Challenges and problems in offshore process control

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Outline

- Process control troubleshooting
- Errors in control design
  - Examples from the literature and Fantoft’s experience
- Conclusions

Process control troubleshooting

- Fantoft Prosess as
  - >20 employees.
  - Established in 1986 in Sandvika.
  - Delivers:
    - Studies of System Dynamics.
    - Dynamic Process Simulators.
    - Real-time systems.
  - Troubleshooting of existing control schemes and verification of new schemes.
Two types of task

- Design phase:
  - Verify that the proposed process and instrumentation works as required.

- Operations phase:
  - The process and instrumentation doesn’t work as required.
  - Why?
  - What can we do to fix it?!

Design of control structures

- Key issue for design and retrofit.
- Sensors:
  - What type? Where? How many?
- Actuators:
  - What type? Where?
- Controllers:
Some reasons for errors and problems in control design

- Complexity
- Steady-state mindset
- Interdisciplinarity
- Time pressure
- Cost constraints (not life-cycle cost!)
- Human factors
- Contract structure
- Low use of check-out/verification tools
- Utilities have low prestige – but high value

Fantoft’s Troubleshooting Model

Evaluate PFDs for structural problems

Propose solution

Implement Solution and Follow Up

Verify simulation and solution

Simulate problem areas with control

Inputs from design and operations
Three problem areas

- Degrees of Freedom
  - Under- or over-determined systems.

- Problems with enhancements to PID
  - Split-range, logic, cascade, tracking.

- Actuators
  - Valve type, placement and size.

Cases

- Degrees of freedom
  - Flow loop with too much control.
  - Separator without level control.

- Split range, tracking and other complexities...
  - Heat exchanger control given constraints.
  - Relief and flaring.

- Actuators
  - Butterfly valves are bad for control.
  - Control valves can cause trips.
Flow loop with too much control

Separator without level control
Separator without level control

Heat exchanger control given constraints

- Process gas cooled with cooling water
- Two objectives:
  - $L < \text{Gas T} < H$
  - Water T < H
- Actual values are of secondary importance
Heat exchanger control given constraints

Relief and flaring
Butterfly valves are bad for control

- Installed characteristic: pressure drop of valve should be dominant.
  - Butterfly valves give large flow, low pressure drop.
- Very non-linear characteristic:
  - Sharp increase of flow at low openings.
- Mechanical construction can give rise to flow instabilities.

A control valve that caused tripping...
Finally... use simulators with care

- Proportional gain of 3000 on a LIC.
  - Theoretically fine...
  - ...except for signal noise.
- Actuator problems and non-linearities.
  - Stick-slip.
  - Deadband.

Conclusions

- Dynamic simulation provides a powerful tool for problem removal in design and operations.
- Needs skill in problem formulation, configuration and result interpretation to be effective.
  - Detective work...
  - Evaluation of limitations and results...
- Model must cover both control and process.
  - With high fidelity in each area.