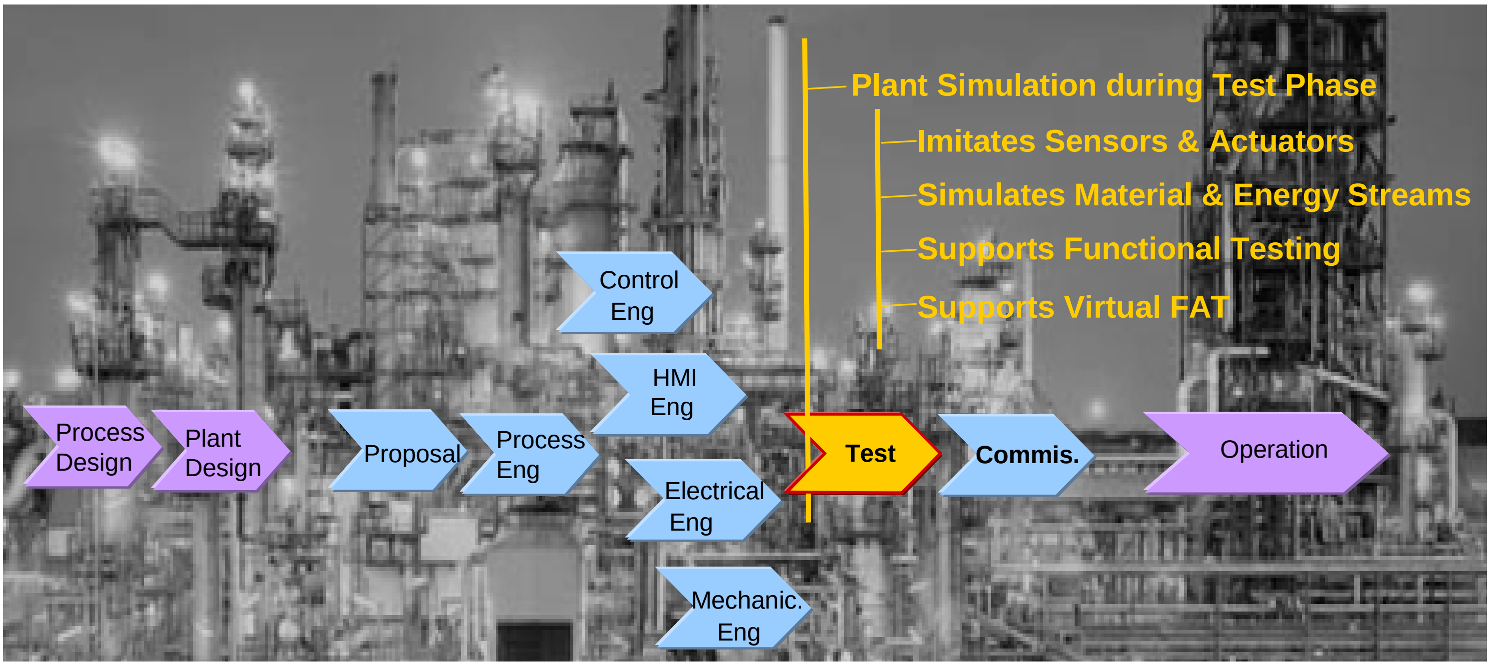


FAT Simulation Support

DECRC I3: Peter Weber, Jürgen Greifeneder

The task of the Factory Acceptance Test (FAT) is to ensure the functionality of the automation system before delivery to site. This covers a whole bunch of different tests ranging from simple address allocation & validation up to complex safety and control verification. Unfortunately, FAT is time consuming and expensive. In addition test coverage is limited due to missing instruments and plant equipement.

For this reason simulation is used to imitate those parts of the plant not installed on the test floor. The idea to apply virtual technologies to mimic missing parts – like sensors and actuators – was further improved by the FAT simulation project: Engineering effort is saved by automatically generating the model and by using this approach already during the application development phase.

