Process Analytics:
are there dinosaurs among us?

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il buono, il brutto, il cattivo

- Part 1 – *The Ugly*
  Critical Assessment – David Novak

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Part I of III

The Stigma of Process Analytics

A critical assessment

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SpectraSensors
the stigma
are we the technology of last resort?

• Even though they have been a common element of process automation for years, there remains a “stigma” associated with Process Analyzers.

  – High Cost (analyzer and the infrastructure)
  – High Maintenance (high skill level of maintenance)
  – Complicated Installation
  – Complicated Operation
  – Low Reliability
  – Questionable Accuracy

• Where Process Analyzers are accepted, it is only with a high commitment to the required investment which includes the cost of installation as well as the cost of continuing maintenance.

  Expectation: High Price => High Performance and High Gain
  Reality, too often: High Price => Low Performance

Why? What are the key factors?
Key Indicators – Issues to Resolve

- The price of the infrastructure now dominates the analytical application:
  - The price of the shelter and HVAC now dominates the price of the analyzer system.
  - It is uneconomical to supply a shelter for only 1 or 2 analyzers.
  - Analyzer engineers are required to be experts at shelter and HVAC design.
  - The price of the analytical technology is discounted to reduce the overall price of the shelter infrastructure – we compete with lower price analyzers rather than lower cost infrastructure.

  Can we eliminate the shelter or, as a minimum, decouple the price/value of the analytical technology from the shelter infrastructure?

- Current process analytical technology is becoming increasingly difficult to maintain due to the high level of training and lack of highly skilled personnel:
  - Maintenance of current process analyzer technology has been identified as an issue for many years but little has been done to alleviate the problem.
  - Dedicated process analyzer training programs
  - Remote system diagnostics and maintenance

  Skilled maintenance is an issue for all sophisticated technology.

  Can we make the operation and maintenance of process analyzers and system simpler?
Key Indicators — Issues to Resolve

• Critical evaluation of different technologies for specific applications is lacking:
  – In many instances, there are multiple technologies available to perform a component measurement.
  – The industry does not provide sufficient information to evaluate the performance of different technologies for different applications – particularly relative to component interference and potential contamination.

  How do we differentiate the value related to performance of an analytical technology in the particular application so that the purchase is not just on the lowest price technology?

• Critical evaluation of sample system design for specific applications is lacking:
  – Most sample systems are designed based on duplicating previous projects with new features added haphazardly.
  – One third are over-designed; one third are under-designed; perhaps one third are adequate.
  – Sample systems are not optimized for the analytical technology or process application.
  – Many sample system components are still not “fit for purpose”.

  Can we develop and maintain the necessary expertise in the industry for proper sample system design and implementation?
Key Indicators – Issues to Resolve

• There are few, if any, “best practices” for analyzer technologies or systems:
  – Although “best practices” were supported in the industry under the American Petroleum Institute (API) Recommended Practices (RP’s) these documents have gone out of favor and currently lack support.
  – Standard specifications are being developed under the Process Industry Practices (PIP) organization but these also lack best practices for process analyzer application design.
  – Many users have developed standard but rarely extend this effort to include best practices for process analyzer applications.

  *Can we avoid re-inventing the wheel for each new project even though we have experience with most applications and have detailed information on what works and doesn’t work?*

• There are few, if any, performance standards for analyzer system designs:
  – We only specify and evaluate the analyzer technology performance and not the performance of the measurement in the actual installed system configuration.
  – CEMS is a notable exception.
  – A+ Corporation published performance criteria and testing methods for natural gas analyzer systems at the 2010 ISA-AD Symposium

  *Why do we not define and evaluate the measurement performance of the entire system and not just the analyzer, and relate that performance to process control requirements?*
Key Indicators – Issues to Resolve

• **Process sample extraction is not optimized for safety or performance:**
  – Standardized process sample probes just now being developed (A+ / Astute / etc.).
  – Designs and practices developed for CEMS are not applied to process applications.
  – Process piping design and HazOp requirements must be considered.
  – The impact of proper sample extraction and preconditioning on analytical measurement performance is not well-understood or well-defined.

  *Can we develop sample probes that are fit for purpose but also meet the requirements for piping design and safe operation?*

• **Sample transport systems are not optimized for performance:**
  – Most process analyzer systems that require heat-traced sample transport tubing have poorly designed transition interfaces and control/monitoring systems.
  – Except for basic studies performed by O'Brien, the impact of proper sample transport tubing design on analytical measurement performance is not well-understood or well-defined.
  – Heat trace tubing systems for process analyzer systems are now one of the most significant costs for the sample system.

  *Can we rationalize the economic tradeoff of the reduced cost for large, centralized shelters and higher cost and complexity for transport of samples over longer distances from the take-off point to the analyze?*
Key Indicators – Issues to Resolve

• Process piping design is not optimized for analyzer system installation:
  – Standardized sample tap designs have not been developed for analyzers in a similar fashion as standard installation designs for temperature, pressure, flow and level transmitters.
  – Although the proper location of analyzer sample taps on process piping is generally understood, standardized practices for these locations are not widely published or used.
  – Accessibility to analyzer sample taps is usually problematic.

