



## From Data Overload to Focused Information

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Chevron Phillips Chemical Co  
Sweeny - Texas

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## Agenda

- Chevron Phillips Chemical Co - Sweeny
- Data Overload & the Analysis Required
  - Problems with data
  - Some solutions that we applied
    - Control Loop Monitoring & Loop Tuning
    - Some problems with the solutions
    - Some solutions to the problems that the solutions generated
- Experiences of Loop Monitoring & Tuning Implementation
- Conclusion
- Q&A AND Discussions

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## Sweeny



- One traffic light
- 1 NGL Unit, 3 Ethylene Units and some pipelines
  - 5 LCN
    - 700 PID controllers in each ethylene unit
- Challenges
  - Business Environment
    - Competitive
      - APC applications and optimizers have become necessary
    - Point Configuration Data, Event Journals, Alarm Analysis
  - Manpower (Number and Skill-set)
    - 2 Process Control Engineers
    - 1 Applications Engineer

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## Problems

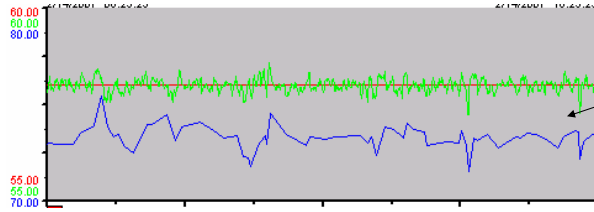


- Complex Applications
  - Hardware & Software
  - Configurations – PCN, DMZ, BN
  - Maintenance – versions, bugs & features, reports
  - Backups
- Data Data Everywhere
  - Who, What & When
  - Use of Historical Data for Monitoring Applications
    - Already happened on Friday @ 5:00 PM
    - IMPOSSIBLE to keep on top of ALL Loops
    - Data Compression – Doesn't show the true picture

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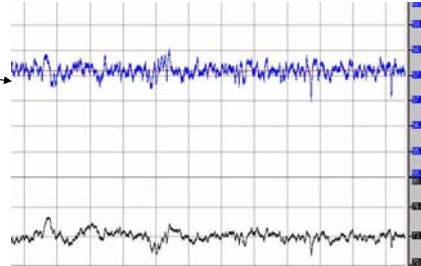
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Compressed data  
Through Historian

Uncompressed Data



- Powerful tool for PID Loop monitoring
  - Now we can monitor LOTS of loop

BUT

- Added to problems
  - Assesses 30,000,00,000 metrics for each control loop
  - Have to set baselines and thresholds
  - How do we visualize the data & analyze it
  - Develop a work flow
    - Analyze, identify problems, fix ....



## What Metrics to Analyze



1. **Variance and Variability**
2. **Error type statistics**
  1. Average Absolute Error and Average Error
  2. Integral Error
3. **CO Noise Band**
4. **Service Factor**
5. **Closed Loop Performance Index**
6. **Oscillation Analysis - Detection and Diagnosis**



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## Configuration



- **Setting Baselines & Thresholds**
  - Templates
- **Data Visualization & Workflow**
  - Dashboards
  - Reports (email)

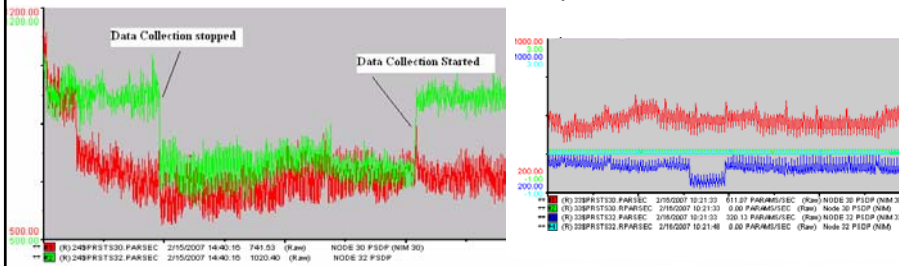


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## Hidden problem DCS Loading



