Real Time Combustion Optimization at Colorado Springs Utilities

Gordon Littleton, Springs

Winter Fomis Conference
Clear Water Beach, Florida
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Martin Drake Power Plant

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Nixon Power Plant

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Springs's Optimization Objectives

Nixon Plant

- Bubbling agreement required lower NOx right away (33% reduction)
- Early generation Low-NOx burners needed better performance (slagging, and LOI)
- Base loaded so efficiency needed to remain steady

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Springs's Optimization Objectives

Drake Plant

- Low NOx burners on 3 coal units in 4 yrs with associated efficiency and LOI "hits
- Some cycling operation, so better HR means more run time
- Ability to sell fly ash or at least avoid disposal costs
- Low emissions - under the public's eye

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Springs's Optimization Objectives

- Common Factors:
  - Entered a 3-4 year program to minimize operator affected "controllable losses"
  - Loss (or diversion) of staff and Engineering Expertise
  - Looking forward to scrubber and OFA operation. Technology that could be used if scrubbers, SCR & OFA added later
  - Best control until BAT required

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Springs's Optimization Objectives

- Common Factors: (Continued)
  - Springs goal to add "sustainable value for our citizen-owners"
  - Competitive costs with 4 rate reductions in 3 years
  - Happy and productive work force

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Plant Requirements – The Easy Stuff

- DCS and good data historian
- Ability to make things talk to each other
- Accurate usable information (not data) in front of the operators at all times
- Things we could control with a computers and operator actions

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Plant Requirements – The Harder Stuff

- Willpower and leadership to change:
  - Management's acceptance
  - Operator's acceptance
  - Maintenance's Acceptance
  - IT's perceptions (it's a PC, isn't it?)

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Where Did We Start?
First Tool - Focused Culture Change

- Change culture to embrace change and encourage participation
- Always discuss together what's best to do next; Type 1, 2, or 3 decisions made accordingly
- "Human Elements" were identified as big issue

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Operator Human Elements - Each One "Knows" what's best

- Fire high or fire low?
- To Spray or Not to Spray?
- Lot's of air or Minimum air?
- Stack losses or LOI losses?
- Blow soot all at once or a little bit at a time?
- Mill Bias?

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Humans Respond to What's Measured

- Post measures are "after the fact"
- Mw/coal good "post" measures
- Engineering or PTC test are "post" measures
- Our feeders are antique and inaccurate and not good tools
- Folks don't know quite when things "got bad"
- How can you post measure what each shift and operator is doing?

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Second Tool Chosen - EtaPro by GP

- Real time feed back & Highly Configurable
- Tool for I&C, Engineering, and Operators
- Good human interface, usable by all plant personnel
- Works with existing inputs
- Came with a great deal of support on installation and set-up; provided a stable of expertise to supplement “more with less”efforts

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Results from EtaPro by GP

- Marked increase in efficiency when first installed; another when showed up on evals

- Became an Operations, Engineering, and Maintenance trouble shooting tool

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Troubleshooting with EtaPro

- If an O2 probe goes bad, the fans crank up- operator sees red bar - writes wo
- Economizer or air heater pluggage - same scenario
- Operators used to running 1/2 CT fans in winter; get warm day, back pressure bar grows, fans come on!
- Operators can’t make Feedwater Temp “green”- ask why. Find bad division plate

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Fine Tuning - Trade Offs

- Which modes of operation are better?
- Can we maximize efficiency (or at least get back what we lost with low NOx burners) and still sell low LOI ash?
- Can we have consistent operations using CRO's with less than 3 years experience?
- Lots of ways to run efficiently short term - how about consistent long term operation?

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Third Tool - NeuCo's CombustionOpt™

- No new instrumentation or equipment
- Minimal plant interruption
- Online learning = fast implementation
- In closed-loop after 6 weeks
- Safe, flexible DCS integration
- Training and documentation
- Online learning = low maintenance
- Total project time 10-14 weeks

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Effective Measures -

Applies to all tools!