Today's Situation

Quality assurance is a key to success in complex engineering projects. To keep a high level of quality while facing increased complexity and shorter delivery and commissioning times people have continuously improved their test environment. Nevertheless, in-house tests suffer from inherent deficiencies mainly the missing physical instruments and production hardware. Due to this IO signals, like "PumpStart" or "MotorRunning", have to be imitated as close as possible to reality. Different approaches are used today to mimic the behavior of the various instruments, as for example electrical switches and potentiometers, manual value forcing in the control builder as well as various simulation approaches. These simulation tools cover a broad spectrum ranging from own developed, specialized tools to simulate the sensors and actuators of a plant up to dedicated control applications that model the plant behavior on the controller. In some cases also commercial products are in use like Matlab/Simulink or AspenTech.

Independent of the approach chosen building the model requires a significant engineering effort. The higher the requirements upon fidelity, the higher the effort is to build the model. Moreover, commercial simulation tools generate additional license costs, introduce additional complexity and require specialists to maintain them. These drawbacks have motivated the authors to develop a solution approach, which overcomes most of the drawbacks of today's approaches and which is very well accepted by internal engineers as well as external customers according to their positive feedback.

Solution Approach

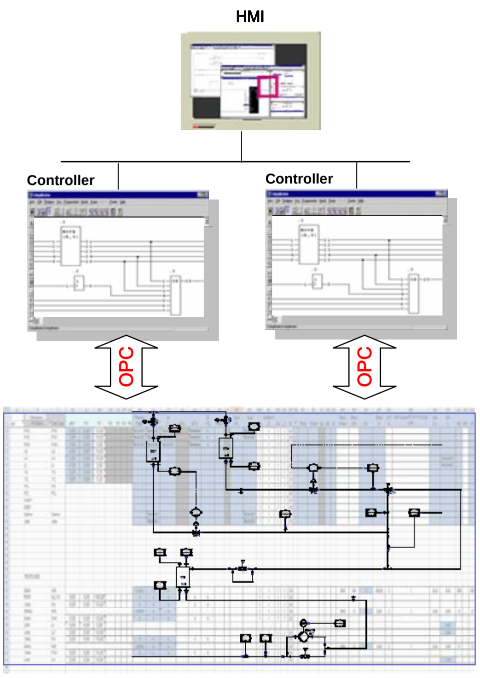
Interviews with several ABB engineering organizations identified the following key requirements:

1. It must be possible to embed the real control code and the HMI applications into the virtual test environment without any changes or special adaptations. This is to make sure that the applications installed at the customer site are the ones subjected to testing.
2. The model should be generated automatically; at least the additional engineering effort to build the model should be as minimal as possible. This is an important aspect that significantly increases acceptance by the engineers and speeds up the introduction of simulation technologies in the engineering process.
3. The simulation model should be highly scalable starting from an individual sensor or actuator up to simulating the complete plant. This allows performing tests already in early stages and a continuous support throughout the complete development phase.
4. The established engineering processes should not be affected by the introduction of virtual test environments nor should additional complexity be imposed. This implies that the investments in current solution libraries and engineering know-how is protected and can be continued on a smooth path to virtualization.
5. Depending on the application and the customers preferences different controller families are in use. Thus, the simulation concept must allow connecting different target controllers and also be open for future controllers to come.

These key requirements and additional input from the engineering organizations have been reflected against commercially available simulation products like Matlab/Simulink. Most of the requirements can be fulfilled by these applications at least after some adaptations but there is no automatic generation of the simulation model nor is there any generation of test records as needed for FAT or formal validation. There is also no data link to the automation system based on which engineering data can be extracted for automatic model generation. Taking additional license fees and intrinsic complexity into consideration the authors came to the conclusion to start an own development of a simulation environment based on MS Excel.