- Should we sample loops @ 1 sec, 2sec, 5sec, 10 sec, 20 sec...
- DCS **Loading** cannot be studied since it REALLY matters during a unit upset condition
  - However **Load** on the DCS can be quantified



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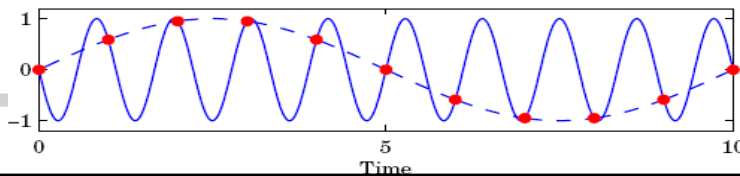
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## Possible Effects of Lower Sample Rates



- Reduce DCS Loading
- Save Hard Disk space !!!!
- Information Loss
  - Will the Performance statistics for loop be effected ?
  - Model Identification may not be possible
    - Process Dynamic information
    - Correlation Structure, Active Model Capture
  - Analysis of Oscillation detection and Loop interactions may be hindered



## So How Can We Do This Analysis



- Sample data at different frequencies
  - Use Excel for
    - Statistic Calculations
    - Frequency Analysis



- Add the SAME Loop to Plant Triage but with different sampling intervals

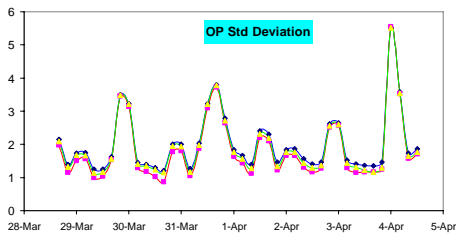
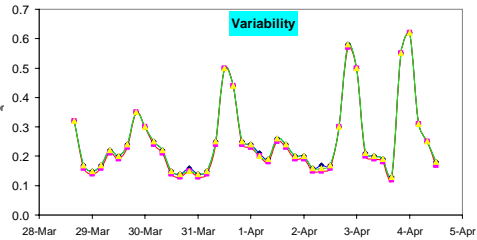
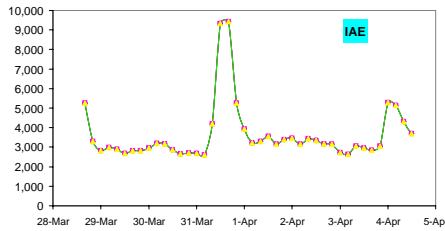
## Design of Experiment



- Q – Does type of loop matter
  - Flow , Temperature, Level, Analyzer....
- We selected a
  - Flow loop and sampled it at 2 sec, 10 sec and 20sec
  - Temperature loop and sampled at 10 sec, 20 sec, 60 sec



# Temperature Loop Statistics Not Affected



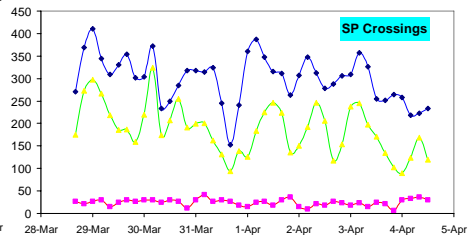
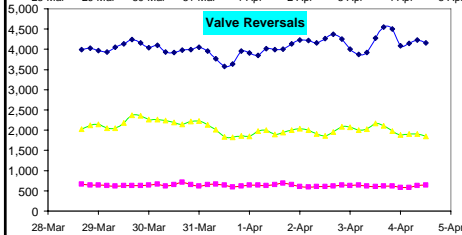
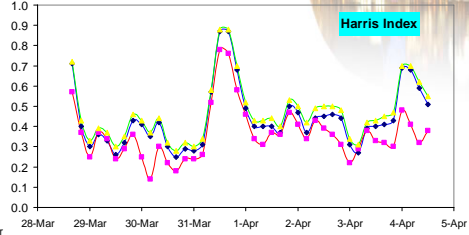
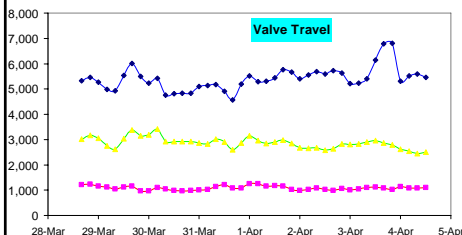
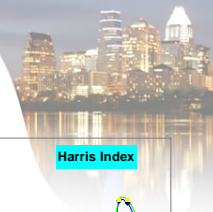
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# Temperature Loop Statistics Affected



