Enrique del Castillo

Distinguished Professor of Industrial Engineering and Professor of Statistics

Office: Dept. of Industrial & Manufacturing Engineering
The Pennsylvania State University
310 Leonhard Building, University Park, PA 16802
Ph: (814) 863-6408, Fax: (814) 863-4745
e-mail: exd13@psu.edu
Web page: http://www2.ie.psu.edu/Castillo/Personal Web Page/Castillo.htm

FIELDS OF INTEREST AND SPECIALTY

- Statistics, including: Process Optimization and Experimental Design, Time Series Analysis and Control and Bayesian Statistics
- Machine Learning, including: large-scale spatial and functional data modeling, statistical learning theory and manifold learning.

EDUCATION

- Ph.D., Industrial Engineering (Engineering Statistics Concentration), **Arizona State University**, December 1992. GPA: 4.0/4.0. Dissertation advisor: Douglas C. Montgomery, Regents Professor, Arizona State.
- –, Operations Research, **UNAM**–National University of Mexico, (Mexico City), 1988-1989.
- M.Eng., Operations Research & Industrial Engineering, **Cornell University**, May 1988.
- B.S., Mechanical and Electrical Engineering, **UNAM/Universidad Panamericana**, (Mexico City), 1986.

ACADEMIC POSITIONS AND RESEARCH EXPERIENCE

- 2007-present: *Distinguished Professor of Industrial Engineering*, Department of Industrial & Manufacturing Engineering, Penn State University. NOTE: the Distinguished Professor title is only honorary; it does not involve any endowment or extra compensation.
- 2004-2007: *Professor*, Department of Industrial & Manufacturing Engineering (joint appointment with the Department of Statistics, Eberly School of Science), Pennsylvania State University. Other simultaneous academic activities:
  - Director, Engineering Statistics Laboratory. Web page: http://www2.ie.psu.edu/Castillo/research/EngineeringStatistics/
  - Faculty, Operations Research Program, PSU.
  - Member of the Institute of Cybersciences at PSU.
- 1998-2004: *Associate Professor* (tenured, 2002), Department of Industrial & Manufacturing Engineering, Pennsylvania State University.
- 1993-1998: *Assistant Professor*, Department of Industrial and Manufacturing Systems Engineering, University of Texas at Arlington.
- 1993: *Research Associate*, Mathematics Research Center (Centro de Investigacion en Matematicas, CIMAT), Mexico.

Other temporary appointments:

- Feb. 2012-July 2012: *Visiting Professor*, Politecnico di Milano, Department of Mechanical Engineering, Italy.

- Jan. 2005-May 2005: *Fulbright Scholar and visiting Professor*, Tilburg University, Center for Econometrics and Operations Research, The Netherlands.
- 2004-2008 (summers): *Visiting Professor*, Department of Industrial Engineering, Tecnun-University of Navarra, San Sebastian, Spain.
- 2002: *Visiting Scientist*, Department of Industrial and Systems Engineering, National University of Singapore, Singapore.
- 1989-1991: *Invited Professor*, School of Management, Mexican Institute of Technology (ITAM), Mexico City, Mexico.

TEXTBOOKS

1. Del Castillo, E., *Process Optimization: A Statistical Approach*, NY: Springer (International Series in Operations Research and Management Science), July 2007. (Reviewed in: Journal of Quality Technology, 40, 2, 2008).
2. Del Castillo, E., *Statistical Process Adjustment for Quality Control*, New York: John Wiley & Sons (*Probability and Statistics Series*), April 2002. (Reviewed in: Technometrics, Vol. 45, No. 1, 2003, Journal of Quality Technology, 2003, Mathematical Reviews, 2003a, Zentralblatt Math, Vol.1002, No.02, 2003, Measurement & Control, February 2003, SciTech Book News, Vol. 26, No. 2, June 2002).

BOOK EDITORSHIP

1. Colosimo, B.M., and Del Castillo, E., (editors), *Bayesian Process Monitoring, Control, and Optimization*. CRC Press Inc., 2006. (Reviewed in: Journal of Quality Technology, 39, 4, 2007.)
2. Moyne, J., Del Castillo, E., and Hurwitz, A., (editors), *Run to Run Process Control for Semiconductor Manufacturing*, CRC Press, 2000. (Reviewed in: Journal of Quality Technology, 34, 4, 2003.)

