

Curriculum Vitae

Michael A. Henson

Department of Chemical Engineering
University of Massachusetts
Amherst, MA 01003-3110

EDUCATION

B.S. Chemical Engineering, University of Colorado, Boulder, Colorado, 1985.

M.S. Chemical Engineering, University of Texas, Austin, Texas, 1988.

Ph.D. Chemical Engineering, University of California, Santa Barbara, California, 1992.

PROFESSIONAL EXPERIENCE

Visiting Research Scientist, Advanced Process Control Group, DuPont Company, Wilmington, Delaware, Aug. 1992–1993.

Assistant and Associate Professor, Department of Chemical Engineering, Louisiana State University, Baton Rouge, Louisiana, 1994–2002.

Humboldt Research Fellow, Institute of Biochemical Engineering and Institute for Systems Theory in Engineering, University of Stuttgart, Stuttgart, Germany, 2001–2002.

Associate Professor and Professor, Department of Chemical Engineering, University of Massachusetts, Amherst, MA, 2002–present.

Director, Center for Process Design and Control, University of Massachusetts, Amherst, MA, 2004–present.

Co-Director, Institute for Massachusetts Biofuels Research (TIMBR), 2007–present.

AWARDS

Career Development Award, National Science Foundation, 1995.

Cross-Holloway Award for Excellence in Research and Service, Louisiana State University, 1998.

James McLaurin Shivers Professorship, Louisiana State University, 1999.

Research Fellowship, Alexander von Humboldt Foundation, 2001.

College of Engineering Outstanding Senior Faculty Award, 2008.

PROFESSIONAL ACTIVITIES

Associate Editor

IEEE Control Systems Society Conference Editorial Board, 1994–1996.

Journal of Process Control, 2000–2008.

Automatica, 2005–2008.

AIChE CAST Division

Director, Computing and Systems Technology (CAST) Division of AIChE, 2001–2003.

Programming Chair, CAST Area 10b, Systems and Process Control, 2003.

Other Activities

Member, Technical Committee on Industrial Process Control, IEEE Control Systems Society, 2002–present.

Board of Directors, American Automatic Control Council, 2004–2005.

Trustee, Computer Aids for Chemical Engineering (CACHE), 2005–present.

Conference Organization

Chairman, Chemical Process Control 7, Lake Louise, Alberta, Canada, January 2006.

Chairman, Foundations of Systems Biology in Engineering, Denver, CO, August 2009.

Co-Chairman, Foundations of Systems Biology in Engineering, Santa Barbara, CA, July 2005.

Workshop Organizer

“Modeling and Analysis of Biological Regulatory Networks,” with Frank Doyle (UCSB), American Control Conference, Minneapolis, MN, June 2006.

“Systems Biology,” with Frank Doyle (UCSB), ASEE Summer School for Chemical Engineering Faculty, Pullman, WA, August 2007.

Professional Society Memberships

Senior Member, Institute of Electrical and Electronics Engineers

Member, American Institute of Chemical Engineers

Member, International Society for Pharmaceutical Engineering

Consulting

Alstom Power, Windsor, CT, 2007–present.

Dow Chemical Company, Plaquemine, LA, 1995.

ExxonMobil Chemical Company, Baton Rouge, LA, 1997–2003.

Chevron Chemical Company, St. James, LA, 1998.

Gas Technology Institute, Des Plaines, IL, 2002.

SunEthanol, Amherst, MA, 2007–present.