  *How do we establish standard practices and design specifications for process analyzers so that they are implemented properly by process instrumentation and piping designers?*

• Disposal of effluent process sample is now a critical factor in system design:
  – Environmental regulations will impose increasingly more stringent requirements to reduce the amount of process sample that is extracted and cannot be recaptured.

  *Will current process analyzer technology and implementation practices be suitable to meet the new environmental and emission control requirements?*
Key Indicators – Issues to Resolve

• The “real” constraints associated with particular process analytical measurements are not factored into the implementation decisions for the associated control strategy:
  – Like conventional instrumentation, all analyzer applications and measurements are considered the same – but they are not.
  – Response time and duty cycle of analyzer systems are rarely evaluated relative to performance and maintenance factors.
  – Many process analyzer applications are simple and reliable.
  – Many process analyzer applications are difficult and inherently unreliable either due to the measurement technology or the sample handling.
  – Without a requisite understanding of the inherent difficulties and commitment to the cost of maintenance, difficult applications should not be implemented. Compare:
    – Claus tail gas
    – Distillation tower bottoms
    – Crude tower feed
  – As a rule, we generally do not evaluate the high investment cost of process analyzers against the return of that value from either a reliable or, more important, an unreliable measurement.

Can we engage in constructive conversation with process designers and process control engineers to optimize process analyzer measurement use and performance?
What are the options...

• Define and alleviate the issues that have created the “stigma” with current process analyzer technologies and systems.
  – (Why is this not already happening?)

• Develop new technology that avoids the all of the problems associated with current process analyzers.
  – FTIR / NMR / TDL / Raman / microAnalytics
  – The industry readily embraces new technology that may solve the problem but few have been ultimately successful

• Do nothing...
  – Commitment to process analyzers may decline
  – Alternate technologies will become popular – Advanced Process Control with Inferential or Predictive Models using laboratory analysis for validation.

The dilemma: do we wait and see, or do we adapt?

As long as the stigma exists, there is the threat of extinction...
Part II of III

Myths and mistakes that may contribute to our extinction

the automation conundrum
Are we sick of this ‘mantra’ yet?

- 80% of process analytical reliability issues are due to the sample system.
  - Poor understanding of sample integrity: plugged, leaking, fouled?
  - Poor understanding of sample temperature: condensing, two-phase?
  - Poor understanding of sample pressure: vent header fluctuation?

We need a ‘pipe to pixel’ look at myths and mistakes with process analytical systems to understand the problem.
Myth: manual interventions and analyzer rounds are essential

- today
  - Of $6 billion spent each year on process analytical, approx. 50% is spent to maintain*
  - How many people in your plant look after analyzers?
  - Reliability is suspect
    - Can automation help?

*Source: PAI partners
Myth: Monitoring the analyzer is good enough
(Actually the analyzer is only one part of a large system)
Q: Has our large infrastructure and reliance on manual devices taken on Rube Goldberg qualities?

A Rube Goldberg machine is a deliberately over-engineered machine that performs a very simple task in a very complex fashion, usually including a chain reaction.
Myth: Size (and weight) don’t matter

conventional systems
- Size and weight are not a critical factor
- High infrastructure costs

at-line systems
- Infrastructure minimized
- Small size is important for field maintenance

Conventional sample system designs can be physically large and complex. Picture courtesy of a major petrochemical JV.

The move to by-line analysis requires smaller, lighter components. Picture courtesy of Dow Chemical.
Myth: Manual inspection is good enough

- **conventional diagnostic tools**
  - Rotameters, bubblers, pressure and temperature gauges which require walk-by visual checking
  - Cult of the “analyzer whisperer”

- **automated**
  - Temperature, flow and pressure gauges replaced with *bus-enabled* sensors
  - Remote graphical visualization

Rotameter replacement: NeSSI-bus-enabled sensor can measure fluid flow, pressure and temperature, and serve in Div/Zone 1. (Courtesy of CircorTech)
Myth: Automation needs to be done in the DCS*

• Unmet need → the SAM**
  – Provides local signal management

• Functional spec
  – Form → instrument style X-proof enclosure
  – Function → PAC*** like
    • Serial I/O capabilities
    • 4-20 mA is NOT the answer
  – Standard “applet” container
    • Turn repetitive tasks to commodities

* DCS = Distributed Control System
**SAM = Sensor Actuator Manager
***PAC = Process Automation Controller

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"Who can solve SAM?"
Analytical Engine – going in the right direction?

- Small amount of sample used
- Integral pressure & temperature control
- Integral filtration
- microAnalytical ready
- Sample returned to pipe (no venting req.)
- A complete solution

Based on a patent awarded to Dow Chemical
Let’s end the myths

• Unless we become more reliable (and cost effective) we may become extinct
• We can improve reliability through automation but this can increase cost. (conundrum)
• Has the NeSSI initiative, to date, improved our systems or repurposed them by perpetuating the myths?
• Systems with less infrastructure will be much easier to automate.

"When men got structural steel, they did not use it to build steel copies of wooden bridges."