Case study of the use of Simatic Batch at Ursus Breweries, Timisoara

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***Summary**: A new control system based on PCS7 was to be implemented in a brewery in Timisoara, Romania. Due to the client's requirements Simatic Batch was recommended as a method through which full operator control of the control system is provided with minimal direct interaction with the low-level control logic. The implementation of Batch through the course of the project and the current use of Simatic Batch is evaluated in this report.*

1. Introduction

Compania de Bere Romania, a subsidiary of SABMiller (plc), recently installed a new Brewhouse, together with Cellars for fermentation, in Timisoara, Romania. This Brewhouse and Cellar were to replace the existing system which was based largely on manual control. The decision was made to develop and implement a fully automated control system for both sections of the brewery based on programmable logic controllers (PLC's) and computer-based sequence definition and control. Simatic PCS7 with the use of Simatic Batch was identified as the preferred method for implementation of this type of control in the brewery. This combination would ensure a large degree of automation of the control system, yet at the same time providing the Brewmaster with simple tools for sequence definition without the need to modify the base Automation System (AS) software.

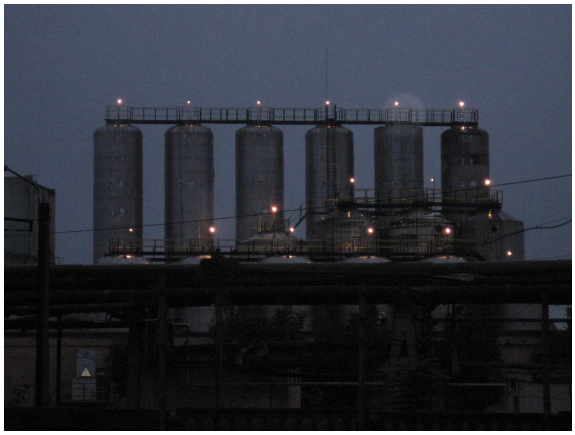

Figure 1 – Some of the vessels used in the Fermentation Cellar.

2. The user requirements

The brewery has been operating since 1718 and produces a number of popular brands of beer. One of the user requirements was a fully automated system that would ensure the consistent production of a brand of beer at a high rate of efficiency. Thus, the same method for making a brand of beer is required. This would make the operation more predictable, which is vital as the brewery was in full production continuously and cannot afford complications in production.

Another requirement from the end client was the conformity of the Batch control system selected to the ANSI/ISA S88.01 standard for Batch control of a manufacturing process. This would help to ensure the quality control and efficiency of such a system.

A major requirement was the low-maintenance of such a system. The system needed to be robust, which would minimise down-time. Such a system had to be easy to use to troubleshoot problems in the respective plants, while at the same time requiring little need to resolve problems on the system itself.

The control system had to be completely flexible, allowing the Brewmaster to produce different brands of beer with ease, easily modifying recipe process set-points and modifying the process operation steps to meet the production requirements. The system also was to be simple to use for any computer-literate person, whether they possessed engineering knowledge or not.

3. Simatic Batch and its benefits

Simatic Batch is a high level method of control which can be applied to a pre-defined PCS7 project with the required Batch interface blocks, and SFC blocks configured for use from the Batch level. As such, once a project has been completed and commissioned according to the client's requirements, the client has complete control of the automation system without needing to modify the lower level control.

The control sequences can be logically defined in ways similar in concept to flowcharts, with the steps utilising control provided by the SFC's. Instances of these sequences can be run when

required (on-demand, time-based or sequentially) as part of the process, and fully monitored as each step is executed and displayed graphically. Sets of recipes can be planned and run throughout the period of production, and full planning is provided by Batch for this purpose. Should a problem arise the user has the ability to pause the recipe, and even to end it immediately if required.

Each unit (such as a tank or material distribution route) is allocated completely while devices (such as valves or pumps) within the unit are required for the process. Thus, there is no conflict between processes for the use of the unit. It is a major requirement that good design has been undertaken to prevent the use of some devices in a unit while other devices in the same unit are also required.

Simatic Batch has been designed to conform with the requirements of the ANSI/ISA S88.01 standard for Batch Manufacturing Control Systems[1]. Thus, all of the requirements of this standard are met through the design and implementation of recipes with pre-defined control, with the use of formulas and materials required for the process.