PUBLICATIONS

Nonlinear Control

1. Henson, M. A. and D. E. Seborg, “Input-Output Linearization of General Nonlinear Processes,” *AIChE J.*, **36**, 1753–1757 (1990).
2. Henson, M. A. and D. E. Seborg, “Critique of Exact Linearization Strategies for Process Control,” *J. Process Control*, **1**, 122–139 (1991).
3. Henson, M. A. and D. E. Seborg, “An Internal Model Control Strategy for Nonlinear Systems,” *AIChE J.*, **37**, 1065–1081 (1991).
4. Nahas, E. P., M. A. Henson, and D. E. Seborg, “Nonlinear Internal Model Control Strategy for Neural Network Models,” *Comput. chem. Engng.*, **16**, 1039–1057 (1992).
5. Henson, M. A. and D. E. Seborg, “Theoretical Analysis of Unconstrained Nonlinear Model Predictive Control,” *Int. J. Control*, **58**, 1053–1080 (1993).

6. Henson, M. A. and D. E. Seborg, "Time Delay Compensation for Nonlinear Processes," *Ind. Eng. Chem. Res.*, **33**, 1493–1500 (1994).
7. Henson, M. A. and D. E. Seborg, "Adaptive Nonlinear Control of a pH Neutralization Process," *IEEE Trans. Control Systems Technology*, **2**, 169–182 (1994).
8. Meadows, E. S., M. A. Henson, J. W. Eaton, and J. B. Rawlings, "Receding Horizon Control and Discontinuous State Feedback Stabilization," *Int. J. Control*, **62**, 1217–1229 (1995).
9. McLain, R. B., M. J. Kurtz, M. A. Henson, and F. J. Doyle III, "Habituating Control for Non-Square Nonlinear Systems," *Ind. Eng. Chem. Res.*, **35**, 4067–4077 (1996).
10. Henson, M. A., "A Critical Review of Constraint Compensation Techniques for Nonlinear Process Control," Proc. European Control Conf., Brussels, Belgium (1997).
11. Kurtz, M. J. and M. A. Henson, "Input-Output Linearizing Control of Constrained Nonlinear Processes," *J. Process Control*, **7**, 3–17 (1997).
12. Henson, M. A. and D. E. Seborg, "Adaptive Input-Output Linearization of a pH Neutralization Process," *Int. J. Adapt. Control Signal Process.*, **11**, 171–200 (1997).
13. Pottmann, M. and M. A. Henson, "Compactly Supported Radial Basis Functions for Adaptive Process Control," *J. Process Control*, **7**, 345–356 (1997).
14. Henson, M. A. and D. E. Seborg (Eds.), *Nonlinear Process Control*, Prentice-Hall, Englewood Cliffs, NJ, 1997.
15. Doyle, F. J. and M. A. Henson, "Nonlinear Systems Theory," in *Nonlinear Process Control*, Prentice-Hall, Englewood Cliffs, NJ, 1997.
16. Henson, M. A. and D. E. Seborg, "Feedback Linearizing Control," in *Nonlinear Process Control*, Prentice-Hall, Englewood Cliffs, NJ, 1997.
17. Kurtz, M. J. and M. A. Henson, "Feedback Linearization of Discrete-Time Nonlinear Systems with Input Constraints," *Int. J. Control*, **70**, 603–616 (1998).
18. Kurtz, M. J. and M. A. Henson, "State and Disturbance Estimation for Nonlinear Systems Affine in the Unmeasured Variables," *Comput. chem. Engng.*, **22**, 1441–1459 (1998).
19. Henson, M. A. "Nonlinear Model Predictive Control: Current Status and Future Directions," *Comput. chem. Engng.*, **23**, 187–202 (1998).
20. McLain, R. B., M. A. Henson, and M. Pottmann, "Direct Adaptive Control of Partially Known Nonlinear Systems," *IEEE Transactions on Neural Networks*, **10**, 714–721 (1999).
21. McLain, R. B. and M. A. Henson, "Principal Component Analysis for Nonlinear Model Reference Adaptive Control," *Comput. chem. Engng.*, **24**, 99–110 (2000).
22. Zhu, G.-Y., M. A. Henson, and B. A. Ogunnaike, "A Hybrid Model Predictive Control Strategy for Nonlinear Plant-Wide Control," *J. Process Control*, **10**, 449–458 (2000).
23. McLain, R. B. and M. A. Henson, "Nonlinear Model Reference Adaptive Control with Embedded Linear Models," *Ind. Eng. Chem. Res.*, **39**, 3007–3017 (2000).