PUBLICATIONS: REFEREED JOURNAL PAPERS AND REFEREED BOOK CHAPTERS (Published or accepted, from most recent)

1. Tajbakhsh, S., Aybat, S., and Del Castillo, E., "Sparse Precision matrix Selection for fitting GRFs to large data sets", Submitted to **J. of the American Statistical Association**, (2016) (uploaded to arXiv:1405.5576v3). .
2. Baretta, A., Semeraro, Q., and Del Castillo, E., "A Comparison of Simulation-Optimization Approaches for solving the Multihead Weigher Machine setup problem", accepted in **Journal Packaging Technology and Science**, (2016).
3. Govind, N., Del Castillo, E., Runger, G., and Janakiram, M., "Multivariate Bounded Adjustment Schemes", accepted in **Quality Tech. and Quant. Management**, (2016).
4. Del Castillo, E., Colosimo, B., and Tajbakhsh, S. "Geodesic Gaussian Processes for the Reconstruction of a 3D Free-Form Surface", **Technometrics**, 57:1, pp. 87-99, (2015).
5. Woodall, W.H., and Del Castillo, E. "An overview of George Box's contributions to process monitoring and feedback adjustment", **Applied Stochastic Models in Business and Industry**, 30(1), pp. 53-61, (2014).
6. Vanli. O.A., and Del Castillo, E., "Statistical Process Control in Manufacturing", to appear in Tilbury, D. (ed.), *Encyclopedia of Control in Manufacturing Systems* (2014).
7. Tajbakhsh, S., Del Castillo, E., and Rosenberger, J.L., "A Bayesian Approach to Sequential Optimization Based on Computer Experiments", **Qual. & Rel. Eng. Int.**, 31, pp. 1001-1012, (2015).
8. Lian, Z., Vanli, O.A., and Del Castillo, E. "Setup Adjustment for asymmetric cost functions under unknown process parameters", **Quality Tech. and Quant. Management**, 11(4), pp. 471-489, (2014).

9. Alshraideh, H., and Del Castillo, E., "Gaussian Process Modeling and Optimization of Profile Response Experiments", **Qual. & Rel. Eng. Int.**, 30(4), pp. 449-462, (2014).

10. Tanco, M., Del Castillo, E., and Viles, E., "Robustness of 3-level Response Surface Designs Against Missing Data", **IIE Transactions**, 45, pp. 544-553, (2013).

11. Alshraideh, H., and Del Castillo, E., "Statistical performance of tests for factor effects on the shape of objects with application in manufacturing ", **IIE Transactions**, 45, 2, pp. 121-131, (2013). Featured summary in the *IE Magazine* (vol. 45(1), p. 48) "Research Highlights: when the response is the shape of a part".

12. Smucker, B., Del Castillo, E., and Rosenberger, J., "Model-Robust Designs for Split-Plot Experiments", **Computational Statistics & Data Analysis**, Volume 56, Issue 12, pp. 4111-4121, (2012)

13. Smucker, B., Del Castillo, E., and Rosenberger, J., "Model-Robust Two-Level Designs Using Coordinate Exchange Algorithms and a Maximin Criterion", **Technometrics**, 54(4), pp. 367-375, (2012).

14. Del Val A.G., Fernandez, J., Del Castillo, E., Arizmendi, M., and Veiga, F., "Monitoring and classification of thread quality when tapping nodular cast iron with TiN coated HSS cutting taps" accepted in **Int. J. of Advanced Manufacturing Technology**, (2013).

15. Del Castillo, E., Colosimo, B.M. , and Alshraideh, H., "Bayesian Modeling and Robust Optimization of Functional Responses affected by Noise Factors", **Journal of Quality Technology**, 44, 2, pp. 117-135, (2012).

16. Del Castillo, E., and Colosimo, B.M., "Statistical Shape Analysis of Experiments for Manufacturing Processes", **Technometrics**, 53(1), pp. 1-15, (2011).

17. Smucker, B., Del Castillo, E., and Rosenberger, J., "Exchange Algorithms for Constructing Model-Robust Experimental Designs" **Journal of Quality Technology**, 43(1), pp. 28-42, (2011).

18. Miranda, A.K., and Del Castillo, E., "Robust parameter design optimization of simulation experiments using stochastic perturbation methods", **Journal of the Operational Research Society**, 62, pp. 198-205, (2011).

19. Del Castillo, E., "Statistical Shape Analysis of Manufacturing Data", in Colosimo, B.B., and Senin, N., (eds.), *Geometric Tolerances: Product Design, Manufacturing, Quality Inspection and Monitoring*, Springer, (2010).

20. Runger, G., , Lian, Z., and Del Castillo, E., "Optimal multivariate bounded adjustment", **IIE Transactions**, 42(10), pp. 746-752, (2010).

21. Del Castillo, E., and Santiago, E. "A matrix-T approach to the sequential design of optimization experiments", **IIE Transactions**, 43(1), pp. 54-68, (2010).

