Considerations for selecting an Advanced Process Optimization System

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Agenda

What is an advanced process optimization system?
Aggregation and segregation of multiple data sources
Raw data conversion to valuable information
Monitoring & control
Process optimization – getting something back from the system
Modeling of Complex Systems

Typical Modeling Projects

- Wind Park Optimization
- Modeling of Cell Processes
- Business Process Modeling
- Optimizing Constraint Systems

Signal "C":

ACC = 01.01
module-type
SOM

Cable termination rack
ECC cabinet with ECC 01.01 double frame

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What is an Advanced Process Optimization System?

Fundamental Aspects:

- Processes
- Advanced Process Control (APC)
- Process Optimization
- System (Manufacturing, Monitoring, Control, …)

→ Bringing the parts together to provide a solution
Why do process optimization?

Add business value

Improve product quality

Increase yield

Improve manufacturing efficiency (materials, energy use, resource use…)

Reduce costs (development, materials, resources…)

Reduce risks by improving safety (early fault detection, less invasive work for operators, better process control…)
Roadmap to an Advanced Process Optimization System

- Existing Process
- Requirements
- Determining Important Variables
- Defect Analysis
- Improvement

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PAT Basics – Holistic Approach

Advanced Process Control

Quality built in by design
Right First Time

monitoring product quality

Real-Time Release

Monitoring process data

mathematical translation

Closed loop control

Temp., Speed, Liquid addition, Compression
Force, ...

Process Analyzer

Sample

Process output

LIMS

Hold / release

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PAT Architecture
Cross-Functional Team and Network

Demand (Customer)

Supply (Cross-Functional Team)

Team Lead

Project Expert Team

Integrator

Suppliers

System Design, Development, IT

Automation, Device, Analyzer Supplier

Raman Spectroscopy
NIR / MIR
Fluorescence...

Team lead coordinates activities within team and involves production, process, laboratory, analyzer and data analysis experts as required.

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PAT Data Flow principle:
focus on line data acquisition and processing

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Example: E.coli producing recombinant protein – Modeling and Monitoring

1. Bioprocess

2. Choice of sensors

3. Data capturing

4. Control Variables selection

5. Statistical modeling

6. Statistical and numerical solutions

7. Generalization or Refinement for similar bioprocesses

Monitored bioprocesses

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variable names change to understandable
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Data organization and analysis

File formats
Merging of data streams
Analysis
- Preprocessing and data scaling
- Quantitative or qualitative analysis or both?
- Methodology: PLS, PCA, neural networks?
Model update – continuous learning, automatic or manual updates?
Is the goal having a measurement that provides process information; or is it knowing everything about it and having the most expressive chemometric model and PAT tools to carry out the measurement?
Data analysis – begins with visualization

Mean of process variables grouped by batches run

NIR Transflectance spectra of bioprocess

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Data analysis

• Determine if data transformations (scaling, derivatives, scatter corrections) are needed to bring out signal from data and put variables on same scale
• Qualitative analysis can be used to give a process signature
• If have a quality parameter, or reference values for critical parameters, then quantitative regression models can be developed
• In all cases, models must be validated against independent data
Regression modeling of quality

Develop PLS regression model for product quality from 33 process parameters measured in chemical process; can use the model information to discern which variables are important in predicting quality

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Qualitative analysis of data to show batch consistency of 3 batches?

All 3 batches reach common process end point

Process start
Monitoring process with models: quantitative and quantitative

- PLS regression for measuring quality
- PCA scores
- Statistical limit at 95% confidence

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Advanced Process Optimization System

System and Infrastructure
- Hard Elements (Devices, Analyzers, MES, LIMS, SCADA, …)
- Soft Elements (Cross-functional team and network, internal and external)

Process
Measurement system
Models
Control Strategies

→ All together enable Advanced Process Optimization.
Conclusions

Collecting quality data is just one part of the application; success is related to the knowledge gained about the process, and not to the volume of data generated.

Provide infrastructure to handle the data as well as the tools to enable process optimization.

Also need:
- Work in cooperation with the process owners
- Have buy-in and support from end-users
- Have good relationship with suppliers
- Collect the data to meet the control objectives
- Explore data analysis options that can be integrated with control systems
THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?

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