

Course On

How Well are Your Controllers & Process Performing: Good, Bad or Optimal?

Prof. Sirish Shah

Dr. Lakshminarayanan

30-31 January 2002

CPEC-ICS

Block 28, #02-08, Ayer Rajah Crescent,
Singapore 139959

ABOUT THE INSTRUCTORS

Prof Sirish Shah is the co-author of the textbook “*Control loop performance assessment: Theory and applications*”, Springer-Verlag, 1999. Shah received his B.Sc. degree in control engineering from Leeds University in 1971, an M.Sc. degree in automatic control from UMIST, Manchester in 1972, and a Ph.D. degree in process control (chemical engineering) from the University of Alberta in 1976. During 1977 he worked as a computer applications engineer at Esso Chemicals in Sarnia, Canada. Since 1978 he has been with the University of Alberta, where he currently holds the NSERC- Matrikon -ASRA Senior Industrial Research Chair in Computer Process Control.

In 1989, Shah was the recipient of the Albright & Wilson Americas Award of the Canadian Society for Chemical Engineering in recognition of distinguished contributions to chemical engineering. He has held visiting appointments at Oxford University and Balliol College as an SERC fellow in 1985-86, and at Kumamoto University, Japan as a senior JSPS (Japan Society for the Promotion of Science) research fellow in 1994. Shah's research over the last 25 years has focused on the broad area of computer process control. The main area of his current research is process and performance monitoring of closed-loop control systems and industrial processes. He has published extensively in academic journals and conference proceedings. He has been a consultant with a number of different industrial organizations.

Dr. Lakshminarayanan (Laksh) was a Senior Consultant in the Development and Engineering Research Center of Mitsubishi Chemical Corporation in Japan since 1998 prior to joining the Department of Chemical and Environmental Engineering, National University of Singapore. At MCC, he was involved in projects relating to the application of multivariate statistical methods for modeling, monitoring and control. He obtained his BEng in Chemical Engineering from BITS, Pilani, India (1988), an M.Sc. degree in Chemical Engineering from IIT Madras, India (1991) and a Ph.D. degree in Computer Process Control from the University of Alberta, Canada in 1997. His research interests include process modeling and control, advanced data analysis and bioinformatics.

Workshop targets

This workshop will focus on methods for measuring performance of control loops in manufacturing plants and the diagnosis of control loop problems. It will be supported by industrial case studies to illustrate the application of the techniques. The workshop will equip participants with the knowledge to carry out control loop performance audits.

With the availability of user-friendly PC based software and massive amounts of data collected through process historians, multivariate statistical methods are beginning to enter the mainstream of a process engineer's bag of 'tools' for analysis and process troubleshooting. This workshop will present an overview of multivariate statistical methods such as PCA and PLS for process monitoring.

Course Outline

Assessment of performance of single-input-single-output loops:

- ◆ The key literature will be surveyed: Individual experts and centers of excellence for each of the topics within the course will be identified.
- ◆ Motivational introduction to control loop performance assessment via industrial case studies.
- ◆ Minimum variance as a benchmark for the lowest achievable output variance: The key concept is the comparison of the actual output variance with the minimum variance. Minimum variance is estimated by time series analysis of routine closed-loop operating data. It characterizes the most fundamental performance limitation of a system due to the existence of time-delays.
- ◆ Signal processing methods for estimating the minimum variance of univariate control loops: The key algorithms required will be presented and worked examples provided.

Practical implementation:

- ◆ Practical performance assessment benchmarks: Practically there are many other limitations on the achievable control loop performance. Performance assessment in a practical context by means of a user-defined benchmark or control action constraints will also be discussed.
- ◆ Control loop performance evaluation via spectral analysis of data.
- ◆ Survey of commercial products and services.

Assessment of performance of multivariable controllers:

- ◆ Extensions of performance assessment to advanced multivariable control systems.
- ◆ Evaluation of the interactor matrix: Extension of minimum variance control benchmarking to multivariable controllers requires knowledge of the time-delay/interactor-matrices, a fairly stringent requirement. However, simpler forms of the interactor matrix allow the performance of the multivariable closed loop system to be evaluated rather easily. The workshop will demonstrate how to estimate this term from routine operating data.