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23. Vanli, O.A., and Del Castillo, E., "Bayesian Approaches for On-line Robust Parameter Design", **IIE Transactions**, 41, pp. 359-371, (2009).

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27. Lian, Z., and Del Castillo, E. "Adaptive Deadband Control of a Drifting Process With Unknown Parameters", **Statistics & Probability Letters**, 77(8), pp. 843-852, (2007).

28. Vanli, O.A., Patel, N.S., Janakiram, M, Del Castillo, E. "Model Context Selection for Run to Run Control", **IEEE Transactions on Semiconductor Manufacturing**, 20, 4, 506-516, (2007).

29. Del Castillo, E., M. J. Alvarez, L. Izarbe, and E. Viles, "A New Design Criterion for Robust Parameter Experiments", **Journal of Quality Technology**, 39, 3, pp. 279-295, (2007).

30. Rajagopal, R., and Del Castillo, E., 'A Bayesian Approach for Multiple Criteria Decision Making with Applications in "Design for Six Sigma"", **Journal of the Operational Research Society**, 58(6), pp. 779-791, (2007).

31. Cavalier, T.M., Conner, W. A., Del Castillo, E., and Brown, S.I., "A Heuristic Algorithm for Minimax Sensor Location in the Plane", **European Journal of Operational Research**, 183(1), pp. 42-55, (2007).

32. Runger, G., Barton, R., Del Castillo, E. and Woodall, W., " Optimal Monitoring of Multivariate Data for Fault Patterns", **Journal of Quality Technology**, 39(2), pp. 159-172, (2007) .

33. Ray, C.D., Gattani, N., Del Castillo, E., and Blankenhorn, P.B. "Identification of the relationship between equilibrium moisture content, dry bulb temperature, and relative humidity using regression analysis." **Wood and Fiber Science Journal**, 39(2), pp. 299-306, (2007).

34. Del Castillo, E. "Statistical Process Adjustment: a brief retrospective, current status and future research", **Statistica Neerlandica**, 60(3), pp. 309-326, (2006).

35. Miro, G., and Del Castillo, E., "A search method for the exploration of new regions in robust parameter design," in A. Khuri (ed.) *Advances in Response Surface Methodology*, World Scientific Publishing (2006).

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39. Rajagopal, R., and Del Castillo, E., "A Bayesian Method for Robust Tolerance Control and Parameter Design," **IIE Transactions**, 38(8), pp. 685-697, (2006).

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41. Ragajopal, R., and Del Castillo, E., "Model-Robust Process Optimization using Bayesian Model Averaging", **Technometrics**, 47,2, pp. 152-163, (2005).

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44. Gattani, N., Del Castillo, E., and Ray, C., "Time Series Analysis and Control of a Dry Kiln,", **Wood and Fiber Science Journal**, 37(3), (2005).

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46. Miro, G., Del Castillo, E., and Peterson, J.J., "A Bayesian Approach for Multiple Response Surface Optimization in the Presence of Noise Variables", **Journal of Applied Statistics**, 31 (3), pp. 251-270, (2004).

47. Peterson, J.J. Cahya, S. and Del Castillo, E., "A Comment on "Confidence regions around the ridge of optimal response on fitted second order polynomials"", **Technometrics**, 46 (3), pp. 355-357, (2004).

48. Miro, G., and Del Castillo, E. "A Dual Response Approach to the Multivariate Robust Parameter Design Problem", **Technometrics**, 46(2), pp. 176-187, (2004).

49. Cahya, S., Del Castillo, E., and Peterson, J.J., "Computation of Confidence Regions for Optimal Factor Levels in Constrained Response Surface Problems," **Journal of Computational and Graphical Statistics**, 13 (2), pp. 1-20, (2004).

50. Colosimo, B. M., Pan, R., and Del Castillo, E., "A Sequential Markov Chain Monte Carlo Approach to Setup Process Adjustment Over a Set of Lots", **Journal of Applied Statistics**, 31 (5), pp. 499-520, (2004).

51. McGarvey, R.G., Cavalier, T.M., Del Castillo, E., and Lehtihet, E.A., "A Unified Framework for Probabilistic Sequential Tolerance Control" **Int. J. of Production Research**, 42(7), pp. 1443-1453, (2004).

52. Height, J., Iyer, P.S., Del Castillo, E., Tink, B., and Hawkins P. "Intervention Effectiveness Research: Understanding and Optimizing Industrial Safety Programs Using Leading Indicators," **Chemical, Health & Safety Journal, American Chemical Society**, 11(2), pp. 9-19, (2004).

53. Miro, G., and Del Castillo, E., "Two approaches for enhancing the dual response approach to Robust Parameter Design", **Journal of Quality Technology**, 36 (2), pp. 154-168, (2004).