24. Zhu, G.-Y and M. A. Henson, "Model Predictive Control of Interconnected Linear and Nonlinear Processes," *Ind. Eng. Chem. Res.*, **41**, 801–816 (2002).
25. Li, R., M. A. Henson and K. J. Kurtz, "Selection of Model Parameters for Off-Line Parameters Estimation," *IEEE Transactions on Control System Technology*, **12**, 402–412 (2004).

Biochemical Reactors

1. Henson, M. A. and D. E. Seborg, "Nonlinear Control Strategies for Continuous Fermentors," *Chem. Eng. Sci.*, **47**, 821–835 (1992).
2. Kurtz, M. J., G.-Y. Zhu, A. Zamamiri, M. A. Henson, and M. A. Hjortso, "Control of Oscillating Microbial Cultures Described by Population Balance Models," *Ind. Eng. Chem. Res.*, **37**, 4059–4070 (1998).
3. Kurtz, M. J., M. A. Henson, and M. A. Hjortso, "Nonlinear Control of Competitive Mixed-Culture Bioreactors via Specific Cell Adhesion," *Canadian J. Chem. Eng.*, **78**, 237–247 (2000).
4. Zhu, G.-Y., A. M. Zamamiri, M. A. Henson and M. A. Hjortso, "Model Predictive Control of Continuous Yeast Bioreactors Using Cell Population Models," *Chem. Eng. Sci.*, **55**, 6155–6167 (2000).
5. Zhang, Y. and M. A. Henson, "Bifurcation Analysis of Continuous Biochemical Reactor Models," *Biotech. Progr.*, **17**, 647–660 (2001).
6. Zhang, Y., A. M. Zamamiri, M. A. Henson and M. A. Hjortso, "Cell Population Models for Bifurcation Analysis and Nonlinear Control of Continuous Yeast Bioreactors," *J. Process Control*, **12**, 721–734 (2002).
7. Zamamiri, A. M., Y. Zhang, M. A. Henson and M. A. Hjortso, "Dynamic Analysis of an Age Distribution Model of Oscillating Yeast Cultures," *Chem. Eng. Sci.*, **57**, 2169–2181 (2002).
8. Daoutidis, P. and M. A. Henson, "Dynamics and Control of Cell Populations in Continuous Bioreactors," *AIChE Symposium Series*, **326**, 274–289 (2002).
9. Mhaskar, P., M. A. Henson and M. A. Hjortso, "Cell Population Modeling and Parameter Estimation of Continuous Cultures of *Saccharomyces cerevisiae*," *Biotech. Progr.*, **18**, 1010–1026 (2002).
10. Zhang, Y., M. A. Henson and Y. Kevrekidis, "Nonlinear Model Reduction for Dynamic Analysis of Cell Population Models," *Chem. Eng. Sci.*, **58**, 429–445 (2003).
11. Henson, M. A., "Dynamic Modeling and Control of Yeast Cell Populations in Continuous Biochemical Reactors," *Comput. chem. Engng.*, **27**, 1185–1199 (2003).
12. Henson, M. A., "Dynamic Modeling of Microbial Cell Populations," *Current Opinion in Biotechnology*, **14**, 460–467 (2003).
13. Hjersted, J. and M. A. Henson, "Population Modeling for Ethanol Productivity Optimization in Fed-Batch Yeast Fermenters," Proc. American Control Conf., Portland, OR (2005).

14. Henson, M. A., "Biochemical Reactor Control: Challenges and Opportunities," *IEEE Control Syst. Mag.*, **26**, August, 54–62 (2006).
15. Hjersted, J. and M. A. Henson, "Optimization of Fed-Batch Yeast Fermentation using Dynamic Flux Balance Models," *Biotechnology Progress*, **22**, 1239–1248 (2006).