Plant-wide disturbance and root-cause diagnosis:

- ◆ Plant wide disturbances: A faulty control loop can cause widespread process disturbance. Examples will be presented to motivate the study of methods for detection of plant-wide disturbances and for diagnosis of the root cause.
- ◆ Common causes of control loop failure: Ender (1993) shocked the process industries with the extent to which valve faults caused poor performance of control loops. A new procedure for diagnosis of valve stiction will be presented.
- ◆ Detection of plant wide disturbances: A technique will be presented that combines principal components analysis with controller performance assessment to detect measurements at various places in a plant which are influenced by the same process disturbance.

Process Monitoring and Modeling using Multivariate Statistics

- ◆ Basics of Univariate Process Monitoring – Shewart Charts, CUSUM Charts etc.
The basic concepts will be reviewed. The shortcomings of the univariate approach will be pointed out and the need for a multivariate approach to process monitoring will be outlined.
- ◆ Introduction to Multivariate Statistical Methods: The theory and key concepts of multivariate methods such as Principal Components Analysis (PCA), Partial Least Squares (PLS) and Canonical Correlation Analysis (CCA) will be presented.
- ◆ Application to Process Monitoring and Modeling: This segment of the workshop will discuss applications of the above statistical methods to Multivariate Statistical Process Control (MSPC), fault detection & isolation and identification of multivariable dynamic process models from plant data. Numerous industrial case studies will be used to reinforce the theory introduced earlier.

REGISTRATION FORM

“HOW WELL ARE YOUR CONTROLLERS AND PROCESS PERFORMING: GOOD, BAD OR OPTIMAL” 30 – 31 January 2002

Location & Times: The course will be held in CPEC-ICS, Block 28, #02-08, Ayer Rajah Crescent, Singapore 139959. Registration is at 0845 hrs on 30 January 2002. The course will finish at 1200 hrs on 31 January 2002.

Fee Per Participant: S\$ 700.00

Fee Per Participant for CPEC Industrial Consortium Members: \$650.00 entitled to a maximum of 2 participants

Personal Details

(Please print or attach business card)

[] Professor [] Dr [] Mr [] Mrs [] Miss
(Please tick as appropriate)

Name (Please underline surname or family name)

Designation: _____ Company: _____

Current job duties (please tick):

- | | |
|--|--|
| <input type="checkbox"/> Process development and scale-up | <input type="checkbox"/> Manufacturing/Production – processing operations |
| <input type="checkbox"/> Manufacturing/Production – direct technical support to processing | <input type="checkbox"/> Manufacturing/Production technical support – plant engineering, safety, environmental, industrial hygiene |
| <input type="checkbox"/> Engineering design/construction | |
| <input type="checkbox"/> Logistics, planning, purchasing, regulatory compliance | |

Academic training (identify all that apply):

Undergraduate degree Graduate degree Other: _____

Field of training or degree major (identify all that apply):

Chemistry Chemical Engineering Other: _____

Mailing Address: _____

Fax: _____ Phone: _____ Email: _____

Payment [by cheque, made payable to CPEC]

My registration fee of _____ is being paid by cheque no.: _____
(Please refer to the Registration Details.)

Signature of Delegate: _____ Date: _____

REGISTRATION DETAILS

- The registration fee covers training materials, lunches and morning/afternoon refreshments.
- Registration will be accepted only if it is accompanied by the registration fee, paid in full.
- Registration for the course closes on **20 January 2002**.
- As seats are limited, acceptance is subject to seat availability.
- All registrations received before 20 January 2002 will be acknowledged. Registrations received thereafter will not receive acknowledgement.
- Cancellations will not be entitled to any refund. Replacement of delegates is acceptable. Any replacement must be faxed to the course secretariat in advance.

Please send registration form and payment to:

Ms Karen Lee, CPEC/ICS, Block 28, Ayer Rajah Crescent, Unit #02-08, Singapore 139959
Tel: 874 4237; Fax: 873 4805; Email : karenlee@nus.edu.sg