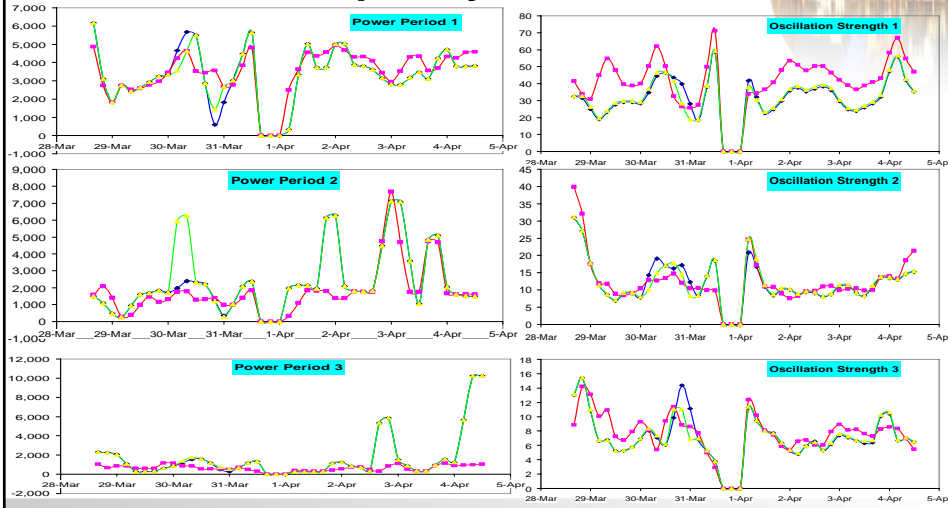
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# Temperature Loop Frequency Statistics



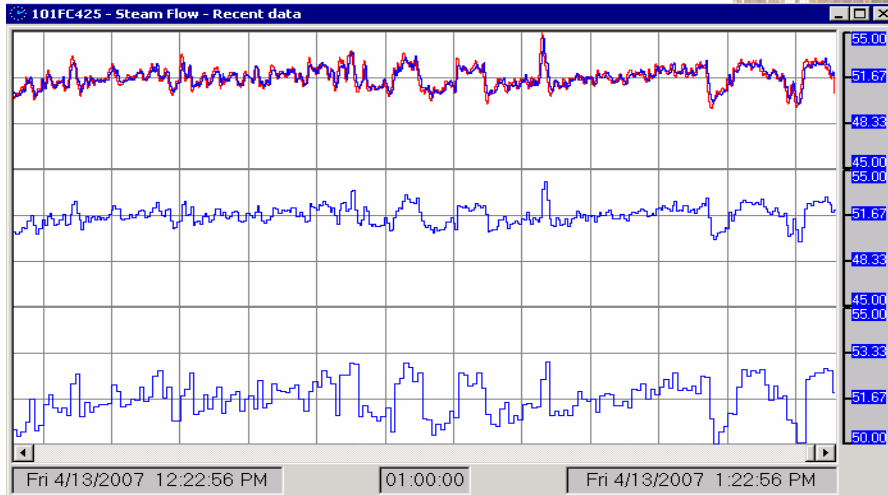
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# Raw Data – Flow Loop



