DISCOVERING HOW PROCESS OPERATION AND CONTROL TECHNOLOGY REALLY WORKS

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Layout of the talk

- Imperial College carbon capture plant project
- Process automation and control
- Industrial IT and computer aided process engineering
- Alarm management example
- Other site systems
- Closing remarks
Imperial College carbon capture plant project

FEED contractor: Strata Technology
Engineering contractor: Techno Project Industriale
Instrumentation and control: ABB
Control system contractor: Charter Tech
Electrical contractor: JMS Electrical Services

Photography: Armitage Communications

Project Manager: Daryl Williams
Imperial College project

Technical features
- 50 kg/hour capture of CO₂ using MEA solutions
- 12 metre high stripping and absorption columns
- High density of instrumentation
- 800xₐ control system

The new Imperial College pilot plant
- Investment by Imperial College and ABB
  - £700K for the physical plant, two dedicated pilot plant staff
  - £1M by ABB for ABB Control room and instrumentation
- Activities
  - Undergraduate training (120-140 each year)
  - International summer school programme
  - Professional courses and training
- ABB instrumentation/control
  - Full 800xₐ industrial control system
  - Full suite of ABB instrumentation
  - UK showcase for ABB’s customers and clients
Imperial College project

Process automation and control
Process automation and control

- RTO/APC
- Root cause
- Historian
- Programming tools
- Connectivity server
- Ethernet network
- Plant network
- Controller and I/O
- Fieldbuses

- Operator interface

The plant is not represented in the control system.

Industrial IT and computer aided process engineering
### Model-Based Operation
- Scheduling
- Workflows
- Real-time optimization
- Hardware in loop
- Model-based alarm handling
- Model-based root cause analysis

### Data-Driven Operation
- Controller performance assessment
- Fault detection
- Fault diagnosis
- Root cause analysis
- Stiction detection
- Empirical modelling

### Model-Based Design
- Dynamic process simulation
- Optimal design
- Control structure selection

### Data-Driven Operation
- Controller performance assessment
- Fault detection
- Fault diagnosis
- Root cause analysis
- Stiction detection
- Empirical modelling

### First Principles Model
- Used for optimization

\[
\begin{align*}
\dot{x}(t) &= f(x(t), u(t)) \\
y(t) &= f(x(t), u(t))
\end{align*}
\]

First principles model e.g. from FEED used for optimization
**IT and CAPE**

First principles model e.g. from FEED used for HIL simulation and operator training

\[
\dot{x}(t) = f(x(t), u(t)) \\
y(t) = f(x(t), u(t))
\]

**Industrial IT and CAPE**

Connectivity model from P&ID used for root cause analysis.
Industrial IT and CAPE

Functional description of control system and structure
Interlock specifications

RTO/APC root cause historian programming tools

Real-time data

$\sigma_{ij} + 1$
Industrial IT and CAPE

Industrial IT and Computer Aided Process Engineering

Obvious conclusion:
- It is useful to know about industrial implementation

Alarm management example
Alarm management example

Alarm
‘...indicating to the operator ... an abnormal condition requiring a response’

Alarm flood / Alarm shower
‘A condition during which the alarm rate is greater than the operator can effectively manage’

Alarm management example

Where to place the code?
- External to DCS
- As a DCS server?
- At the controller layer?

Easy to implement, but requires open access to alarm logs. Integration with alarm hiding is not straightforward.
Alarming management example

Implementation is done by the DCS vendor. Allows easier access to alarm logs. Integration with alarm hiding is still not straightforward.

Implementation is done by the DCS vendor. Allows access to alarm logs and integration with alarm hiding. Can it be programmed in an IEC 61131-3 language?
Other site systems

Process automation and control
Other site systems

And the other systems?

Truly integrated operation will need information from so many more sources …

END