



# CCA 2017 Workshops

5 & 6 December 2017

Liliesleaf Farm, Rivonia, South Africa

**The A - Z of APC**  
5 December 2017

**Workshop on process data analytics**  
6 December 2017



For more information contact [cca2017@sacac.org.za](mailto:cca2017@sacac.org.za)  
[www.sacac.org.za/cca](http://www.sacac.org.za/cca)



## Introduction

Advanced process control (APC) is a well established technology in the process industries, and is becoming more popular in the mining and metallurgy fields. This workshop aims to introduce delegates to the key concepts currently used in APC, as well as introducing some exciting new ideas. The speakers come from both universities and industry, and are all leaders in their fields.

## Who Should Attend

Control practitioners who would like to learn more about modern techniques in process control.

## Workshop Program

A series of topics will be discussed in this workshop, each topic presented by an expert in the field.

**8:00**

### Arrival and Registration

**8:20**

### Welcome and Introduction

**8:30**

### It's about the PID, stupid!

PID control remains the most used and abused technology when automating industrial processes. There are many benefits to PID control: it is robust as well as easy to understand and implement. Because there are hundreds and sometimes thousands of PID controllers in an industrial process, there is no such thing as individual attention paid to each and every one. The talk will give an overview of the prevalence of PID control and of recent advances in auto-tuning and performance assessment. The overall benefit of PID control will be discussed.

Margret Bauer (Wits) is an honorary professor at the University of the Witwatersrand. Margret received her PhD from University College London, UK, and was Principal Scientist at ABB Germany from 2007-2015. Her research is on automation and industrial process control in various industries.

**9:25**

### Deconstructed PID

The interrelationship between proportional, integral and derivative action in PID is often misunderstood. This is further aggravated by different implementations of the basic PID algorithm namely PI-D or I-PD. While there are many excellent loop tuning methods available, many practitioners prefer tweaking PID tuning constants or using rules of thumb rather than doing the required step test and data analysis. To address these issues, a PID simulator was developed that shows how the different PID components interact, both offline as a training tool as well as a real time tool running parallel with the plant to be used for tuning.

Gustaf Gous (SASOL) is a Lead Specialist in process control engineering currently working at the Secunda Chemical Operations plant of Sasol in Secunda, South Africa. He finds himself pursuing a technical career in control while life tends to constantly herd him into management roles.

**10:20**

### Tea and Coffee



**10:40**

## **Linear - it really is not so bad**

Linear dynamic models are the basis of the vast majority of industrial APC. The generation of these models, and their use in multivariable control will be discussed. Expected benefits are described.

Kevin Brooks' (BluESP) control career began with Honeywell Hi-Spec Solutions, in the area of APC and optimization. He worked on a number of processes, mainly with Sasol. As APC Engineering Leader he led projects in both South Africa and Europe, in particular Eastern Europe. Kevin joined BluESP, the AspenTech distributor for South Africa, in 2007, where he has led projects in ethylene, fuel gas network optimization and novel applications in the platinum, copper, lead and zinc industries.

**11:35**

## **Non-linear - it really is better**

Nonlinear APC is relatively new and not a widely used tool, due primarily to the complexity of defining and maintaining nonlinear models, but also the benefit for continuous processes running at a fixed operating point is negligible. There may, however, be scope to start with a linear approximation of a process and only add nonlinear behaviour where it will add value, such as time-varying nonlinear dynamics, optimisation that moves the process across nonlinear dynamics, discontinuities by switching in or switching out process units or even nonlinear economic objectives. Nonlinear APC is well suited as an enabler for recent trends, such as time-varying economic objectives (eMPC) and plant-wide control.

Loutjie Coetzee (Mintek) is a research and development engineer at Mintek. He specialises in developing the model based control toolbox for Mintek's StarCS control platform and have been involved in commissioning a number of APC systems for the mining industry, in the fields of milling, thickener and leaching control.

**12:30**

## **Lunch**

**13:15**

## **Kalman filters - everything you were afraid to ask**

Kalman filters are generally used to estimate observable states and parameters which are difficult to measure directly. However, the filter sometimes fails to estimate variables which are supposedly observable. This talk will describe how to determine which states and parameters of a nonlinear observer model can be estimated with reasonable accuracy from available measurements, and how to improve observability with the addition of derivatives. The grinding mill will be used as an example.

