PASI 2005

Annotated Reading List

This document provides an introduction to the literature in process control with an emphasis on design. Specific references are provided for each section. This list provides an introduction into the topics; a more comprehensive reading list is available in the course outline at the following WEB URL.

www.chemeng.mcmaster.ca/graduate/CourseOutlines/764Course_WEB_Page/Opt-Based_Control_Design.ppt

Before addressing each topic, the list begins with the following resources that are essential for the study of control design.

For a coverage of the theory of linear control systems applied to the design problem:

> Skogestad, S. and I. Postlethwaite, *Multivariable Feedback Control: Analysis and Design*, Wiley, New York, 1996

For a coverage of interaction analysis:

> McAvoy, T., *Interaction Analysis*, ISA, Research Triangle Park, 1983.
>
> McAvoy, T., Interaction analysis and Control System Design, Draft in development.

For a good industrial view of control design:

> Luyben, W., B. Tyreus, and M. Luyben, *Plantwide Process Control*, McGraw-Hill, New York, 1999
>
> Shinskey, F.G., *Controlling Multivariable Processes*, ISA Press, Research Triangle Park, USA, 1981
>
> Liptak, B., *Instrument Engineer's Handbook* (3rd Ed.), Vol 2. Process Control, CRC Press, Boca Raton, USA, 1999
>
> Duckelow, S., *The Control of Boilers* (2nd Ed.), Instrument Society of America, Research Triangle Park, 1991

For an up-to-date view of some research in a related area:

> Seferlis, P. and M. Georgiades, *The Integration of Process Design and Control*, Computer-Aided Chemical Engineering, 17, Elsevier, Amsterdam, 2004.

Introduction

Many excellent review articles have been published over the last many decades. A few are given below.

Roberts, J., Process Control for Tomorrow's Plants, *CEP*, 54, 37-57 (1962)

Rosenbrock, H., Distinctive Problems in Process Control, *CEP*, 58,43-50 (1962)

Rijnsdorp, J., Chemical Process Systems and Automatic Control, *CEP*, 63, 97-115 (1967)

Foss, A., Critique of Chemical Process Control, *AIChE J*, 19, 209-214 (1973)

Lee, W. and V. Weekman, Advanced Control Practice in the Chemical Process Industry: A View from Industry, *AIChE J*, 22, 27-37 (1976)

Evans, L., Impact of the Electronics Revolution on Industrial Process Control, *Science*, 195, 1146-1151 (1977)

Takatsu, H., T. Itoh, and M. Araki, Future Needs for the Control Theory in Industries – Report and Topics of the Control Technology Survey in Japanese Industry, *Journal Proc. Contr*., 1998.

Defining the Control Design Problem

The "problem" is really a challenge and an opportunity for us to apply our skills. The following resources concentrate on defining the problem and estimating the benefits.

Marlin T., J. Perkins, G. Barton, and M. Brisk, Advanced Process Control Applications, Warren Centre Study of Opportunities and Benefits, ISA, Research Triangle Park, 1987.

Marlin T., J. Perkins, G. Barton, and M. Brisk, Benefits from Process Control: Results of a Joint Industry-University Study, *J. Proc Cont*., 1, 68-83, 1991

Downs, J. and E. Vogel (1993) "A Plant-wide Industrial Process Control Problem", *Comp. Chem. Engr*., 17, 245-255.

Li, D., C. Tongwen, H. Marquez, and R. Gooden, Proceed ACC, Denver, CO, paper TA12, 2317-2322, June 4-6, 2003.

Martin, G., L. Turpin, and R. Cline, Estimating Control Function Benefits, *Hydroc Proc*, 68-73, 1991

Craig, I. And R. Henning, Evaluation of advanced industrial control projects: a framework for determining economic benefits, *Control Engineering Practice*, 8, 769-780 (2000).

Shunta, J.P., *Achieving World Class Manufacturing Through Process Control*, Prentice-Hall, Englewood Cliffs, NJ, (1995)

King M., How to Lose Money with Advanced Controls, *Hydrocarbon Processing*, 71, 47-50 (1992)

Friedman, Y.Z., Avoid Advanced Control Project Mistakes, *Hydrocarbon Processing*, 71, 115-120 (1992)

Single-Loop Control

Many undergraduate textbooks cover this material. I will naturally recommend my textbook in chemical engineering and provide a few other references for a more theoretical presentation (Goodwin) and a more applied view (Shinskey and Astrom).

Marlin, T., *Process Control, Designing Processes and Control Systems for Dynamic Performance*, McGraw-Hill, New York, 2000.