Simatic Batch also allows the archiving of completed batches, together with the generation of reports which can be kept for future use. Data can also be logged while the recipe is under way, and this can be compiled into reports for quality purposes.

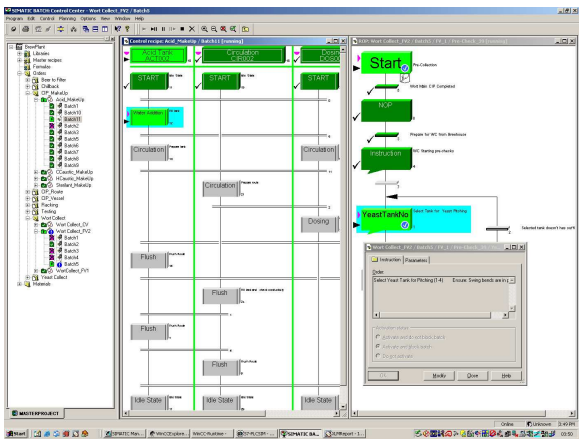

Figure 2 – The standard operation of Simatic Batch.

[1] Brandl, Dennis. '*S88.01 – The Standard for Flexible Manufacturing and Batch Control*'. www.batchcentre.tudelft.nl/standards/s88/S88%20Overview.doc, Last accessed 18 October 2005.

4. The implementation of PCS7

The base logic of the control system is provided with PCS7. Thus, each device in the control system is viewed as a complete object. That is, it is associated with a pre-defined set of I/O's, is defined and controlled using CFC logic, and is visible on the SCADA as a single device with its alarms, real-time trends and information pop-ups. Further control is provided with the use of SFC's located in the CFC's, where pre-defined control strategies are contained for the complete automated use of the associated device. Each device is part of a local control unit called an equipment phase, which itself comprises a section of a plant unit. Thus, PCS7 provided the user with platform for control where each device can be manually controlled and operated, and a high degree of consistency in operation can be achieved.

The complete process as can be operated in remote-manual control with the basis of PCS7. Thus, should the automated sequences be unavailable for use the plant will still be functional.

5. Implementation of Simatic Batch with PCS7

Simatic Batch V6.0 (which was used for the Timisoara project) operates in conjuction with WinCC, and communication with the equipment phases takes place via the WinCC data manager. Batch co-ordinates the processes which should occur via the pre-defined strategies within the equipment phases, and allows control at the AS level to occur as required. In this way, basic control at the AS level (such as with a PID control) can be started by Batch and ended once a setpoint defined in Batch is achieved, but the actual control takes place at the AS level.

All of the functionality provided by PCS7 which is pre-defined and coded in the SFC's and CFC's according the process is compiled into a process cell used by Batch. With this information the sequences (called recipes) can be defined in a flow-chart format with a clear beginning and end to the process. Each unit required by the process is selected for the recipe, and all equipment phases (with their associated control strategies) can be used in any order, at any time. Thus, complete functionality is provided to the Brewmaster who can modify the processes to meet the production requirements.

Another benefit of using Batch in conjunction with PCS7 is the ease with which problems in the

processes can be identified and resolved. With the use of SFC visualisation the recipe operation for the specific equipment phase can be completely monitored where necessary. Thus, there is no need to undertake trouble-shooting at the AS level, and the operators can identify problems and notify the specific personnel. This ensures that the AS-level code will not be modified except by trained and authorised personnel. Also, the processes taking place within each unit can be displayed continuously within the SCADA environment without the installation of Batch on the machine, allowing the operators to maintain control of the process.

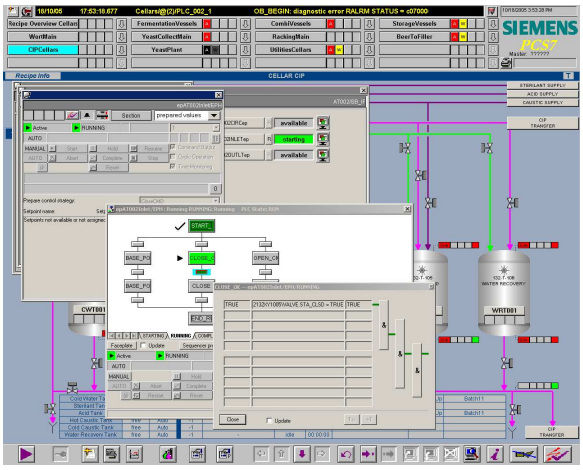

Figure 3 – Troubleshooting recipe operations in the WinCC environment.