Technical Accomplishment

The requirements listed above can almost naturally be mapped to a conceptual design as depicted in the figure below



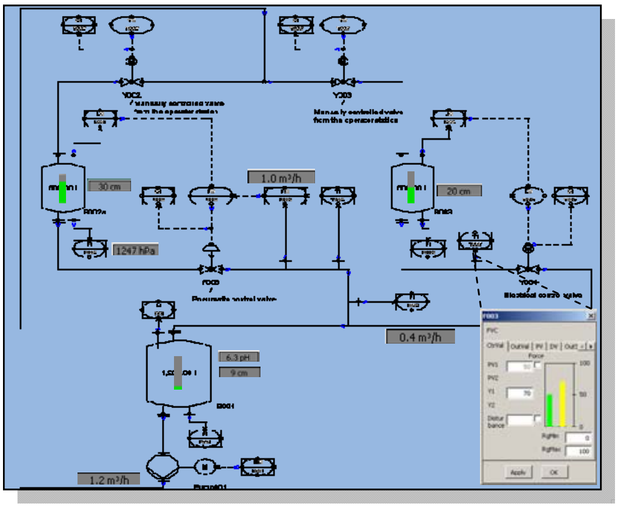
MS Excel based plant simulation

As illustrated in the figure the real production plant is replaced by a simulation model that imitates the behavior of sensors and actuators including the signals that interface the controller with the model.

The power of MS Excel in combination with VBA extensions was found to be absolutely sufficient to compute the state of the plant over time as needed for FAT testing. Moreover the model can calculate the material and energy flows in the plant as the physics has been implemented in Excel formulas to a certain level of detail.

On the control level either real controllers or soft-controllers can be connected to the model. In both cases the communication is based on the OPC standard, which allows interfacing different controller types as all of them provide OPC servers. The HMI station is also connected via OPC, and can be used as in its real environments.

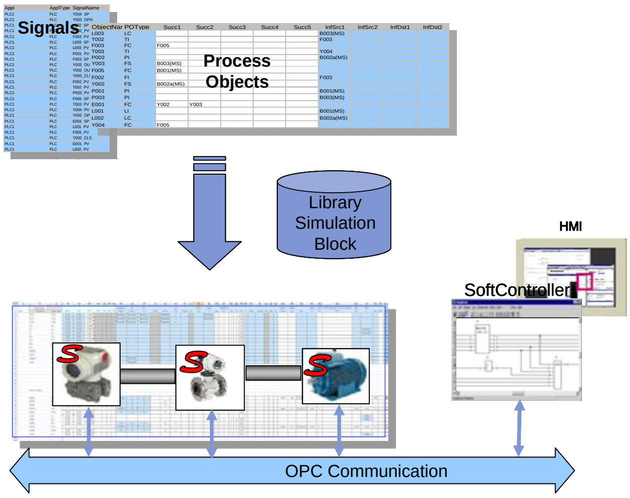
The simulation model can be controlled by different user interfaces. The most intuitive and important one is the P&I diagram that is also the base for implementing the control application. A hardcopy of the P&I diagram can be included into MS Excel. This hardcopy is then semi-automatically animated by UI controls like textboxes or bar charts.



Animated P&ID visualizes the simulation state

Model Generation

The model is generated based on predefined simulation blocks provided in a library that can be extended or adapted by the user. The information for auto-generation of the model is taken from the engineering system 800xA based on the open interfaces provided; the user browses to an individual object or a subset of objects to be simulated and the required information is read and compiled into the simulation model. The generation process itself is based on a pre-defined mapping of control solutions to simulation blocks in the library.



Model generation

Customer and ABB internal Benefit

Growing complexity, shorter delivery times and ongoing cost pressure have an impact on the quality assurance of automation solutions. The challenge for automation suppliers to keep or even raise the level of quality has been taken-up by DECRC. The approach to FAT simulation described in this article creates a number of benefits for ABB and its customers. The most important ones are shorter commissioning times, earlier start of production, a higher quality level of the automation solution and reduced cost for reworking. Finally, the engineering units' (P&P, O&G, BMI, Power) response to this contribution was really overwhelming. Consequentially a productization project has been started in 2009.

Contact

Peter Weber
phone: +49 (0) 6203 / 71 – 6274
e-mail: peter.weber@de.abb.com

Jürgen Greifeneder
phone: +49 (0) 6203 / 71 – 6222
e-mail: juergen.greifeneder@de.abb.com