- Many variables -- measurement must be long term
- People have to see you measuring -- and often!
- Smoother operations reflected in reduced variability in ops and fewer trips
- Don’t forget the intangibles that can’t be measured – smoother operations, lack of human induced swings and trips, minimization of heat cycle stresses

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Nixon Results with CombustionOpt

- Baseline: had been running at .45 lbs/mmbtu
- Achieved consistent low NOx operation at average of 0.29 lbs/mmbtu (on consistent coal)
- Helped mills operate at 100% PRB coal
- Controlled large “swings” in CO

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Drake Results with CombustionOpt (ProcessLink)

- Boiler efficiency improved by 0.75 %
- Fuel savings of $97,000/year (on a small unit)
- Identified performance problems:
  - Slipped coal nozzle
  - Broken mill damper roll pin
  - Plugged coal pipe
- NOx runs where we want it:
  - From limit of 0.46 to 0.35 on hot coal
  - Lower on regular blend

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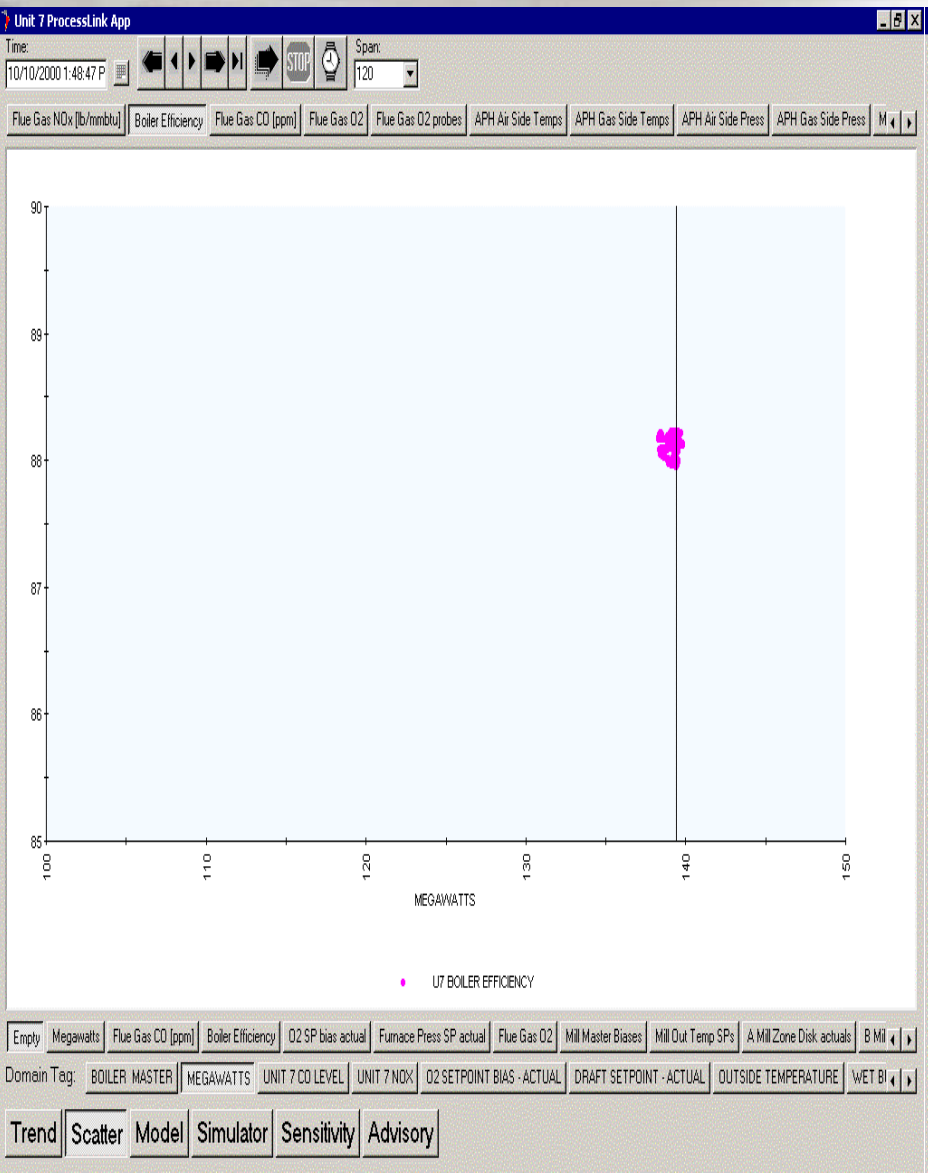
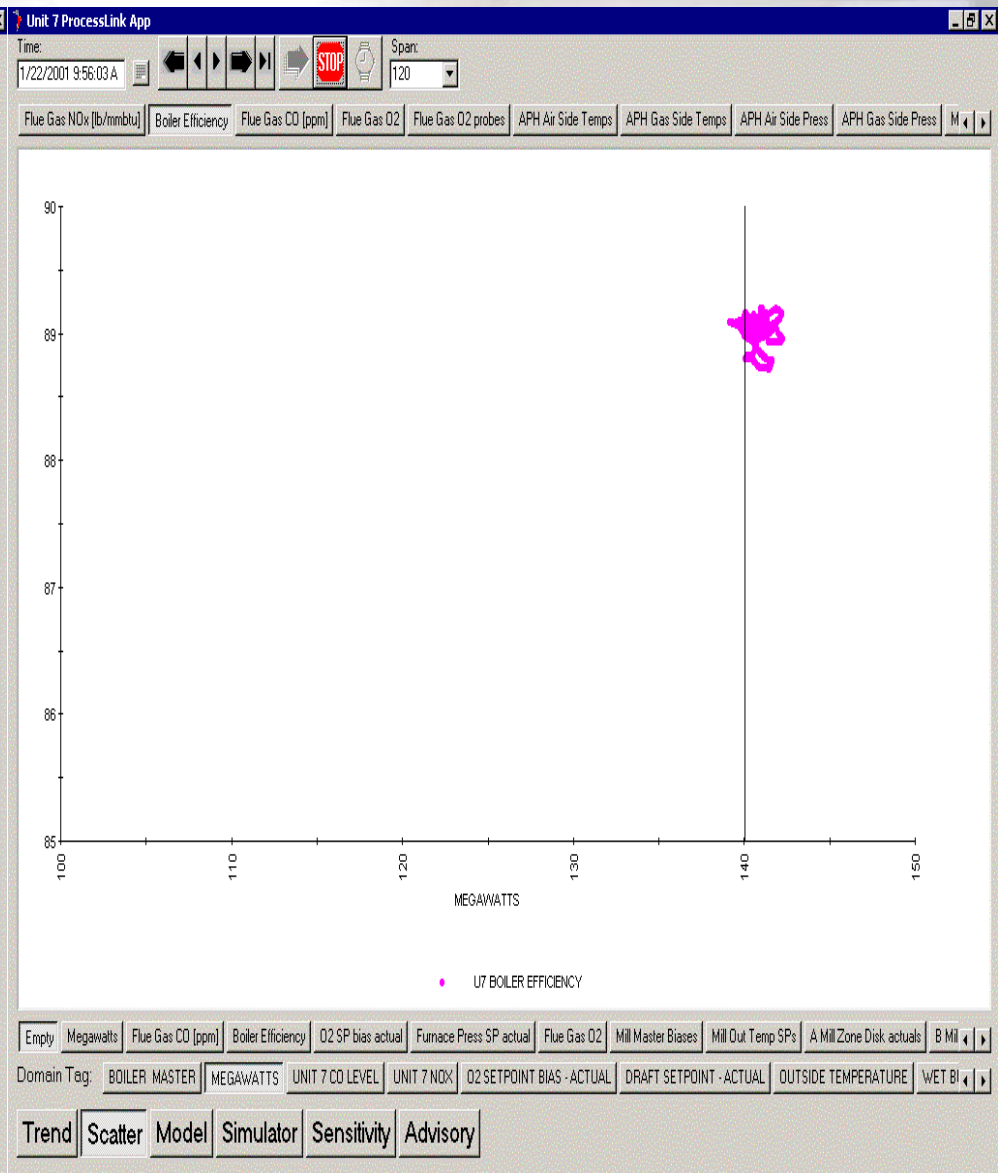
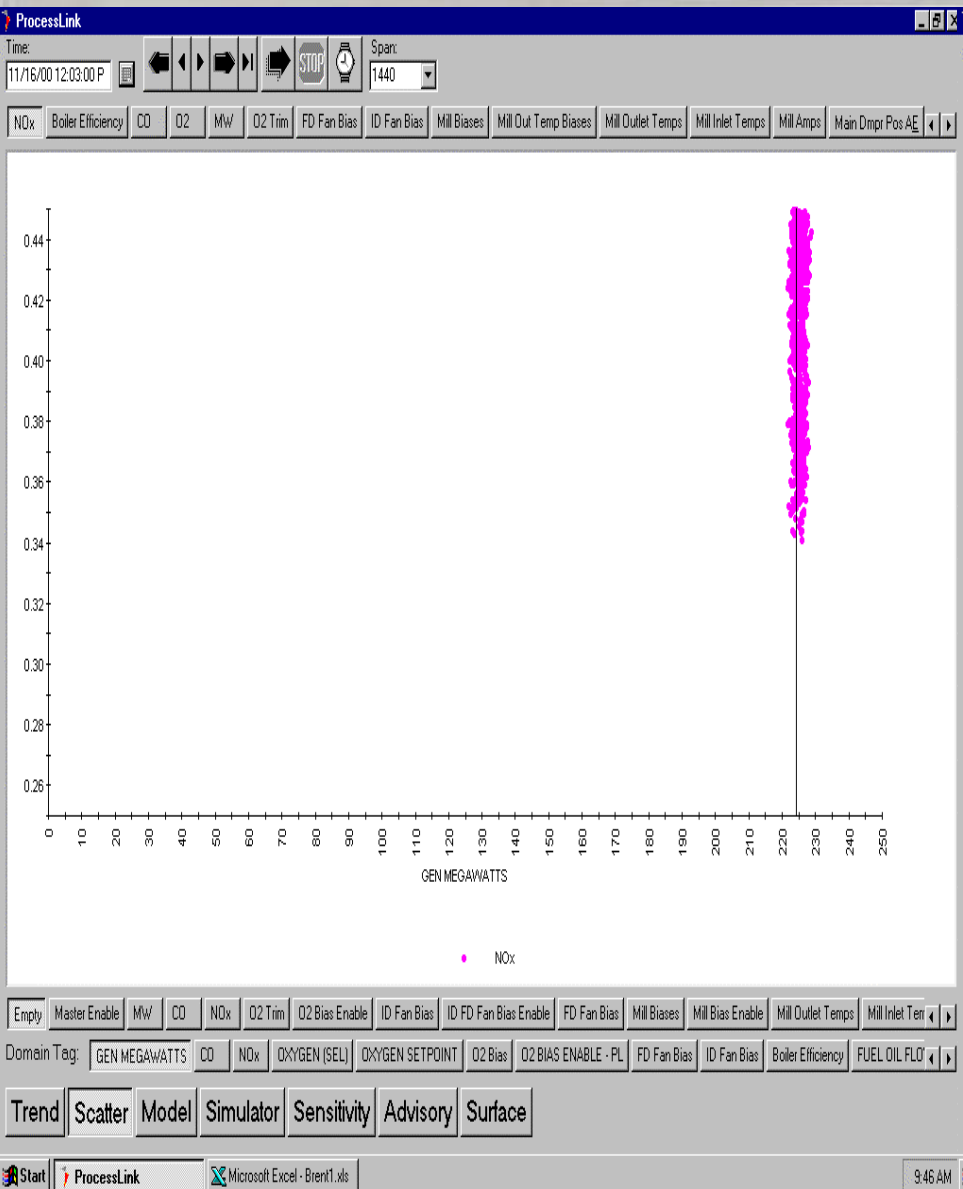
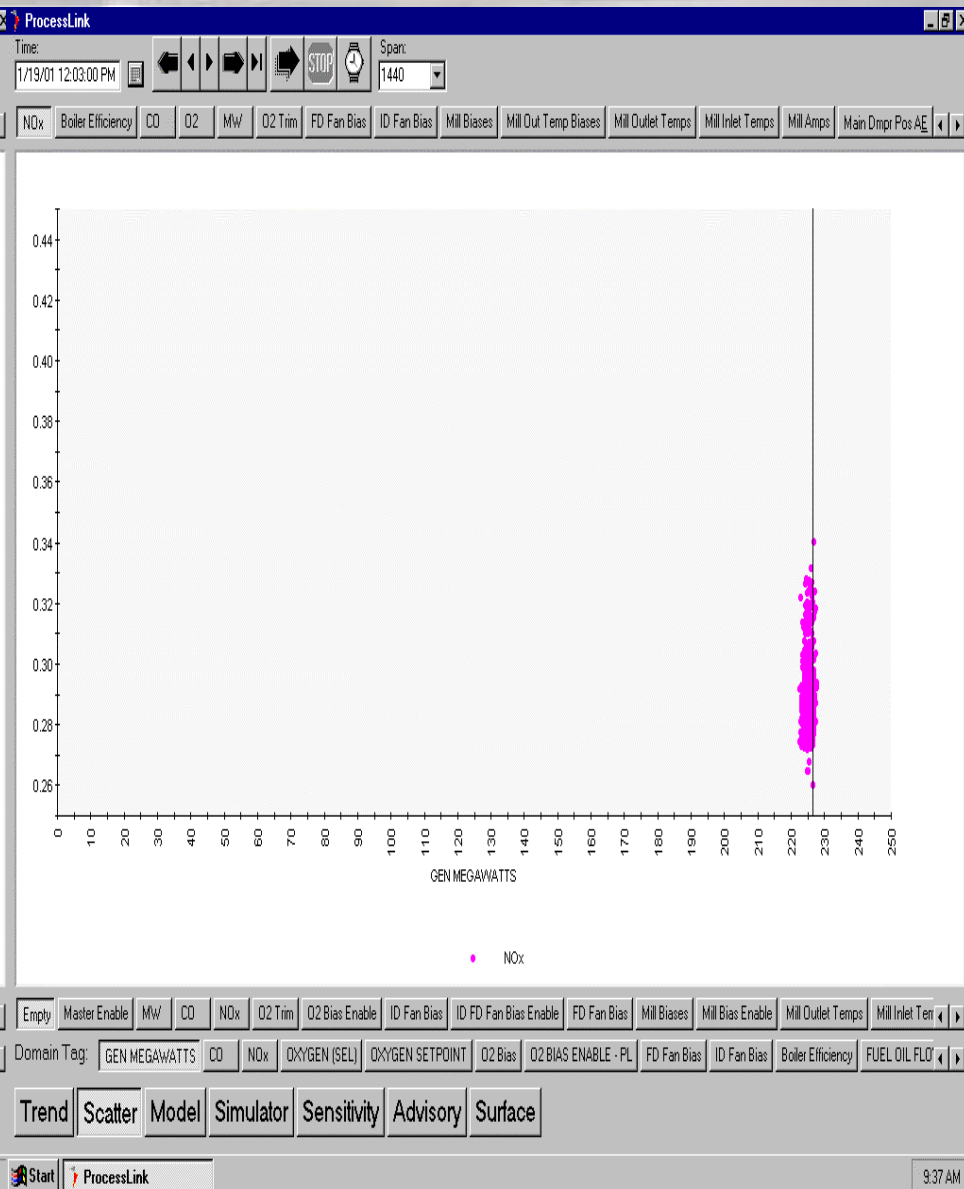
Drake Boiler Efficiency Before & After