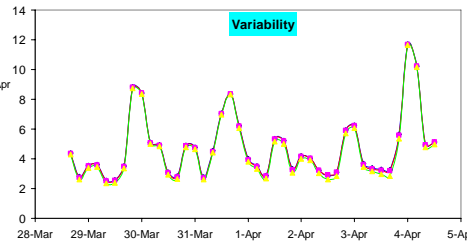
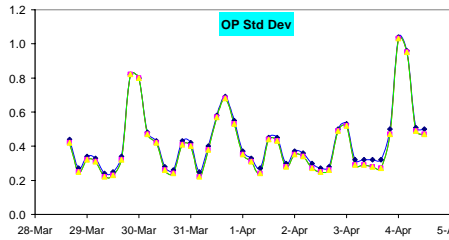
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# Flow Loops Statistics Not Affected



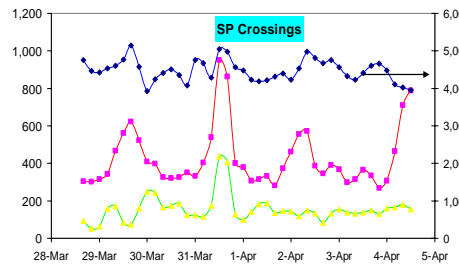
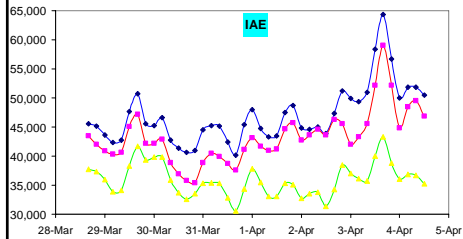
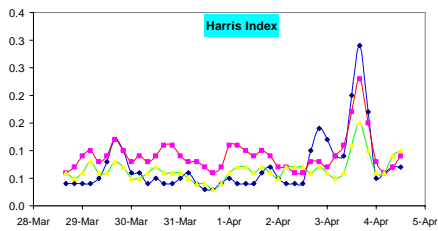
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# Flow Loop Statistics Affected



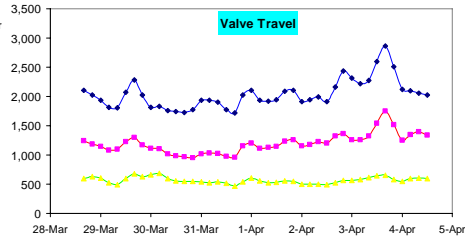
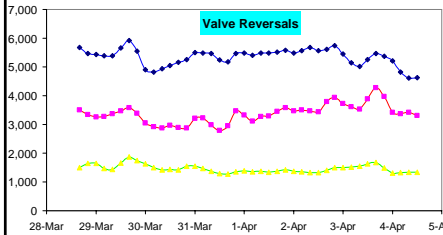
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# Flow Loop Statistics Affected Cont.



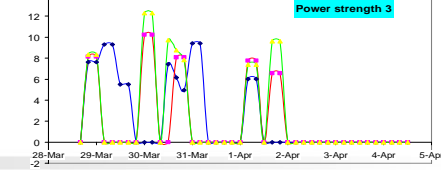
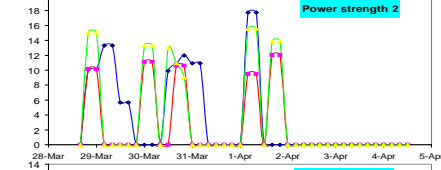
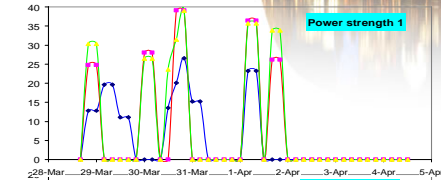
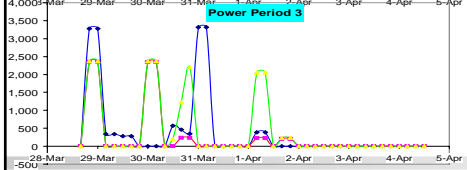
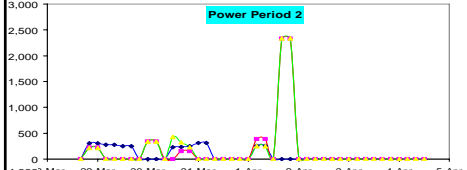
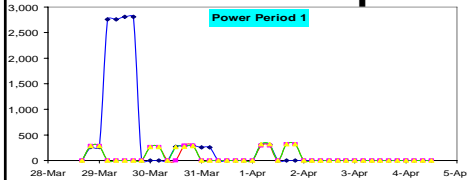
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# Flow Loop Frequency Statistics



