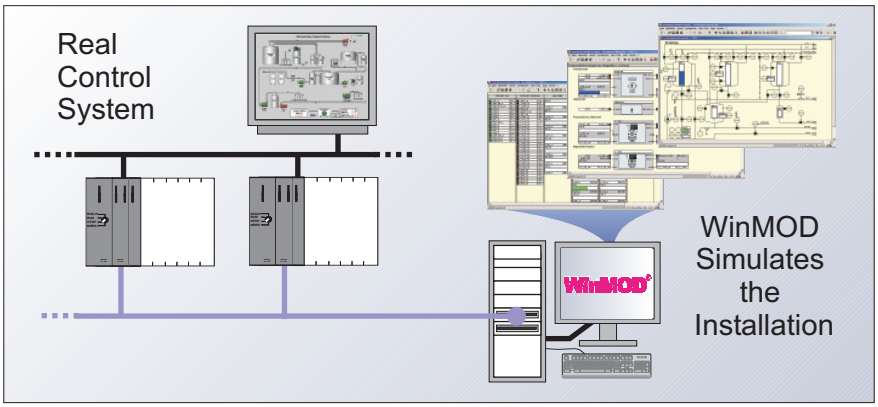

Figure 2: In the typical test scenario, the real control system is connected to the simulation PC where WinMOD simulates the installation.

combined in a way that enables operation of the original controller software. Feed-back loops of software servos are closed by connecting them to the (simulated) "installation" that returns signals with realistic values and timing.

A typical system for Factory Acceptance Tests (figure 2) consists of the original control system, that is connected to the simulation PC by a bus system, e.g. PROFIBUS. On the PC the simulation system is running that simulates the components of the installation, in especially the I/O-modules, the drives, the controlled systems and, when required, the behavior of the process.

The simulation system and the chosen bus communication have to provide the required real-time behavior, and the signal map of the real control system has to be fully processed also by the simulation. With these pre-conditions fulfilled, the simulated installation is, after testing, replaced directly by the real installation.

Requirements to Simulation Systems

These goals and requirements demand a simulator that is especially designed and developed for this purpose. It has to provide the communication abilities to the real control systems and it has to process the large amount of signals efficiently. It has to provide the needed ability for real-time responsiveness as well as a technological oriented user interface. Furthermore, it has to flawlessly integrate into the engineering processes at the user.

The simulation system WinMOD was developed for these requirements. The simulation project is created largely by import of data from existing sources. Signal maps are imported and connected with configurable signal elements by drag-&-drop.

Signals are inspected directly and are modified by a mouse-click in WinMOD. Test scenarios for typical and special situations can be stored, selected and executed automatically.

With the WinMOD functionality for documentation and data export, test results are easily exchanged between suppliers and customers. They are presented in a comprehensible form, also for technology oriented personnel. Such features are essential for the efficiency of creating and applying simulated installations.

Performance of Factory Acceptance Tests

When performing a FAT with the WinMOD simulation of an installation, the proceeding is basically the same as during commissioning and start-up with the real installation. In contrast to a conventional FAT, the behavior of the installation is available and tests are performed with realistic autonomous responses in real-time.

In addition, testing with the simulated installation enables new possibilities: Limit values can be freely exceeded and fault situation can be provoked in any situation without risk of damage. Test scenarios can be easily played through and enable to exactly re-produce fault situations. Finally, tests in simulation can not harm the real installation.

Advantage of FATs with Simulated Installations

With a Factory Acceptance Test performed with simulation, real commissioning and start-up are considerably improved.

The automation software did already run with a (simulated) installation and it was tested for more than only a limited number of cases. This makes a fundamental difference. With WinMOD, the depth of testing with respect to the number of nominal situations, fault situations or even specification errors does considerably increase. The technology-oriented user interface of the simulation enables to easily follow test procedures and their results.

Hardware efforts are considerably reduced, since the installation is simulated on a conventional PC. The place for acceptance testing can be freely chosen and is not limited to the installation site. In the same way, the point in time of testing does not depend on construction progress, but instead follows the completion of the software.

In this way functional faults and specification errors can be detected and corrected early before commissioning and start-up. Commissioning and start-up are clearly shortened, the risks are reduced, and commitment of capital and personnel is reduced. At the same time, plant safety is increased.

These advantages are considerable and proven in practical application. Suppliers and customers, who performed Factory Acceptance Tests with WinMOD, report their positive experience and that the approach and the WinMOD system are worthwhile.

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