6. The implemented system – the Brewhouse

The first phase of the project undertaken by the client was the replacement of the old manually-operated Brewhouse with a new, fully automated Brewhouse using PCS7 and Simatic Batch. This phase of the project was undertaken and completed by Siemens with some assistance by SAM. Towards the end of this phase, as the new Brewhouse became fully operational, the production load between the two Brewhouses could be changed so that the new Brewhouse could replace the old one.

The Brewhouse control system comprised the following:

At the AS level, one S7 417-4 PLC was used with required communication modules, together with several ET200 distributed I/O stations.

At the OS and Batch level, two WinCC servers were configured for redundancy. Two client stations were also configured on the two Batch servers, which were also configured for redundancy.

7. The implemented system – the Fermentation cellars

The second phase of the project was similar in concept to the first phase, as a new Fermentation Cellar was built to replace the old Cellar. This second phase was implemented and is being currently completed by SAM. PCS7 and Simatic Batch was again implemented for the automated control.

The Cellar control system comprised the following:

At the AS level, one S7 417-4 PLC was used with required communication modules, together with several ET200 distributed I/O stations.

At the OS and Batch level, two independent WinCC and Batch enabled stations were configured for controlling the Cellar, directly connected to the Cellars PLC. In time, these stations would become clients on the Brewhouse network, one for WinCC and one for Batch. The PLC would then be connected to the Brewhouse Industrial Ethernet network.

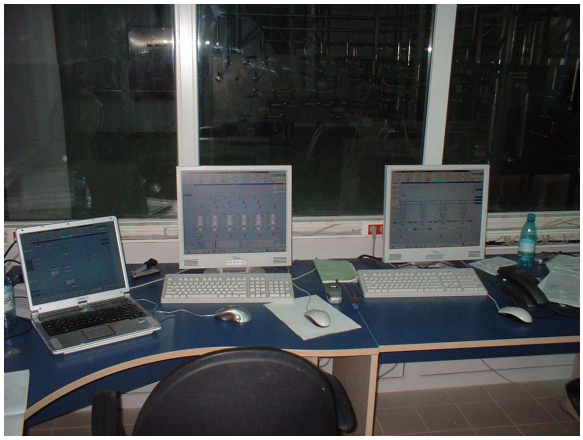

Figure 4 – The two independent stations in the Fermentation Cellar prior to the project merge.

The Cellars project structure was relatively simple due to the Cellar configuration. In the Cellar were 12 Fermentation vessels, 8 Combi Vessels (which could be used for either Fermentation or Maturation) and 6 Storage Vessels. Each of the vessels in each set were identical in function, and the Combi Vessels possessed the functionality of both types of vessels. Each vessel was assigned as a unit, with equipment phases based on the operation of the type of valves associated with the vessel (i.e.

Drain, Isolation, CIP and Transfer). The standard operations (such as opening and closing valves) were defined in the SFC's, together with the process specific functions (such as opening the valve after a certain time). Another set of units was for the sets of valves required for transferring beer to the tanks from the Brewhouse and transferring beer between the tanks etc. Specific lower level control also had to be added to allow the automatic route selection based on the tanks currently in use, as well as the chase water volumes for preparing the routes for transfer. Units were also defined for the CIP (Cleaning in Place) Plant and the Yeast Plant.

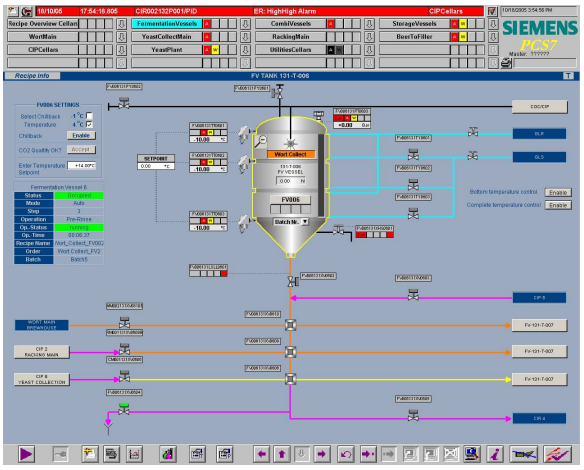

Figure 5 – One of the Vessels with associated devices as displayed on the SCADA.

