Improving the Business Performance of Defs's South Texas Assets Using Web-Based Optimization Technology

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BACKGROUND

DEFS was asked to consider applying a web-based optimization service to the Three Rivers gas plant. The Three Rivers plant is a single train cryogenic gas plant with a throughput of 80 mmscfd through the one processing train in operation during the operations timeframe. The plant has the capability of operating at 80%+ ethane recoveries at full load, and can run in a "sloppy recovery" mode to approximate rejection operation.

DEFS's management team was skeptical! They had implemented traditional advanced control and optimization technologies and the results did not meet expectations. The packages were costly to deploy, costly to maintain, and didn't have a high service factor through the many different operational mode changes that plants are subject too.

eSimulation, Inc's web-based optimization service appeared to be different from traditional advanced technology approaches. First, the web-based optimization service combined:

- A rigorous chemical engineering process model that considers all of the operational constraints that the plant works within,
- An economic model that considers the contract mix at the front end of the plant and all business constraints the plant works within,
- Plant process and analyzer data
- The current price deck for residue and product commodity prices as well as T&F charges,

To calculate

- Optimal setpoint move suggestions for the facility.

These optimal targets are updated every three hours and are accessed over a secure web page for implementation by the DEFS operations staff.

Second, the web-based optimization approach appeared to allow for sophisticated optimization technology to be offered at a price that is affordable for mid-stream processing applications. Plant data is extracted from the electronic control system using an industry standard interface. The data is transferred over the internet to eSimulation's data center where it is processed in a rigorous process optimizer. The optimization results are then presented on a secure web page.

Lastly, the web-based optimization concept would allow the maintenance and support services required to keep the model matching the plant under a variety of process conditions, and operational modes, to be centralized which provides the potential for reducing costs.

THREE RIVERS PROJECT OBJECTIVES

DEFS management agreed to pilot the web-based optimization service at their Three Rivers gas plant. Objectives of the pilot project were as follows:

- To demonstrate that the chemical engineering modeling technology could effectively simulate plant operations using live plant data.
- To show that the economic model could be developed to reflect Three Rivers' business operations.
- To demonstrate that eSimulation's optimizer could add value and improve DEFS profits.
- Lastly, that the profit improvements could be measured given the feed, price, and ambient condition fluctuations that are typical of mid-stream processing operations.

THREE RIVERS PROJECT IMPLEMENTATION

The Three Rivers project was kicked off in September 2001. The Three Rivers optimizer was an early implementation of web-based optimization and it took 6 months to commission the system (current

commissioning time is 3 – 4 months). The project went smoothly largely due to the help of the local plant supervisor who was extremely supportive.

Kickoff:

A kickoff meeting was held to review the P&ID's and gather the required process equipment design data. This included heat exchanger design sheets, column specifications, and compressor/expander performance curves. The kickoff meeting also served to familiarize plant personnel with web-based optimization functionality and to begin gaining their confidence.

Process model development:

The process model was built using a rigorous process modeling and optimization system. The system utilizes equation based optimization technology which converges the process model rapidly and robustly by solving all of the chemical engineering modeling equations simultaneously. The optimizer was designed specifically for mid-stream applications and is based on rigorous chemical engineering models such as SRK equations of state and rigorous compressor models.

Install control system link and establish communications:

DEFS was responsible for providing a local PC interface to the Emerson Process Management Delta V system. The interface is an industry standard OPC server provided by Emerson. Installation of the PC and OPC server was contracted to Barry Payne and Associates, Inc..

eSimulation went to the plant and loaded its DataPump software onto the local PC. The DataPumpTM utilizes an industry standard OPC client architecture which allows it to communicate with most electronic control systems (DCS, HMI/PLC hybrid, etc..) through an industry standard OPC server link.

The plant data was at first transferred to the web-based optimization system using a dedicated phone line and a commercial Internet Service Provider. This worked well, but it was thought that a performance improvement could be obtained by transferring the data through DEFS's own network connection. However, this raised the question of Internet security.

At this point DEFS's IT group got involved and performed an extensive analysis of the web-based optimization system's communications requirements/architecture. A rigorous penetration study was completed to identify security risks which needed to be addressed prior to transferring the data over the DEFS network. The IT group made several recommendations which were made prior to the network solution

being adopted. It should be noted that the DEFS IT group determined that the amount of data traveling over their network was so small that it was within the noise band of communications bandwidth to the plant.

eSimulation completed web page development for the Three Rivers application and began posting plant data on the DEFS portion of eSimulation's secure website. This allowed DEFS to familiarize themselves with the web interface.

Economic model development:

eSimulation met with the DEFS Commercial representative responsible for the plant to review the contract structure and to identify business constraints that the plant worked within. This is a crucial step in the implementation process. It is important to obtain Commercial Group buy-in so that the economic model can be accurately developed to reflect contract types, and to enter the commodity prices into the optimizer on an ongoing basis.

Integration of plant data into model:

The plant data was then integrated with the process model. Each plant data point is brought into the model and then the model is tested thoroughly. This checkout process often results in "discovery" benefits associated with improperly tagged, or mis-calibrated, instrumentation.

Optimizer validation and tuning:

After the optimizer was thoroughly tested, preliminary targets were posted on eSimulation's website for review by the DEFS management staff. After management was comfortable with the move suggestions, the operators were given passwords and began making the suggested moves.

