Lessons Learned From Deploying Web-Based Optimization Across Enogex's Gas Processing Assets

Andy Deck and Barry Ballard

Enogex, Inc.

Oklahoma City, Oklahoma, U.S.A.

Mark Roop and James Jones

eSimulation, Inc.

Houston, Texas, U.S.A.

ABSTRACT

Enogex was the first company to deploy eSimulation's web-based optimization system (eSimOptimizer[SM]). The results of their first application, applied to the Custer plant, were presented at previous GPA meetings in 2001 and 2002. Enogex followed this success with additional web-based optimization applications at their other gas processing facilities.

This paper will summarize the lessons learned by Enogex in deploying web-based optimization technology. This includes the resources required to deploy and support the web-based optimization systems. The discussion will then describe how Enogex receives and measures value from the web-based optimization applications under a variety of plant configurations and economic conditions.

The paper will then discuss the human factors associated with sustaining a web-based optimization initiative at the plant level. Included will be a discussion of the reasons that web-based optimization application utilization can wane over time and what steps Enogex is taking to address these issues. Specifically, the paper will introduce eSimulation's new Value Capture Program which is being developed and refined with Enogex to address key human factor issues so that Enogex can maximize and sustain asset profitability.

OPTIMIZATION EXPERIENCE

Enogex's experience with eSimulation's rigorous eSimOptimizer[SM] process optimization service has been gained by deploying the system to the gas processing plants shown in Figure 1:

Plant	Capacity	Configuration	Status
Custer	180	Cryo	Plant sold
Cox City 4	120	Cryo with Fractionation	eSimOptimizer[SM] active

Cox City 3	30	Cryo	eSimOptimizer[SM] active
Cox City 1 & 2	30	2 Cryos	In progress
Thomas	135	Cryo	Plant being reconfigured, optimizer turned off
Canute	60	Cryo	Optimizer discovered need for compressor unloaders, optimizer turned off, unloader project completed, capacity now too low to justify recommissioning
Wetumka	60	2 Cryos with Fractionation	eSimOptimizer[SM] active

Figure 1 - Enogex plants were eSimOptimizer[SM] has been deployed

This experience has resulted in Enogex drawing the following conclusions relative to deploying and supporting eSimOptimizer[SM] systems:

1. **The eSimOptimizer[SM] system can be commissioned in a reasonable timeframe and works well under a variety of operational and economic conditions.**

   eSimOptimizer[SM] is an all inclusive optimization service that can be commissioned in 3 to 6 months (depending on plant complexity).
2. **Very little of Enogex's resources are required to deploy eSimOptimizer[SM]systems and to keep them functioning properly.**

   Onsite meetings include a ½ day kickoff meeting, half day meeting to establish communications, possible 1 day review meeting, and support of the commissioning effort.
3. **Operators can easily learn to use the eSimOptimizer[SM] system.**

   Enogex has found that it is very easy for process operators to learn how to use the eSimOptimizer[SM] system. Optimization results are updated every three hours on a secure area of eSimulation's website. The operator is given the current value for the optimization variables and the suggested optimal targets for entry into the control system. The financial incentive for Enogex is displayed with the suggested optimization moves.
4. **The eSimOptimizer[SM] model is robust under a variety of operational conditions.**

The eSimOptimizer[SM] system utilizes a steady state model of the process to develop the optimization targets. The model must be tuned to solve under the typical fluctuations inherent in gathering and processing operations. Once commissioned, eSimulation continues to tune the eSimOptimizer[SM] model so that it responds robustly under fluctuating conditions. Once lined out, the model typically solves with a 90% to 95% success rate.

5. **eSimOptimizer[SM] identifies ways to increase profits differently under different economic and processing conditions.**

   In a low liquids processing margin environment, eSimOptimizer[SM] adds value by trimming product recovery targets during both rejection and recovery mode operations. During periods of ethane recovery operation, ethane recovery is trimmed to save fuel and maximize overall plant profitability. During periods of ethane rejection operation, ethane and propane recovery are set to maximize overall profitability.

   In periods of high liquid processing margins, eSimOptimizer[SM] usually looks for ways to minimize overall energy consumption while maximizing ethane recoveries. This is often accomplished by modulating all optimization handles to allow tower pressures to be increased to save residue compressor fuel. eSimOptimizer[SM] can also help manage potential bypass and blending opportunities should they arise from overcapacity on the systems.Processors often find themselves running up against CO2 specification limits for their NGL liquids produced. Overall profitability may drive processors to occasionally exceed the CO2 specification in the NGL product. eSimulation is currently in the process of automating an eSimOptimizer[SM] add-on application which will advise Enogex on how best to manage this key constraint on an ongoing basis.