Goodwin, G., S. Graebe, and M. Salgado, *Control System Design*, Prentice-Hall, Upper Saddle River, 2001.

Shinskey, F.G., *Process Control Systems*, McGraw-Hill, New York, 1996.

Astrom, K., T. Hagglund, *PID Controllers; Theory, Design and Tuning*, Instrument Society of America, Research Triangle Park, 1995

Interaction Analysis

McAvoy, T., *Interaction Analysis*, ISA, Research Triangle Park, 1983.

Haggblom, K. and K. Waller, Transformations and Consistency Relations of Distillation Control Structures, *AIChE J,* 34, 10, pp. 1634-1648 (1988)

Skogestad, S., Consistency of Steady-State Models Using Insight about Extensive Variables, *IEC Res*, 30, pp. 654-661 (1991)

Swaney, R. and I. Grossmann, An Index of Operational Flexibility, Parts I and II*, AIChE* J, 31, 621-641 (1985)

Controllability

Rosenbrock, H., *State-Space and Multivariable Theory*, New York, Wiley, 1970

Rosenbrock, H., *Computer-Aided Control System Design*, Academic Press, New York, 1974

Skogestad, S. and I. Postlethwaite, *Multivariable Feedback Control: Analysis and Design*, Wiley, New York, 1996

Frieland, B., Control System Design, *An Introduction to State-Space Methods*, McGraw-Hill, New York, 1986

Skogestad, S., E. Jacobsen, and M. Morari, Inadequacy of Steady-state Analysis for Feedback Control: Distillate-Bottom Control of Distillation Columns, *IEC Res*, 29, pp. 2339-2346 (1990)

Integrity

Classic Paper on Relative Gain: Bristol, E., On a New Measure of Interaction for Multivariable Process Control, *IEEE Trans. Auto. Control AC-11*, pp.133-134 (1966)

Campo, P. and M. Morari, *IEEE Trans Auto Contr*, 39, 5, pp. 932-943 (1994)

Grosdidier, P. , M. Morari, and B. Holt, Closed-loop Properities from Steady-state Gain Information*, IEC Fund*, 24, pp. 221-235 (1985)

Maniousouthakis, V. and Y. Arkun, Synthesis of Decentralized Process Control Structures Using the Concept of Block Relative Gains, *AIChE J*, 32, 991-1003 (1986)

Skogestad, S. and I. Postlethwaite, *Multivariable Feedback Control: Analysis and Design*, Wiley, New York, 1996

Direction and Performance

Stanley, G., M. Marino-Galarraga, and T. McAvoy, Short-Cut Operability Analysis: 1. The Relative Disturbance Gain*, IEC PDD*, 24, pp. 1181-1188 (1985)

Marino-Galaragga, M., T. McAvoy, and T. Marlin, Short-Cut Operability Analysis:3. Methodolgy for the Assessment of Process Control Designs, 26*, IEC PPD*, pp. 521-531 (1987)

Skogestad, S. and M. Morari, Effect of Disturbance Directions on Closed-loop Performance, *IEC Res.*, 26, pp. 2029-2035 (1987b)

Short-Cut Control Design Method

Swartz, C., A Computational Framework for Dynamic Operability Assessment, *Comp. Chem. Engr*., 20, 365-371 (1996)

Luyben, W., B. Tyreus, and M. Luyben, *Plantwide Process Control*, McGraw-Hill, New York, 1999

Cao, Y., D. Rossiter, Input Selection and Localized Disturbance Rejection*, J. Proc. Cont*., (1998).

Optimization-Based Control Design

Robinson, D., R. Chen, T. J. McAvoy, P. D. Schnelle, An Optimal control Based Approach to Designing Plantwide Control System Architectures*, J. of Proc. Cont*., 11, P223-236, 2001

Kookos, I. K. and J. D. Perkins, An algorithmic method for the selection of multivariable process control structures. *Journal of Process Control* **12**, 85-99 (2002a)

Kookos, I. K. and J. D. Perkins, Regulatory control structure selection of linear systems. *Computers & Chemical Engineering* **26**, 875-887 (2002b)

Bansal, V., J. D. Perkins, E. N. Pistikopoulos, R. Ross, J. M. G. van Schijndel, Simultaneous Design and Control Optimization under Uncertainty, *Comp. & Chem. Eng*., 24, P261-266, 2000

Narraway, L. and J. Perkins, Selection of Process Control Structure Based on Linear Dynamic Economics, *IEC Res*., 32, 2681-2692 (1993)