Systems Biology

1. Henson, M. A., D. Müller and M. Reuss, "Cell Population Modeling of Yeast Glycolytic Oscillations," *Biochemical Journal*, **368**, 433–446 (2002).
2. Henson, M. A., "Modeling the Synchronization of Yeast Respiratory Oscillations," *J. Theoretical Biology*, **231**, 443–458 (2004).
3. Henson, M. A., "Cell Population Modeling of Autonomously Oscillating Yeast Cultures," *Comput. chem. Engng.*, **29**, 645–661 (2005).
4. To, T., M. A. Henson and F. J. Doyle III, "Modeling the Synchronization of Biochemically Coupled Circadian Oscillators," Proc. Foundations of Systems Biology and Engineering, Santa Barbara, CA (2005).
5. Parker, R. S., F. J. Doyle III and M. A. Henson, "Integration of Biological Systems Content and the Process Dynamics and Control Curriculum," *Chem. Eng. Educ.*, **40**, 181–188 (2006).
6. Venkatasubramanian, R., M. A. Henson and N. S. Forbes, "Incorporating Cellular Metabolism into Growth Models of Multicellular Tumor Spheroids," *J. Theoretical Biology*, **242**, 440–453 (2006).
7. To, T.-L., M. A. Henson, E. D. Herzog and F. J. Doyle III, "A Computational Model for Intercellular Synchronization in the Mammalian Circadian Clock," *Biophysical Journal*, **92**, 3792–3803 (2007).
8. Hjersted, J., M. A. Henson and R. Mahadevan, "Genome-Scale Analysis of *Saccharomyces cerevisiae* Metabolism and Ethanol Production in Fed-Batch Culture," *Biotechnology and Bioengineering*, **97**, 1190–1204 (2007).
9. Hjersted, J., M. A. Henson and R. Mahadevan, "Validation of a *Saccharomyces cerevisiae* Dynamic Flux Balance Model and Analysis of Metabolism and Ethanol Production in Fed-Batch Culture," Proc. Foundations of Systems Biology and Engineering, Stuttgart, Germany (2007).
10. Henson, M. A. "Molecular Level Modeling and Dynamic Systems Analysis of Coupled Multicellular Systems," Proc. Foundations of Systems Biology and Engineering, Stuttgart, Germany (2007).
11. Bold K. A., Y. Zou, I. G. Kevrekidis and M. A. Henson, "Efficient Simulation of Coupled Biological Oscillators through Equation-Free Uncertainty Quantification," *Journal of Mathematical Biology*, **55**, 331–352 (2007).
12. Kambam, P. K. R., M. A. Henson and L. Sun, "Design and Mathematical Modeling of a Synthetic Symbiotic Ecosystem," *IET Systems Biology*, **2**, 33–38 (2008).

13. Venkatasubramanian, R., M. A. Henson and N. S. Forbes, "Integrating Cell Cycle Progression, Drug Penetration and Energy Metabolism to Identify Improved Cancer Therapeutic Strategies," *J. Theoretical Biology*, **253**, 98–117 (2008).