   In complex facilities, the optimizer helps to coordinate cryo plant and fractionation train interactions. The optimizer can also be used to determine optimal train loadings since different plants have different performance characteristics. With the upcoming project to integrate Cox City 1 and Cox City 2 into the Cox City 3 and Cox City 4 model, Enogex is planning to leverage this capability.

6. **Value analysis methodology established and tested repeatedly.**

   Documenting optimization benefits can be challenging given that everything is changing (prices, volumes, feed compositions, etc) in a gas plant. eSimulation has developed a value measurement methodology which has proven defensible to management.

   - A material balance template is developed in Excel.

- Data is acquired to populate the material balance from the eSimOptimizer[SM] database (throughput, inlet compositions, product recoveries, and fuel usage).
- A baseline period is selected that reflects similar conditions as the optimization period being analyzed. For example, a winter recovery baseline, winter rejection baseline, summer recovery baseline, and summer rejection baseline are typically developed.
- Post optimization period data are loaded.
- Contract percentages and commodity pricing data are loaded into the spreadsheet.
- The optimization data is then compared to rate normalized baseline data and the net residue, ethane, propane and isobutane volumes are analyzed.

Table 1 shows the results of a recent tune-up of the Cox City 4 plant optimizer. Note that Enogex management advised the plant to change the way the plant was run the week before the eSimOptimizer[SM] tune-up effort. eSimOptimizer[SM] confirmed that the management moves were astute and added significant value. eSimOptimizer[SM] was able to deliver additional value to the plant by fine tuning the management directive:

Rate Normalized Value Analysis - May 18, 2006	Change in C2 Production vs. Baseline (gal/day)	Change in C3 Production vs. Baseline (gal/day)	Change in Power Usage (kwh/day)	Profit Uplift vs. Baseline ($/day)	Profit Uplift vs. Baseline (cents/mcf)
eSim Tuning period following week found additional value	13,951	142	-451	$2,818	1.67
Management directive to alter plant operation done previous week	8,815	142	1,541	$1,211	1.26

Table 1 - Recent Cox City 4 eSimOptimizer[SM] Tune-up Results

Table 2 shows the results of a recent tune-up of the Wetumka plant optimizer:

Value Analysis at April 4, 2006 Commodity Pricing	Change in C2 Production vs. Baseline (gal/day)	Change in C3 Production vs. Baseline (gal/day)	Change in iC4 Production vs. Baseline (gal/day)	Change in Fuel vs. Baseline (mmscf/d)	Change vs. Baseline ($/day)	Units
Product Effects	-663.59	180.38	46.33		-47	$/day
Shrink Effects					-133	$/day
Fuel Effects				-0.03491	-207	$/day
Net Result for Enogex					294	$/day
Net Result (cents per inlet mcf)					0.754	cents/mcf

Table 2 - Recent Wetumka eSimOptimizer[SM] Tune-up Results

LONG-TERM VALUE REALIZATION - HUMAN FACTORS

The primary job of eSimOptimizer[SM] is to identify value opportunities and to guide operators to realize that value. However, the extent to which Enogex actually realizes this value is totally dependent on the operators actually entering the optimization move suggestions into the plant's control system.

In the perfect world this would not be a problem. However, getting the moves made can be an issue which must be addressed in order to maximize asset profitability over the long term. So why is it difficult to keep the operators focused on making the moves?

1. **Don't want to do it** - The easy answer would be to say that operators don't want something else to do. While this may be an issue, focusing exclusively on this aspect alone may lead to an erroneous conclusion.
2. **Want to know the end game** - The operators may want to know the optimal end point (i.e. where the optimizer wants to take the plant when the facility is fully optimized). The eSimOptimizer[SM] system provides guidance to make small moves towards a continuously moving optimum to keep from bumping the process. The operators may not want to make the small move suggestions produced by the optimizer.
3. **Results must be interpreted** - eSimOptimizer[SM] is a steady state optimizer with a well defined, in-plant, scope. It is not designed to help the operator address dynamic disruptions, or to address issues outside of its scope of influence (i.e. amine contactor down limiting plant capability). Therefore, there are times when the optimization moves must be properly interpreted by the operator and may need to be discarded due to upset conditions.

