ANDRITZ Automation

A CASE STUDY OF THE USE OF ACTUAL CONTROLS IN SIMULATION TRAINERS

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ABSTRACT

Results from this case study have shown that by using actual DCS controls, rather than emulated controls, several benefits to both the process and substantial savings in the overall cost have been realized, including:

- The model can be used to test the control logic systems of the plant before it is operated.
- Modifications to the configuration can be made before plant operation.
- That the operators are trained on the actual DCS terminals and use the actual interlock system.

1.0 INTRODUCTION

This paper will discuss the Kiani Kertas project, in terms of the IDEAS training simulator and the use of actual DCS (Elsag Bailey system) with the simulator. IDEAS, a process engineering dynamic simulator, has been used in modelling of process systems, and construction of training simulators, for a wide variety of clients and industries, including MacMillan Bloedel (pulp & paper), Cominco (metallurgy) and Philip Morris (consumer product).

IDEAS performs mass, energy and momentum balances, and offers pressure/flow solutions for complex piping networks. It can utilize over 60 components in solid, liquid and gaseous phases. One significant feature of IDEAS is that it allows interactive operation, therefore modification, scenario analysis and optimization.

IDEAS can be used as a single modelling platform for process design1,2, advanced control design/testing3, DCS configuration checking, operator training and process optimization4. In the Kiani Kertas project, the training simulator was designed and staged in Vancouver/Atlanta, whereupon it was transported to Samarinda, Indonesia, and used to train the operators prior to plant start-up.

This paper will discuss the advantages and disadvantages of using an actual DCS system with the training simulator, rather than using emulated DCS I/O objects. In addition, this case study will also discuss the various problems that occurred, as well as the solutions found.

As well, this paper will consider the directions and trends in training simulators and the respective benefits to these trends.

2.0 PROJECT DESCRIPTION

Figure 1: East Kalimantan Pulpmill

P.T. Kiani Kertas has built a bleached kraft hardwood pulp mill in East Kalimantan, Indonesia. The mill is designed to produce pulp at a capacity of 1500 ADMtpd (air dry metric tonnes per day) initially from mixed Indonesian hardwoods and eventually from plantation Acacia and Eucalyptus. The mill incorporates state-of-the-art technology which satisfies both environmental and process demands.

The purpose of this model was to assist in the verification of the controls strategy, check the original process design, and to perform training of mill supervisors and operators in an on-site training program, prior to mill start-up.

A total of 14 models of individual areas within the pulp mill, including the Water Supply/Effluent Treatment, Washing, Screening, Digesting, Oxygen Delignification, Bleach Plant, Chemical Preparation, Pulp Machine, Power Boiler, Steam Distribution, Evaporators, Recovery Boiler, Causticizing, and Lime Kiln.

Design of these 14 models was performed in both Vancouver and Atlanta, with the staging of the models being in Vancouver with the exception of the RDH digester which was staged in Atlanta. Actual DCS equipment was used during staging, complete with mill configuration.

3.0 PROJECT CHALLENGES AND RESOLUTIONS

3.1 Model Building

As stated earlier, the project focus was to provide simulation models for an entire pulp mill which would be used to test the DCS configuration and to train process operators. There are several methods of using dynamic simulation to provide operator training:

- A PC using emulated process and emulated controls.
- The DCS using emulated process and emulated controls.
- The DCS using emulated process and real controls.

The third method, while it does involve extra DCS control hardware, has proven to have many advantages, both in the short term for the project and in the longer term for operations. Using this method the DCS supplies both the operator interface and the control logic using the controllers that would operate the actual plant. The advantage of this approach for this project was that the models of the process could be used to test the control logic during the engineering phase. Logic changes were tested against the models and corrected during staging. Without the use of the actual controllers this step would not be an option. The long term advantage to the actual controller approach is that changes to the control logic can be implemented within the simulator without changes to the simulation. This advantage means that the long term maintenance costs of keeping the simulator current with the actual plant configuration are minimal. The approach of emulating controls on the simulation computer requires changes to the simulation every time the configuration in the actual plant changes in order to keep the simulation current. Accumulated cost over time will exceed the cost of extra control hardware.

