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PRACTICAL ADVANCED PROCESS CONTROL

FOR ENGINEERS AND TECHNICIANS

A 2-day practical workshop presented by:

Dr Rodney Jacobs

NH Dip, M Dip Tech, BA (Hons), D Tech

Senior Instrumentation Engineer

JOHANNESBURG
18 & 19 August 2011

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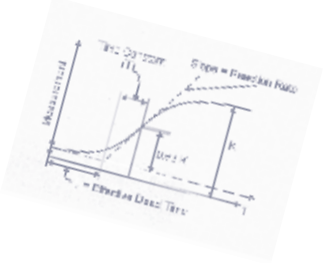
YOU WILL LEARN HOW TO:

- Understand the essentials of Advanced Process Control (APC)
- Grasp the key differences between the various technologies
- Perform simple APC design strategies and implementations
- Be able to perform PID control
- Troubleshoot simple APC problems
- Identify processes suited to APC



WHO SHOULD ATTEND:

- Instrumentation and control engineers
- Process control engineers
- Senior technicians
- Automation engineers
- System integrators
- Electrical engineers
- Chemical engineers
- Chemical plant technologists
- Process engineers

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PRACTICAL ADVANCED PROCESS CONTROL
FOR ENGINEERS AND TECHNICIANS

An intensive, PRACTICAL, two-day workshop presented by

DR RODNEY JACOBS

NH Dip, M Dip Tech, BA (Hons), D Tech

Senior Instrumentation Engineer

Rodney has over 20 years experience in the gold mining industry, underground as well as specialising in Metallurgical operations in the Gold Plants. He has worked predominately in the instrumentation; process control and automation field, and is responsible for hardware and software designs associated with instrumentation. His areas of special interest include PLCs, SCADA systems, process control and programming. Having spent many years on the shop-floor, Rodney has built up a vast amount of hands-on practical experience, and is a past recipient of the N & Z award, which is one of the most prestigious awards, for South Africans in the field of instrumentation.

Rodney is currently active as a Consulting Engineer in the field of instrumentation, both to the mining industry as well as to other general engineering companies, which require specialised solutions. He has also lectured in Electronics, Electrical Engineering and Digital Systems, at a university level. Rodney feels that people are the most important asset of any organisation and has a qualification in Psychology to complement his Engineering knowledge and experience.

Rodney has presented numerous IDC workshops in the United States, England, Ireland, Scotland, Bahrain, United Arab Emirates, Iran, Vietnam, Australia, New Zealand, Malaysia and a great deal of sub-Saharan countries in Africa.

The fee for each workshop covers all materials including workshop manual, lunches and refreshments

The Workshop

In today's environment, the processing, refining and petrochemical business is becoming more and more competitive and every plant manager is looking for the best quality products at minimum operating and investment costs. The traditional PID loop is used frequently for much of the process control requirements of a typical plant. However there are many drawbacks in using these, including excessive dead time which can make the PID loop very difficult (or indeed impossible) to apply.

Advanced Process Control (APC) is thus essential today in the modern plant. Small differences in process parameters can have large effects on profitability; get it right and profits continue to grow; get it wrong and there are major losses. Many applications of APC have pay back times well below one year. APC does require a detailed knowledge of the plant to design a working system and continual follow up along the life of the plant to ensure it is working optimally. Considerable attention also needs to be given to the interface to the operators to ensure that they can apply these new technologies effectively as well.

Pre-requisites

Basic electrical concepts are necessary and it is strongly advised that students attend the IDC "Practical Process Control" class before attending this 'advanced' course.

The Program

DAY ONE

JUSTIFICATION OF ADVANCED CONTROL
- Advanced versus classical control
- Advanced on-line control versus statistical process control
- Comparison of pay back time on various examples of applications in real plants

Practical exercise 1: Model representation

FUNDAMENTALS OF PROCESS CONTROL
- Processes, controllers and tuning
- PID controllers – P, I and D modes off operation
- Load disturbances and offset
- Speed, stability and robustness
- Gain, dead time and time constants
- Process noise
- Feedback controllers

Practical exercise 2: PID loop tuning parameters refresher

FUNDAMENTALS OF TUNING PID LOOPS
- Open and closed loop tuning
- Ziegler Nichols
- Fine tuning for different process types
- Lambda tuning
- Ten different rules compared
- Cascade systems
- Feedforward control
- Deadtime
- Models and disturbances.

Practical exercise 3: Loop tuning refresher (both open-loop and closed-loop)

INTERNAL MODEL CONTROL (IMC)
- Open loop model of the process in parallel with the process
- Control system in two blocks
- Equivalence with a classical controller
- Disturbances rejection and control
- IMC and delays
- IMC and feed forward (measured disturbances rejection)

Practical exercise 4: IMC controller

MODEL PREDICTIVE CONTROL (MPC)
- Single input / output versus multivariable control
- Example on a binary column causality graph
- Constraints and planning ahead before acting
- Different notions of models
- Action model - measured disturbances model
- Unmeasured disturbance models
- Reference trajectories
- Example of a quality blender control system

Practical exercise 5: MPC controller representation

MPC: MODEL REPRESENTATIONS
- State space representation
- Transfer function representation
- Impulse response representation
- Various mathematical formulations

Practical exercise 6: MPC controller interaction calculation

DAY TWO

MPC: MODEL IDENTIFICATION
- Identification requires a good knowledge of the unit
- Black box models / grey box models
- Causality graph of the unit
- What to identify?
- How? Step responses - pseudo random binary signals
- Exercises of identification on various types of petrochemical units

Practical exercise 7: MPC controller calculation programming and setup

MPC: OBSERVERS
- Overall formulation
- Purpose of observers in control algorithm based on state / space representation
- Innovation on measured output - estimation of the state
- Study of Kalman algorithm

Practical exercise 8: Gain scheduling

MPC: CONTROL
- Overall formulation
- Hard constraints on manipulated variables
- Set values and soft constraints on control variables
- The notion of horizon

Practical exercise 9: Feed forward

REFERENCE MODELS
- Handling setpoints on controlled variables
- Measured disturbances rejection
- Unmeasured disturbances rejection
- Handling soft constraints on controlled variables
- Rejection of disturbances

Practical exercise 10: Ratio control

CONTROL FORMULATION PROBLEM
- Quadratic criterion versus geometric control
- Importance of the horizon length
- Use of the weight matrix
- Handling output constraints along the horizon
- Projection of measured and unmeasured disturbances along the horizon
- Final quadratic problem formulation and resolution
- Off-line pre-processing
- On-line calculations

Practical exercise 11: Decoupling circuits (both feed forward as well as inverting)

MPC STEADY STATE OPTIMISATION
- Degrees of freedom and rationale for optimisation
- Economic output submitted to setpoint
- Slogans to maximise or minimise
- Bridge from optimisation to control
- Reachable targets for economic variables
- Interpretation of the horizon for economic variables
- Change of the control formulation problem

Practical exercise 12: Dead time compensation (using formulae as well as a Smith Predictor)

APPLICATION OF THE THEORY TO THE CONTROL OF TWO DIFFERENT UNITS ON A PROCESS SIMULATOR
- Complete application (identification, controller design, control and optimisation)

Practical exercise 13: Cascade control, using PV tracking and initialisation