   Having to interpret results, and make implementation decisions, can be confusing to operators. This is especially a problem if operators strongly exhibit one of the following tendencies:
   - Inexperienced operators that blindly enter the targets without any interpretation whatsoever. This may take the plant in the wrong direction and result in lost confidence.
   - The operator that overanalyzes the moves and doesn't fully understand what the moves are trying to do. They may either make no moves or they may pick and choose the moves they make. In either case, not making all the moves can result in poorer, rather than better, plant performance.
   - The operator knows how to keep it between the ditches and is not interested in pushing the plant outside of their comfort zone.
4. **Optimizer not constrained properly** - The optimizer may not be properly constrained with the correct high limits, low limits, and step limits. The high and low constraint limits, set by operations and engineering personnel, may not be set properly given current operational conditions. In this scenario, the optimization moves may not be achievable and the operator may loose confidence in the system altogether.

   Sometimes the optimization move step limits are set too conservatively (i.e. too small). In this case,

the optimizer never has a chance to guide the plant outside of normal deadband operation. Moves can go up, then down. This can cause significant operator frustration.

5. **Results may be invalid due to system lag time** - eSimOptimizer[SM] posts results every three hours based on the last three hours of averaged data. This assures the optimizer does not converge on an out of range data set. Plus, eSimOptimizer[SM] is a steady state optimizer and the three hour averages tended to filter process data. However, if things changed significantly during the three hour period, the optimization results may be out of date and invalid.
6. **Optimizer malfunction** - The optimizer model may not be properly tuned to current plant operational directives (i.e. modes), a problem may exist with the optimizer model configuration, or something has changed and the optimizer isn't working properly. In this case, the operators are supposed to notify eSimulation, but they don't always do this.

Meanwhile, management wants the value optimization provides. However, they may be confused when they ask the operators to make the moves and the operators come back and say they can't make the moves for the above mentioned reasons. This often requires management to get involved in interpreting the moves and/or getting eSimulation involved to help resolve the problem. The degree of difficulty with resolving these issues is dependent on who is responsible for reconciling the differences between optimization results and operator skepticism:

- Plant supervisors are busy and may not have time to do this. Also, they may not fully understand the plant and/or optimization move targets to effectively interpret the move results with the operators.
- Operations management personnel are busy. They may not have the time to work with operators, plant supervisors, and eSimulation to reconcile these differences.
- Engineering would be perfect, but they are usually working on more highly value adding projects.

If these issues are not adequately addressed, the optimization initiative can wane. If it wanes, management is at risk of not maximizing asset profitability.

PLAN FOR ADDRESSING HUMAN FACTORS

Enogex and eSimulation have taken the following measures to address these human factors to minimize the risk of the optimization initiatives degrading over time:

1. **Enogex has put utilization of the eSimOptimizer[SM] system into each of their operator's and operations management's 2007 performance appraisals.**

This serves to align the objectives of operations and management personnel toward maximizing asset profitability.

2. **eSimulation is implementing "fast scans" for the eSimOptimizer[SM] system**

   The optimizer is still run on a three hour cycle to assure the plant has a chance to reach steady state. However, eSimOptimizer[SM] now uses the last ½ hour of plant data for each optimization run. With this change, the optimized values are much more relevant to current conditions.

3. **Enogex and eSimulation are working to enhance the eSimOptimizer[SM]service with the new Value Capture Program**

   eSimOptimizer[SM]'s base engineering service does not include any ongoing process analysis services. It identifies value and relies on the operators to deliver that value. As mentioned previously, this approach may not be sufficient to capture all available value over the long term. Therefore, eSimulation is working with Enogex to develop and refine the new Value Capture Program which includes the following:

   Value Capture Report - includes a summary of previous week's process performance and a process plan for current week's operation as shown in Figure 2.

Wetumka eSimOptimizer Value Capture Report
Week of February 19 – February 25, 2007

1. Potential Value of Optimization

Full case runs using operating data from February 17th-18th show an opportunity to increase profit by approximately $3199 ($457/day) for the week. This profit is achieved by decreasing Plant A and Plant B C2 Recovery by 1% (to 59.8%) and 0.5% (to 59.4%) respectively and reducing fuel cost by $1218 ($174/day). The margins are slightly negative on C2 and the optimizer is balancing C2 and C3 recoveries to maximize overall profitability. Detailed results are discussed in Section 3 below.