Derik le Roux (UP) is a lecturer at the University of Pretoria. He completed his PhD in 2016 on "Grinding mill circuit control from a plant-wide control perspective." His main area of research is state and parameter estimation in the process industry.

**14:10**

## **'Big data' and analytics in the process industry - more than just hype?**

Process data analytic methods rely on the notion of sensor fusion whereby data from many sensors and alarm tags are combined with process information, such as physical connectivity of process units, to give a holistic picture of health of an integrated plant. The discovery and learning from process data refers to a set of tools and techniques for modeling and understanding of complex data sets.

Sirish Shah (University of Alberta) is on faculty at the University of Alberta, Canada, where he held the NSERC-Matrikon- Suncor-iCORE Senior Industrial Research Chair in Computer Process Control from 2000 to 2012. The main area of his current research is process and performance monitoring, system identification and design, analysis and rationalization of alarm systems. He has co-authored three books, the first titled "Performance Assessment of Control Loops: Theory and Applications", a second book titled "Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches" and a more recent brief monograph titled, "Capturing Connectivity and Causality in Complex Industrial Processes".



**15:00**

**Collaboration between Academia and Industry- It Really Can Work**

Process control has undergone an evolution over the years. This talk gives an overview, and includes information about projects performed in collaboration with industry during the last decade. Fields covered include control performance monitoring, soft sensor design and application, abnormal situation detection, MPC and advanced regulatory controls.

Rainer Dittmar is a Professor at the West Coast University of Applied Sciences, in Heide Germany. He obtained his Ph.D. from Technische Hochschule Merseburg in 1975. He worked in process control at the PCK Schwedt Refinery, and as head of the pilot plant automation group at Chemieanlagenbau Leipzig. After a period back in academia, he joined Honeywell Process Solutions as a consultant. He has been at his current university since 1996.

**15:55**

**Tea and Coffee**

**16:15**

**Discussion: A final word**

**17:00**

**End**

**Workshop Registration and Costs (5 & 6 December)**

The workshop is presented as part of the Control Conference Africa 2017 (CCA2017) which is a conference hosted by the South African Council for Automation and Control (SACAC). CCA 2017 promotes the exchange of ideas and developments in control engineering in Africa and builds on previous South African events in control engineering.

The CCA 2017 conference specifically addresses control engineers from African countries, African control engineers based abroad who wish to reconnect to their roots, and all control engineers who want to connect with Africa. The conference is co-sponsored by the International Federation of Automatic Control (IFAC), of which SACAC is the National Member Organisation for South Africa.

**To register, please visit the webpage:**

[www.sacac.org.za/cca/registration](http://www.sacac.org.za/cca/registration)

	Day 1 only (5 Dec)	Day 2 only (6 Dec)	Both days (5 & 6 Dec)
Standard Registration	R 3000	R 3000	R 5000
Student Registration	R 2000	R 2000	R 3500
SACAC Members	R 2500	R 2500	R 4200

Registration fees cover lunch, refreshments and all conference material.

For registration after the deadline, an additional charge of R500 will be added to the fees listed above. The registration for the workshop is independent from the registration for the conference.



## Introduction

Process data analytic methods rely on the notion of sensor fusion whereby data from many sensors and alarm tags are combined with process information, such as physical connectivity of process units, to give a holistic picture of health of an integrated plant. The discovery and learning from process data refers to a set of tools and techniques for modeling and understanding of complex data sets. Such data sets generally include normal numerical (or non-categorical) data but should also take into account categorical (or non-numerical or qualitative) data from Alarm and Event (A&E) logs combined with process connectivity or topology information. The latter refers to the capture of material flow streams in process units as well information flow-paths in the process due to control loops.

This is particularly useful when one is analyzing data from highly integrated processes to understand propagation of process faults as would be required in hazard and operability (hazaop) analysis for safe process operation. Highly interconnected process plants are now common and the analysis of root causes of process abnormality including predictive risk analysis is non-trivial.