Drake NOx Before & After Optimization





Building on Initial Success at Springs Utilities

- CombustionOpt installed at Unit 6 (Complete)
- Integrate additional instrumentation and control functionality
  - MK Engineering LOI probes at Martin Drake (Partially Complete)
  - ASI intelligent sootblowing system at Nixon (Partially Complete)
  - ASI heat flux sensors planned for Martin Drake

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Fourth Tool: Real-Time LOI at Drake

- Installed GE's MK Engineering LOI sensors for Unit 7 to minimize and balance LOI across the boiler
- Striving for ash sales, efficiency, reduction of emissions
- Wanted no more operator hassles - feed into CombOpt
- A total of eight LOI sensors were installed and calibrated
- Data was routed to DCS, PI and optimization programs

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Optimization with LOI Signals

- Models of the LOI signals were built with the following primary inputs:

  Boiler Master, Burner Sec Air Controls, Mill Biases, Ambient Conditions, Gas Flow (if any)

- Direct Search allowed new models to resolve cause-effect relationships between manipulated variables and LOI

- ProcessLink Objective's were reset to lower not only Nox and CO, but also LOI across all four-burner columns

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Preliminary LOI Optimization Results

- Results comparing one week with CombustionOpt optimizing for LOI vs. prior week without LOI.W
- Work with this portion of the program delayed by coal blending project. Will resume with burner tuning; modeling in Combustion Optimization
- Initial results show substantial impact on ash:
  - Deviation improved from 0.98 to 0.57.
  - Mean improved from 11.2% to 9.7% - a 13% reduction
  - Work with this portion of the program delayed by coal blending project. Will resume with burner tuning; modeling in Combustion Optimization

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Preliminary LOI Results (Continued)

- These LOI improvements were made without sacrificing boiler efficiency gains or NOx reduction already achieved
- Providing local on-line LOI extends CombustionOpt's ability to control combustion and improve boiler performance
- Consistent with MK Engineering analysis of LOI "signatures" which indicate strong relationship between smooth steady LOI trends and good unit operational performance
- Results are expected to improve as the models benefit from more operating experience

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Do You Need Combustion Optimization?

- Does every operator run the unit the same way?
- Does every shift run the unit the same way?
- Are dispatchers understanding and accommodating to operator swings and fine tuning?
- Are experienced, intuitive operators readily available these days?
- Do your operators try to find the best available biases and trims every 10-15 minutes?
- When things are fixed or adjusted in your plant do they stay fixed and adjusted?

If you answered Yes to all, you don't need optimization…

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Nixon's Herd

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