2. Last Week's Results

Optimization Success Rate	96.4%
Maximum Consecutive Failures	1
Data Flow Uptime	100%
Operator Logins	3
Number of Support Requests	0
Last Price Update	6-Feb

There were no new support requests last week but one outstanding request from the last meeting. The response for that one is attached. As previously indicated, until the BG and Propane analyzer results can be brought into the system, results for the fractionation plant should be followed cautiously.

3. Description of Full Case Optimization Results for February 19th

Please refer to **Profit Sensitivity, Optimization Results for 2/19/2007 12:01am** on the website for detailed results. The logical description is included below.

To maximize recovery, inlet temperature should be minimized. The optimizer would maximize Cryo pressure to save fuel at current margins and adjust reboiler temperatures upward slightly to cool the Cold Separator and balance C2 and C3 recoveries. Deethanizer reflux is maximized to recover maximum C3 from the DC2 overhead while bottoms temperature is minimized to save fuel and pressure is increased slightly to maintain predicted Propane VP at the upper limit. Depropanizer pressure and reflux flow are minimized to save fuel. The optimizer increases bottoms temperature to recover all possible C3 from the BG stream. The maximum bottoms temperature is limited by predicted C4s in the Propane (maximum limit set at 2%).

Note that predicted C3 recoveries for these moves are slightly negative while Propane production increases. The optimizer sees an opportunity to reduced overall C3 recovery but increase C3 recovery to rack product by slightly reducing the load (feed rate) on the Deethanizer. Again, caution is advised because of the lack of analyzer feedback for the fractionation plant.

Figure 2 - Example Value Capture Report

Full Case Run Analysis and Reporting - The Value Capture Report includes a significant upgrade to the eSimOptimizer℠ system that provides an estimate of the end-point of where the eSimOptimizer℠ model would take the plant under current economic and process conditions.

This end-point estimate is derived by running offline case studies using the fully configured and reconciled eSimOptimizer℠ model for the plant. We call this the Full Case analysis and it is posted on a special optimization screen as shown in Figure 3 below:

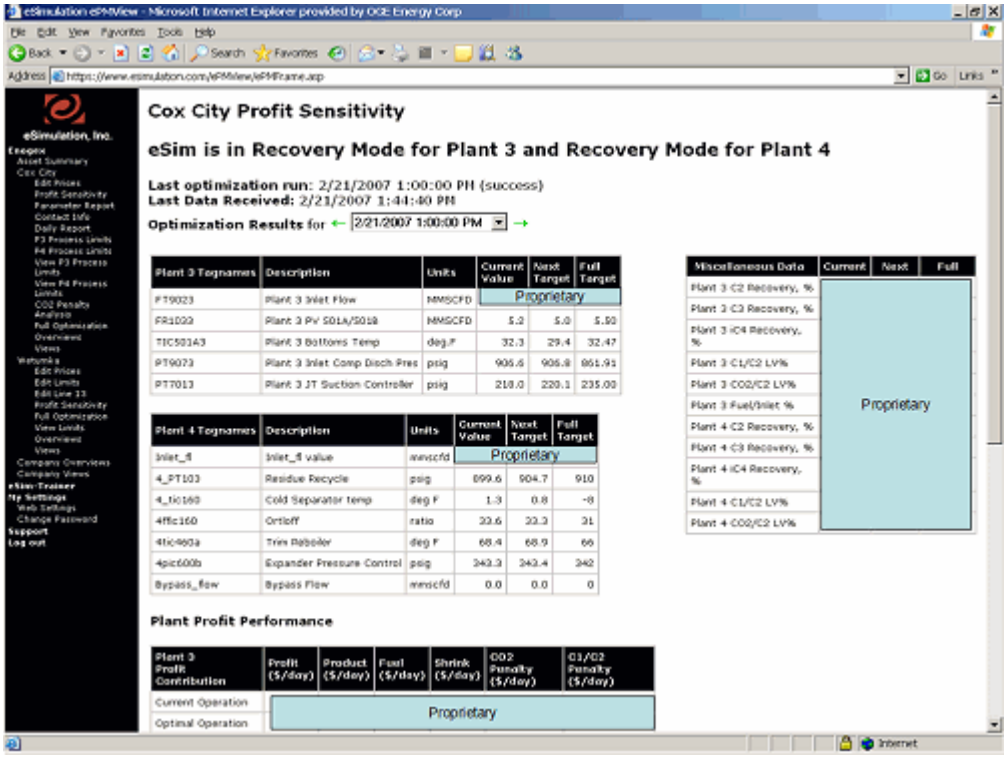

Figure 3 - Example Full Case Optimization Results

This Full Case Run analysis, as well as the offline case analyses required to fully describe the suggested optimization moves, are compiled by eSimulation for each plant weekly on Monday. The Value Capture Report is then emailed to the Enogex plant and operations management team.