It was decided on the Kiani Kertas project that the model worksheets would include the process and minimal worksheet controls, but that testing start-up and shutdown logic and other complicated interlocking would wait until the DCS configuration arrived. This approach was thought to save both time and money in eliminating the requirement to reproduce the control logic on the simulator. In practice however, the configuration arrived too late to be used in the model debugging process and the additional hardware needed was at times a burden to obtain. This was resolved by adding additional controls on the worksheet, sufficient for model debugging and then provide a switch object that could divert control from either the simulation controller or the DCS controller. This capability provided two important flexibilities. Areas which ran on different DCS controllers could be switched to local worksheet control, minimizing the need for DCS controllers. In addition, the move from worksheet control to DCS control could be exercised either one loop at a time or globally. In practice the controller migration from DCS to worksheet was done one loop at a time and progressed very smoothly. The ability to have local controls on the worksheet meant that the dynamic process models were tested thoroughly before DCS staging began, additional DCS hardware for model verification was not required, and DCS configuration was not on the critical path of model development. Model development and DCS configuration programming developed on parallel paths and were brought together during the staging process.

3.2 DCS Model Based Staging

The DCS chosen for the Kiani Kertas project was Elsag Bailey. Elsag Bailey allows low level communication to the input/output devices using a card located beside the controller called a Universal Simulation Module or USM. A Sun workstation was used as a server that would communicate between multiple USMs and multiple Power Macintosh computers. Within this architecture different mill areas could be simultaneously tested and debugged saving time during the staging process. In addition, configuration problems that were detected by the simulator could be corrected and the controllers put back on-line within minutes allowing a fast turnaround on any logic changes. It became apparent, however, with the first process model (the Power Boiler) that the time taken to check individual loop settings such as transmitter ranges and addressing errors would be excessive.

After "brainstorming" it was decided that staging would be done in two passes. The first would be on a "virtual test panel" simulation worksheet that would allow the DCS configuration to be tested for addressing errors, ranges and single loop logic errors.
Then, the configuration would be tested against the full dynamic model for inter-loop logic errors. This two pass system proved to be the key to staging success. The virtual test panel was six to eight times faster than the traditional hardware test panel for finding and correcting errors, and the configuration was then ready for full model testing in much better condition. The remaining areas of the mill were tested using this approach with great success. Because the project was the responsibility of a consortium, vendor representatives were invited to Vancouver to witness the staging process and to agree to logic changes that were discovered as a result of the staging process. Vendor representatives were at some times pleased to see resolutions to control issues that had been issues for a number of years on different projects resolved. Client representatives were then invited to witness staging as well.

At the completion of staging, the models were prepared for training by adding the training scenarios. The Scenario Manager object communicates with certain objects on the worksheet to provide failure mechanisms that would be common in the actual plant as training exercises for the process operators. Scenarios were provided by the client in communication with Simons Technologies. Once the scenarios were added to the worksheets they were ready for shipping to the site at Samarinda, Indonesia.

3.3 Operator Training

Upon the completion of staging, the simulation hardware and software was shipped to site, after which it became apparent that more DCS support was required than anticipated. Although the software on the DCS and the simulation software was debugged and tested prior to shipment, an earlier version of the DCS software was loaded at site. In addition, the batch programming section of the DCS software was not loaded, which made sections of the Power Boiler logic inoperable.

With assistance from Elsag-Bailey in Singapore and our Simons Technologies engineer, the DCS software was re-compiled and the client DCS support engineer loaded the batch programming code. In future we will determine the revisions required of all DCS software at site and allow more time for systems setup. When training commenced, it became apparent that the operators had not been trained on interlock logic. This made the training on the simulator a frustrating experience, because if a system was interlocked, then the operator did not know how to get the equipment operation past the interlock.

After meeting with the client it was decided that, as a prerequisite to simulator training, certain basic requirements had to be met, and an understanding of interlock logic was crucial. Time was then spent by operations personnel in gathering and training on interlock logic sequences, and subsequent training on the simulator was dramatically improved. Had operators arrived on the actual boiler without interlock training, then start-up would have been more drawn out. As it turns out, the boiler was brought on line in short order.

Another problem area that was uncovered by the simulator was the difference in units between some of the vendor training material and the units that were displayed on the DCS. Because the units in the manuals in one area were in volume and the units on the DCS were in mass, the operators did not know what the set points were for start-up. The units on the DCS have precedent because they contain the latest information regarding the final control elements chosen. Having access to the simulator corrected this problem in enough time to make to correct information available for start-up.

Also during operator training, operators discussed small changes to the DCS configuration that they would like to have implemented. These changes were then routed to the site engineer who would obtain vendor approval and make then make the change. Additional client involvement during staging would have minimized these requests, but they were still contained and implemented prior to start-up.