Early on, the optimizer experienced some reliability issues. The model must converge over a range of operation and it took some time to get the model fit properly to reflect actual plant conditions. eSimulation has since updated its software, and implementation methodology, to improve robustness and the web-based optimization system now maintains a very high availability level.

THREE RIVERS POST AUDIT RESULTS

Two discovery benefits were uncovered by the optimizer. First, the plant was running a recycle stream to improve recoveries. The optimizer showed that this was costing DEFS money and DEFS shut the recycle off.

This resulted in an immediate improvement in profits which, while small, was never-the-less easily identified. Second, the web-based optimization service identified a valve problem when the optimizer suggested a move, the operator made the move, and nothing happened.

Early benefit calculations showed that the optimizer was adding significant value versus baseline operations. However, DEFS management insisted that they couldn't move forward with other optimization projects until the benefits were calculated using their own internal performance data. If the results didn't show up in their economic reports, then it would be difficult to proceed with other projects.

Considering that everything is constantly changing in the plant (feed rate, feed compositions, commodity pricing, ambient conditions, etc…), establishing an optimization performance benchmark can be difficult. After repeated conversations with DEFS management, it was decided that a comparison of current operations versus 3 year averaged historical monthly accounting rollup data would suffice. The following is the methodology which was adopted:

- DEFS provided monthly accounting data for the plant. This data included feed rate, inlet ethane concentration, inlet propane concentration, ethane recoveries, propane recoveries, and fuel use rollups for the previous 3 years.
- The baseline data was normalized to current feed rates and inlet concentrations conditions.
- Optimized operation was compared to the baseline performance data at current commodity pricing and the following was calculated:
    - Change in product revenues
    - Change in shrink required.
    - Change in fuel required.

The results were tallied in a spreadsheet to compare optimized versus un-optimized performance on a month-over-month basis.

The actions taken during the post audit evaluation period (April 2002 – March 2003) showed an improvement in earnings that provided a less than one year payout for the project:

Three Rivers Project

Actions taken:

- **Suggested recycle strategy**
- **Optimized fuel versus recovery**
- **Bypass advisory**
- **Daily reporting**

Troubleshooting Report

- **Identified faulty control valve**
- **Quantified impact of compressor repair**
- **Identified losses around plant**

Based on the results achieved with the Three Rivers project, the Gulf Plains optimization project was initiated.

GULF PLAINS PROJECT OVERVIEW

In July of 2002 the Gulf Plains web-based optimization project was kicked off. The Gulf Plains plant is a single train cryogenic plant with fractionation that processes approximately 120mmscfd of gas. The Gulf Plains project was eSimulation's first to include fractionation. It was also required a much more complex economic model than was required for the Three Rivers project.

When the project was kicked off, an expansion was going on at the site and plant personnel were not available to provide support during implementation. eSimulation acknowledged this constraint and proceeded to implement the project.

The implementation process was very similar to the Three Rivers project. This demonstrated to DEFS that very little client resources are required to support the implementation process:

- A kickoff meeting was held to review the P&ID's and gather process equipment design data.
- The process model was built to represent both the cryogenic plant and fractionation train.

- DEFS contracted Control Works, Inc. to install an OPC Server link to the Rosemount RS/3 control system.
- The meeting with the Commercial representative was held to understand the contract mix at the front end of the plant.
- The economic model was expanded to accommodate the complexities associated with the producer contracts at the front end of the plant. The plant has several contract types which can provide conflicting objectives and the optimizer had to effectively consider these tradeoffs.
- The plant data was linked to the model and the testing period began. The increased complexity and higher data point count required longer convergence and checkout times.

Move suggestions were posted in early January 2003. Given the level of activity at site, eSimulation sent its personnel to site to work with the operators through the validation and tuning process.

The checkout and tuning process is analogous to checking out a new control system. The initial process limits are entered into the web-based optimization system based on the limits set in the DCS system. When the turnover process begins, operators are asked if they are comfortable with these initial limits. If not, the limits are modified by operations personnel and the optimizer is re-run at the new constraints. The operators review the optimization results to see if they make sense and begin making the suggested moves.

Since the web-based optimization service is usually taking the operators into a regime that they are not used to, the operators often do not know if the limits are correct. Likewise, eSimulation's engineers need to make sure the model is fit properly and that the optimizer constraints are being properly considered. Working together, the operators and eSimulation's engineers configure the system to provide actionable results. It should be noted that this is an ongoing process because things can change at the plant, or the plant is in a new mode, or economics can change and the optimizer must be tuned to properly address these changes. This is why the inclusive services business model inherent in web-based optimization is so important.

During the checkout at Gulf Plains, the operators were diligent about making the moves. The plant did experience a tower flooding problem early on and the process model was tuned so that this didn't happen later on. All-in-all, the operators did a very good job chasing the targets.

GULF PLAINS PRELIMINARY RESULTS

eSimulation's engineers went to the plant to help operators work with the optimization system on two different occasions. This is not typically required for other optimization applications and was provided to allow management to focus on other priorities.

On both occasions, an analysis was performed to get an idea of how much value was being added by the web-based optimization service. These benefits appeared significant.

SUMMARY

Web-Based optimization proved beneficial for the Three Rivers plant. It also has shown promise at the Gulf Plains facility. Based on these early applications a third web-based optimization project was recently commissioned at DEFS's Eunice plant in the Permian Basin.