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## Conclusions of Sample Interval Experiment

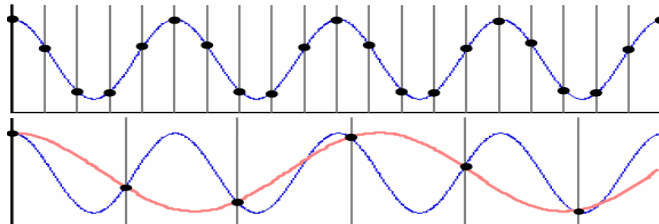


- Some Statistics are not affected by sampling frequency
  - E.g .. IAE (?), Variability , OP Std Dev
- Some Statistics are strong functions of sampling frequency
  - SP Crossings, Valve reversals, Valve travel
    - Can we get a multiplication factor to adjust it to the “Faster sampling Domain”
- Frequency analysis is DEFINITELY messed up
  - Oscillation detection is not possible

## Optimum Sampling... Things to Consider



- Aliasing
  - A false signal that is created as a by-product of sampling and Fourier transformations



### Nyquist Frequency

- The lowest sampling frequency must be no less than twice the highest frequency of interest



# Oscillation Report



Loop	Description	Oscillating	Osc - Valve	Osc - Tuning	Osc - Load	Oscillation period 1	Oscillation strength 1	Oscillation period 2	Oscillation strength 2	Oscillation period 3	Oscillation strength 3
Sort ↑	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort
101AC0111	Overhead Analyzer	0	0	0	0	61.36†	34.43†	170.7†	13.54†	28.54†	11.6†
101AC0311	Bottom Analyzer	0	0	0	0	78.33†	66.84†	40.68†	15.4†	21.28†	4.613†
101FC425	Steam Flow	60	0	0	30	4.06	26.63	4.711	13.84	62.08	8.508
101FC425A	Steam Flow	0.001	0	0	0.001	4.283	36.07	42.67	11.73	5.513	8.993
101FC425B	Steam Flow	0	0	0	0	4.28	42.85	40.29	9.654	5.5	9.609
101LC5504	A-Debutinizer Level	100*	0	0	30	85.08	40.13	31.5	11.28	4.162	6.282
101TC2826	Tray Temperature	100*	0	0	60	4.329	41.56	37.6	18.1	5.536	13.97
101TC2826	Tray Temperature	100	0.001	0	30	61.65	11.81	4.16	10.1	4.491	9.417
101TC2826	Tray Temperature	20	0	0	0.001	46.69	20.71	21.46	13.22	4.558	12.36



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# Experiences with Plant Triage and PID Tuner



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## Lessons Learned



- **DO** a Baseline study before implementing Loop Monitoring
- Benefits
  - Reduced Valve wear, Operators like you, APC depends on it....
- Feed the operators.
- Initial Loop Assessment is very important
  - Positioner, Filter
  - Behavior in Auto/Cascade
  - Service
- Talk with the operators
  - Process knowledge is of utmost importance.
- Have patience

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## Lessons learned Cont..



- Know the quirks of the software.
- Hysteresis & Stiction cannot be simply “tuned out” like your children at home.
- Think outside the box. Perhaps what's needed isn't tuning but a different control scheme, a different valve, or a different trim, or a different control engineer (don't be afraid to get another pair of eyes involved).
- Document changes – MOC etc....

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## Loop Tuning



“It's nice to be able to bump the process a few times and run with a model and “bam”, you're outta there.”

**NO WAY**

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## Thank You



Any  
Questions/Comments ?



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