It is the extraction of information from the fusion of process data, alarm and event data and process connectivity that should form the backbone of a viable process data analytics platform and this is the main focus of this workshop. For efficient and informative analytics, data analysis is ideally carried out in the temporal as well as spectral domains, on a multitude and NOT singular sensor signals to detect process abnormality, ideally in a predictive mode.

With the explosion of applications of analytics in diverse areas (such as aircraft engine prognosis, medicine, sports, finance, social sciences and the advertising industry) statistical learning skills are in high demand. The emphasis in this workshop will be on tools and techniques that help in the process of understanding data and discovering information that will lead to predictive monitoring and diagnosis of process faults.

## Who Should Attend

The intended audience for this workshop would be industrial practitioners of control including vendors working in the area of on-line data logging and archiving, graduate and senior year undergraduate students with interests in statistical learning and data science and academics.

## Workshop Program

The following topics will be discussed in this workshop starting with a broad update on 'big data' and analytics as it applies to the process industry. Each topic will be accompanied by one or more industrial case study to convey the utilitarian value of the learning, discovery diagnosis from process data.



**8:00**

**Arrival and Registration**

**8:30**

**Welcome and Introduction**

**8:45**

**Topic 1: Data quality assessment and visual analytics**

Data distributions and methods for visualizing process data. Big data versus good data; data quality, outlier detection and filtering. Discuss methods of data display: high density time-series plots; scatter plot matrices; parallel coordinate plots; temporal and spectral correlation plots; radar plots.

**10:00**

**Tea and Coffee**

**10:15**

**Topic 2: Process and performance monitoring**

Multivariate methods for process monitoring and controller performance monitoring with diagnosis; Principal components analysis (PCA) for process monitoring and Partial Least Squares (PLS) for soft-sensor design.

**11:30**

**Tea and Coffee**

**11:45**

**Topic 3: Alarm Data Analytics**

Methods for visualizing alarm data and how to minimize false and missed alarms; dealing with chattering alarms, alarm configuration and rationalization.

**13:00**

**Lunch**

**14:00**

**Topic 4: Statistical design of experiments**

Statistical experimental design procedures are successfully used in many science and engineering applications. The primary goal is two-fold: obtaining the right kind of information, and doing so efficiently. This short lecture will motivate the application of “Design of Experiments” in scientific, engineering and industrial investigations, and then discuss some of the most useful basic concepts. Several actual industrial case studies will be used to illustrate the principles and how they are applied successfully in practice.

**15:30**

**Discussion, wrap-up**

**16h00**

**End**



## Presenters



### Sirish L. Shah

Sirish L. Shah is on faculty at the University of Alberta, Canada, where he held the NSERC-Matrikon- Suncor-iCORE Senior Industrial Research Chair in Computer Process Control from 2000 to 2012. The main area of his current research is process and performance monitoring, system identification and design, analysis and rationalization of alarm systems.

He has co-authored three books, the first titled “Performance Assessment of Control Loops: Theory and Applications”, a second book titled “Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches” and a more recent brief monograph titled, “Capturing Connectivity and Causality in Complex Industrial Processes”.



### Lidia Auret

Lidia Auret is a senior lecturer at Stellenbosch University, Department of Process Engineering. Her research interests include applications of machine learning and statistical inference in process monitoring and process control, especially in extractive metallurgical processes.



### Margret Bauer

Margret Bauer is an honorary professor at the University of the Witwatersrand. Margret received her PhD from University College London, UK, and was Principal Scientist at ABB Germany from 2007-2015. Her research is on automation and industrial process control in various industries.



### Babatunde A. Ogunnaiké

Babatunde A. Ogunnaiké is the author or co-author of more than 100 peer-reviewed publications, and four books including a widely used textbook, “Process Dynamics, Modeling and Control” (1994), and “Random Phenomena: Fundamentals of Probability and Statistics for Engineers” (2009).

He is an Associate Editor of the journal Industrial and Engineering Chemistry Research. He is a 2016 fellow of the American Association for the Advancement of Science (AAAS) and a 2017 fellow of International Federation of Automatic Control (IFAC). He was elected to the US National Academy of Engineering in 2012.