Enogex Operations Conference Calls - On Tuesday morning, Enogex operations management holds a conference call with each of the plants to review the Value Capture Report and be sure there are not extenuating circumstances that will preclude the suggested optimization moves from being made. Once agreed, the plant then uses the normal optimization screens to capture the value identified in the Value Capture Report and to go after additional value as conditions change during the week (throughput, compositions, economics, etc…).

eSimulation has been leading these conference calls in late January and February 2007. After the process is lined out, eSimulation's participation may be reduced to occasionally sitting in on the conference calls, or to attending at Enogex' request.

By providing more analysis of process and optimization data, eSimulation now provides the proper information to Enogex operations management to help them understand where the optimizer wants

to take the plant…and why. This information can then be used by Enogex management to convey the objective of the optimization moves, and to reconcile operator concerns, so that the moves get implemented and value delivered.

Onsite Optimizer Tuning and Operator Training - The Value Capture Program includes semi-annual onsite tune-ups of the eSimOptimizer[SM] system. This involves eSimulation going to the site for 2 days to work with the operators to assure the optimizer is functioning properly. This assures that the eSimOptimizer[SM] system is tuned to reflect current plant operation and to address operator concerns. During this tune-up effort:

- Process limits are reviewed to be sure they reflect current operation, that all limits are set properly, that the model is functioning properly, and that results are achievable
- eSimulation works with the operators to make the optimization moves. Any model issues or constraint issues are resolved during this period.
- eSimulation assists Enogex in analyzing process limits and constraints. eSimulation finds that the majority of eSimOptimizer[SM] applications continue with initially configured limits. However, more value can be captured if the optimizer is riding up against limits and the limits reevaluated to be sure the optimization regime is as large as possible. The question to ask is "why is that limit set where it is?".
- Identify enhancement opportunities to expand model scope or to add functionality.

The combination of weekly Value Capture Report generation, eSimOptimizer[SM] move analysis, Full Case analysis presentation, management conference call support, and the semi-annual tune-ups included with the Value Capture Program provides the components necessary for Enogex to fully realize eSimOptimizer[SM] value potential.

SUMMARY AND RESULTS

Enogex - as eSimulation's longest standing eSimOptimizer[SM] user - has learned a lot about rigorous process optimization applications by deploying eSimOptimizer[SM] across its mid-continent asset base. Enogex has learned that the optimization systems can be deployed quickly and with minimum impact to Enogex' resources. Enogex has worked with eSimulation to refine a value assessment methodology that is defensible with upper management. Finally, Enogex has learned that eSimOptimizer[SM] systems deliver value - under a variety of circumstances - that far exceeds investment costs.

Enogex is working closely with eSimulation to enhance the eSimOptimizer[SM] offering so that it addresses the human factors that can get in the way of full value realization. The combination of Enogex's operator

incentive program, eSimOptimizer[SM] technical enhancements, and the new Value Capture Program provides the tools required to gain continued operator buy-in to the process. The Value Capture Program also provides a valuable tool for Enogex to more effectively manage asset performance and to maximize asset profitability.

Enogex and eSimulation have been designing the Value Capture Program since mid-2006. The first Value Capture Reports were issued in early January 2007. Two "trial" runs were conducted whereby the reports were reviewed by Enogex management only. In late January the operators were tied into the conference calls for full implementation of the process.

One of Enogex' objectives with the Value Capture Program is to create an efficient tool for operations field staff, operations management, and eSimulation technical support to share information and quickly resolve issues. The first conference calls with local operations lasted about 1.5 hours (total for both plants). As of late February, the conference calls were down to 45 minutes (total for both plants). Enogex' objective is to get the conference calls down to 15 minutes per plant and it appears they will achieve that target.

This is just the start of the Value Capture Program at Enogex and both Enogex and eSimulation expect continued evolution. However, the Value Capture Program development is currently going well and serving to keep eSimulation personnel and Enogex personnel engaged and aligned to maximize value for Enogex.