Membrane Separations

1. Jordan, S. M., M. A. Henson, and W. J. Koros, "The Effects of Carbon Dioxide Conditioning on the Permeation Behavior of Hollow Fiber Asymmetric Membranes," *J. Membrane Sci.*, **54**, 103–118 (1990).
2. Henson, M. A. and W. J. Koros, "Multi-Loop Control of a Pilot-Scale Membrane System for Gas Separations," *Ind. Eng. Chem. Res.*, **33**, 1901–1907 (1994).
3. Qi, R. and M. A. Henson, "Approximate Modeling of Spiral-Wound Gas Permeators," *J. Membrane Science*, **121**, 11–24 (1996).
4. Qi, R. and M. A. Henson, "Modeling of Spiral-Wound Permeators for Multicomponent Gas Separations," *Ind. Eng. Chem. Res.*, **36**, 2320–2331 (1997).
5. Qi, R. and M. A. Henson, "Optimization-Based Design of Spiral-Wound Membrane Systems for CO₂/CH₄ Separations," *Separation and Purification Technology*, **13**, 209–225 (1998).
6. Qi, R. and M. A. Henson, "Optimal Design of Spiral-Wound Membrane Networks for Gas Separations," *J. Membrane Science*, **148**, 71–89 (1998).
7. Qi, R. and M. A. Henson, "Membrane System Design for Multicomponent Gas Mixtures via Mixed-Integer Nonlinear Programming," *Comput. chem. Engng.*, **24**, 2719–2737 (2000).
8. Cao, B. and M. A. Henson, "Modeling of Spiral Wound Pervaporation Modules with Application to the Separation of Styrene/Ethylbenzene Mixtures," *J. Membrane Science*, **197**, 117–146 (2002).
9. Cao, B. and M. A. Henson, "Nonlinear Parameter Estimation for Solution-Diffusion Models of Membrane Pervaporation," *Annals of the New York Academy of Sciences*, **984**, 370–385 (2003).
10. Meyer, Howard S. and M. A. Henson, "Methane Selective Membranes for Nitrogen Removal from Low Quality Natural Gas – High Permeability is Not Enough," Proc. Natural Gas Technologies II: Ingenuity and Innovation, Phoenix, AZ (2004).

Polymerization Reactors

1. Kurtz, M. J., G.-Y. Zhu and M. A. Henson, "Constrained Output Feedback Control of a Multivariable Polymerization Reactor," *IEEE Transactions on Control System Technology*, **8**, 87–97 (2000).
2. Li, R., M. A. Henson, A. B. Corripio, K. M. Dooley and K. J. Kurtz, "Dynamic Modeling of Cross-linking and Gelation in Continuous Ethylene-Propylene-Diene Polymers Reactors using Pseudo-Kinetic Constant Approach," *Chem. Eng. Sci.*, **59**, 2297–2313 (2004).
3. Li, R., A. B. Corripio, M. A. Henson and K. J. Kurtz, "On-line State and Parameter Estimation of EPDM Polymerization Reactors," *J. Process Control*, **14**, 837–852 (2004).

- Gonzalez-Ruiz, R. A., B. Quevedo-Sanchez, R. L. Laurence, E. B. Coughlin and M. A. Henson, "Kinetic Modeling and Parameter Estimation of Slurry Propylene Polymerization using $\text{rac-Et(Ind)}_2\text{ZrCl}_2/\text{MAO}$," *AIChE J.*, **52**, 1824–1835 (2006).
- Quevedo-Sanchez, B., E. B. Coughlin and M. A. Henson, "Analysis of the Formation of 4-Butenyl End-Group in Zirconocene Catalyzed Polypropylene," *Journal of Polymer Science Part A: Polymer Chemistry*, **44**, 3724–3728 (2006).
- Quevedo-Sanchez, B., J. F. Nimmons, B. E. B. Coughlin and M. A. Henson, "Kinetic Modeling of the Effect of MAO/Zr Ratio and Chain Transfer to Aluminum in Zirconocene Catalyzed Propylene Polymerization," *Macromolecules*, **39**, 4306–4316 (2006).