Simulation training style also evolved during time spent at site. The original intent was to perform traditional north American style classroom training that would be delivered by an instructor in English and then the students would take the knowledge from the classroom environment and try it on the simulator. Simons Technologies was to provide training on how to use the simulator for key client trainers. The client trainers would
then perform all operator training. At site it became apparent that the expectation was that Simons Technologies needed to expand the scope and provide assistance to client trainers and

perform most of the training. We then sent a key start-up person to site and he assisted the client team in understanding mill operations. In addition, upon observation of the learning methods of the Indonesian people, the teaching methods were adjusted and the classroom/instructor style was discarded in place of a workshop oriented approach. This approach had the operators work more in teams and solve start-up problems on the simulator in a group interactive setting rather than a classroom environment. This change of teaching method to match the learning style allowed more access to the simulator by the operators and in a way that facilitated learning. At times however, there were too many operators crowded around too few DCS screens, but additional training time resolved that issue.

4.0 DISCUSSION

As the advantages outlined in Section 3.0 show, the use of actual DCS controls, the ability to check the DCS configuration prior to plant start-up, training manuals embedded within the simulator, and the capability of the trainee to use the actual DCS screens for the plant are of very great benefit, particularly in terms of a cost saving. Therefore the trend that is occurring within the industry is for a new generation, completely packaged training simulator, complete with DCS configuration check, training manuals, and evaluation system.

For example, in a project now underway, Simons Technologies, Vicom Multimedia Inc., and Transtech Interactive Training Inc. are producing a process simulator, complete with embedded training manuals, evaluation procedures, multimedia presentations, and dynamic simulation.

This package includes software links between the Vicom and IDEAS software, as well as an interface to WonderWare, and the operator screens. Trainees can launch simulations from the training software and be evaluated while operating the simulated plant. In addition, using the PASCE 3D design data, actual equipment layouts, process schematics and other design information can be sent to the multimedia database and animated or rotated for the use of the trainee. P&IDs are accessible and brought before the trainee for his clarification on the details of the process. Audio and video segments can be launched whether automatically or by the rainee to assist in learning. If a paper copy is required, then the system will print out the desired sections. Using computer based training (CBT) the trainee is free to learn at his own pace and follow the path that brings him the most knowledge out of the system, not simply following a pattern set out in paper-based systems.

5.0 CONCLUSIONS

There are both short and long term benefits to control system staging and operator training when using actual controllers rather than emulated controllers. New advances in DCS design using devices such as Elsag Bailey's USM have allowed simulators to be attached at an input/output level to keep long term maintenance costs of a simulator low, and current with the plant control configuration.

Dynamic process models require emulated control during the model building phase in order to ensure accurate results and proper time management among all parties during staging and training. Once staging begins, emulated controls can be switched to actual DCS control one loop at a time to ensure process stability.

Installation of a dynamic trainer in the field using actual controls requires knowledge of the DCS and good coordination to ensure that software revisions are identical, and that all features loaded in the mill DCS are loaded into the training system.

Good coordination is required during project implementation to ensure that the current DCS configuration is used during training, that training manuals are current with data contained in the control system and that vendors are available to approve any logic changes that may affect their process guarantees.

Having a simulator embedded within a training systems will serve as a safety net if coordination breaks down.

6.0 BIBLIOGRAPHY

1. Ulinder, J.D., "Fixed Time Zone Methodology for Plug Flow Simulations as Applied to an Oxygen Delignification Reactor", Control Systems 92 Conference, 1992, Whistler, B.C., Technical Session, CPPA.

2. McGarry, M., Trask, M., Gelbart, A., "Dynamic Computer Simulation Technology for Food Processing Engineering", FoodPro '96, Sydney, Australia, 1996.

3. Dewitt, S.A., and Wang, P.H., "Adaptive Predictive Nonlinear Control - Part 3: Advanced Control Development, Simulation Testing, and Mill Performance", Control Systems 92 Conference, 1992, Whistler, B.C., Technical Session, CPPA.

4. Meincer, W.P., Ma, M.S., Powell, F.G., McGarry, M.F., "High-Fidelity Real Time Dynamic Process Simulation with Object Oriented Programming Part 1: The Tool", Control Systems 92 Conference, 1992, Whistler, B.C., Technical Session, CPPA.