The main emphasis of development was to allow the operator as much control at the Batch level as possible, without needing to modify data at the AS level. The main areas at which AS modification is required with the developed system is with operational setpoints for identical processes performed using the vessels, as a single recipe is used for each type of vessel. However, once recipe commissioning has been completed these setpoints should be set indefinitely and will not need to be modified at any stage.

A standard set of SFC's were used for the different types of vessels. Thus, only three different types of recipes needed to be developed in Batch (depending on the process). This allowed recipe instances to be created where the operator is able to make a selection between different units (such as different vessels to receive beer from the Brewhouse. This was also preferable for maintenance and making modifications to the unit operation at a single location for all units of the similar kind.

A lot of design needs to take place before such a system can be successfully implemented. As the program structure at the AS level affects the Batch level operation much care has to be taken to ensure correct and efficient operation for the specific set of processes.

8. Merging the two projects

As part of the pre-designed system, the two PCS7 projects (for the Brewhouse and Cellars) were to be merged so that a single set of redundant servers for both WinCC and Batch were to control the process. This merge was a complex process, as manual merge operations had previously been undertaken where conflicts with the equipment phases had been encountered. This resulted in the loss of functionality at the recipe level, rendering the pre-defined Brewhouse recipes invalid. Towards the time of completing the automation on the Cellars, the two projects were merged by the author's colleague in Germany with the assistance and verification of Siemens. Once verified, the single project was implemented on site, and the complete system was re-configured with the servers and the new clients in the Cellars. One Engineering Station is now used for configuring both sections of the control system.

Figure 6 – The top of the Fermentation Cellar, with the Brewhouse in the distance.

9. Evaluation

The expansion possibilities for such a system are great, as demonstrated in the merging of the Brewhouse and Cellars control systems into one, complete system. However, due to the complex nature of the merge, it is a risky operation. However, at any stage further plant sections with a large number of extra devices with their associated equipment phases and units can be added to the

control system. Also, the processes currently operated can be further diversified and enhanced in many ways. The method of extending the plant in this way is complex and needs to be undertaken by trained personnel, but the flexibility for operation provided by the combination of PCS7 and Simatic Batch is a major benefit.

Another requirement of such a system is good initial design. The structure of the control system needs to be implemented initially with all future PLC's, which will avoid the need for a project merge at a later stage.

In such a system, the use of redundant servers for both WinCC and Batch is critical. Should anything happen to one of the servers, or especially in the case of an upgrade or addition of extra functionality while the control system is required for process control, the redundant partner will be able to continue to support the operation. This was critical in the second phase of the project (for the Cellars) where the Brewhouse was currently in full operation and could not be stopped for any reason.

In general, the control and automation provided by the combination of PCS7 and Simatic Batch proved to be effective in the Brewhouse and Cellar environment, where the process is controlled from a high level perspective and the process is not too time-critical. In special cases an operation can be controlled at a low level (such as in a PID loop) using normal control defined in CFC's. Multiple processes can be controlled and monitored simultaneously in different sections of the plant via the use of Batch, and the full functionality of each process provided by the PCS7 foundation allows the Brewmaster to make any modification to a sequence without technical knowledge.

10. Conclusion

Such a project was successful due to the commitment and dedication of the Systems Integrator, the client High-Tech Processing and the end client (Ursus Breweries (SA) in Timisoara). Although the use of Simatic Batch in the brewery environment is new, the use of the software in conjunction with PCS7 as the base control system eliminated many potential problems. The use of products from a single OEM also eliminated many possible incompatibility problems. The high level of product and technical support also helped to overcome the problems that arose.

11. Acknowledgements

Such a project could not have been completed successfully without the support and assistance of Siemens (South Africa). Their advice and co-operation helped to resolve many issues that arose during project implementation. The aid of Siemens AG A&D (Germany) was invaluable in completing the project merge as well as identifying means to generate reports from Batch archives. High-Tech Processing's assistance and contribution to understanding the process was also appreciated.