Distillation Columns

- Zhu, G.-Y., M. A. Henson, and L. Megan, "Low-Order Dynamic Modeling of Cryogenic Distillation Columns Based on Nonlinear Wave Phenomenon," *Separation and Purification Technology*, **24**, 467–487 (2001).
- Bian, S., M. A. Henson, P. Belanger and L. Megan, "Nonlinear State Estimation and Model Predictive Control of Nitrogen Purification Columns," *Ind. Eng. Chem. Res.*, **44**, 153–167 (2005).
- Bian, S., S. Khowinij, M. A. Henson, P. Belanger and L. Megan, "Compartmental Modeling of High Purity Air Separation Columns," *Computers and Chemical Engineering*, **29**, 2096–2109 (2005).
- Khowinij, S., M. A. Henson, P. Belanger and L. Megan, "Dynamic Compartmental Modeling of Nitrogen Purification Columns," *Separation and Purification Technology*, **46**, 95–109 (2005).
- Bian, S. and M. A. Henson, "Measurement Selection for On-Line Estimation of Nonlinear Wave Models for High Purity Distillation Columns," *Chemical Engineering Science*, **61**, 3210–3222 (2006).
- Chen, Z., M. A. Henson, P. Belanger and L. Megan, "Nonlinear Model Predictive Control of High Purity Distillation Columns for Cryogenic Air Separation," *IEEE Transactions on Control System Technology*, submitted for publication.

Process Modeling and Control

- Henson, M. A., B. A. Ogunnaike, J. S. Schwaber, and F. J. Doyle, "The Baroreceptor Reflex: A Biological Control System with Applications in Chemical Process Control," *Ind. Eng. Chem. Res.*, **33**, 2453–2466 (1994).
- Henson, M. A., B. A. Ogunnaike, and J. S. Schwaber, "Habituating Control Strategies for Process Control," *AIChE J.*, **41**, 604–618 (1995).
- Pottmann, M., M. A. Henson, B. A. Ogunnaike, and J. S. Schwaber, "A Parallel Control Strategy Abstracted from the Baroreceptor Reflex," *Chem. Eng. Sci.*, **51**, 931–945 (1996).

4. Doyle, F. J., M. A. Henson, B. A. Ogunnaike, J. S. Schwaber, and I. Rybak, "Neuronal Modeling of the Baroreceptor Reflex with Applications in Process Modeling and Control," in *Neural Systems for Control*, D. L. Elliott (Ed.), Academic Press, New York, NY, 1997.
5. Zhang, Y. and M. A. Henson, "A Performance Measure for Constrained Model Predictive Controllers," Proc. European Control Conf., Karlsruhe, Germany (1999).
6. Zhu, G.-Y., M. A. Henson, and L. Megan, "Dynamic Modeling and Linear Model Predictive Control of Gas Pipeline Networks," *J. Process Control*, **11**, 129–148 (2001).
7. Henson, M. A., "Distribution Control of Particulate Systems Based on Population Balance Equation Models," Proc. American Control Conf., Denver, CO, 3967–3972 (2003).
8. Raikar N., S. R. Bhatia, M. F. Malone and M. A. Henson, "Self-Similar Inverse Population Balance Modeling for Turbulently Prepared Batch Emulsions: Sensitivity to Measurement Errors," *Chemical Engineering Science*, **61**, 7421–7435 (2006).

TEACHING EXPERIENCE

Mathematical Modeling (ChE 361/461), Spring 2006, Spring 2007, Spring 2008.
 Chemical Engineering Laboratory I (ChE 401), Fall 2002.
 Chemical Engineering Laboratory II (ChE 402), Spring 2004.
 Chemical Process Control (ChE 446), Spring 2003, Fall 2003, Fall 2004, Fall 2005, Fall 2006, Fall 2007, Fall 2008.
 Molecular and Systems Biotechnology (ChE 697A), Spring 2005.
 Digital Control of Processes (LSU), Spring 1994, Fall 2000.
 Process Dynamics and Control (LSU), Fall 1994, Fall 1995, Spring 1996, Spring 1997, Spring 1998, Spring 1999, Spring 2000, Spring 2001.
 Development of Mathematical Models (LSU), Spring 1995.
 Measurements Laboratory (LSU), Spring 1995, Fall 1996, Fall 1997.
 Advanced Automatic Process Control (LSU), Fall 1996, Fall 1999.
 Advanced Chemical Engineering Analysis (LSU), Fall 1997.
 Unit Operations Laboratory (LSU), Fall 1998 Fall 1999, Fall 2000.