54. Miro, G., and Del Castillo, E. "An Enhanced Recursive Stopping Rule for Steepest Ascent Searches in Response Surface Methodology," **Communications in Statistics, Simulation and Computation**, 33,1, pp. 201-228, (2004).

55. Pan, R., and Del Castillo, E., "Integration of Sequential Process Adjustment and process Monitoring techniques," **Quality & Rel. Eng. Int.**, 19,4 pp. 371-386, (2003).

56. Rajagopal, R., and Del Castillo, E., "An Analysis and MIMO Extension of a Double EWMA Run-to-Run Controller for Non-Square Systems", **International Journal of Reliability, Quality, and Safety Engineering**, 10(4), pp. 417-428, (2003).

57. Del Castillo, E., "Closed-loop Disturbance Identification and Controller Tuning for Discrete Manufacturing Processes," **Technometrics**, 44, 2, pp. 134-141, (2002).

58. Peterson, J.J., Cahya, S., and Del Castillo, E., "A General Approach to Confidence Regions for Optimal Factor Levels of Response Surfaces", **Biometrics**, 58, pp. 422-431, (2002).

59. Pan, R. and Del Castillo, E. "Scheduling Methods for the Setup Adjustment problem," **Int. J. of Production Research**, 41,7, pp. 1467-1481, (2003). Correction, 42(1), pp. 211-212, (2004).

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61. Del Castillo, E., Pan, R., and Colosimo, B.M., "Small Sample Performance of Some Statistical Adjustment Methods", **Communications in Statistics, Simulation and Computation**, 32(3), pp. 923-942, (2003).

62. Del Castillo, E., and Rajagopal, R., "A Multivariate Double EWMA Process Adjustment Scheme for Drifting Processes", **IIE Transactions**, 34 (12), pp. 1055-1068, (2002).

63. Del Castillo, E., and Cahya, S., "A Tool for Computing Confidence Regions on the Stationary Point of a Response Surface", **The American Statistician**, 55, 4, pp. 358-365, (2001)

64. Cavalier, T. M., Lehtihet, E. A., Del Castillo, E., and McGarvey, R.G., "An Adaptive Sphere-Fitting Methods for Sequential Tolerance Control" **Int. J. of Production Research**, 40(12), pp. 2757-2768, (2002).

65. McGarvey, R.G., Del Castillo, E., Cavalier, T.M., and Lehtihet, E.A., "Four parameter beta distribution estimation and skew test with application to tolerance control," accepted for publication in **Qual. & Rel. Eng. Int.**, 18, pp. 395-402, (2002).

66. Pan, R., and Del Castillo, E., "Identification and Fine Tuning of Closed-loop Processes under Discrete EWMA and PI Adjustments", **Qual. & Rel. Eng. Int.**, 17, pp. 419-427, (2001).

67. McGarvey, R.G., Lehtihet, E.A., Del Castillo, E., and Cavalier, T., "On the Frequency and Location of Set Point Adjustments in Sequential Tolerance Control", **Int. J. of Production Research**, 39(12), pp. 2659-2674, (2001).

68. Xie, M., Del Castillo, E., Goh, T.N., and Cai, D.Q., "On the Monitoring of Trended and Regularly Adjusted Processes," **Int. J. of Production Research**, 39(16), pp. 3641-3650, (2001).

69. Göb, R., Del Castillo, E., and Ratz, M., "Run Length Comparisons of Shewhart $\overline{X}$ charts and most powerful test charts for the detection of trends and shifts", **Communications in Statistics, Simulation and Computation**, 30(2), pp. 355-376, (2001).

70. Del Castillo, E., "Some Properties of EWMA Feedback Quality Adjustment Schemes for Drifting Processes", **Journal of Quality Technology**, 33(2), pp. 153-166, (2001).

71. Del Castillo, E., and Salcedo, I., "An Integrated Economic Model for Inventory and Statistical Process Control", in *Integrated Models in Production Planning, Inventory, Quality and Maintenance*, M.A. Rahim and M. Ben-Daya, eds., Kluwer Academic Publishers (2001).

72. Del Castillo, E., and Semple, J., "Discussion: Optimization in Applied Statistics", **Journal of Quality Technology**, 32, 1, pp. 20-24, (2000).

73. Del Castillo, E., "A Variance Constrained PI Controller That Tunes Itself," **IIE Transactions**, 32, 6, pp. 479-491, (2000).

74. Del Castillo, E., "Long-Run and Transient Analysis of a Double EWMA Quality Controller," **IIE Transactions**, 31, 12, pp. 1157-1169, (1999). **IIE Transactions Best Paper of the Year Award for 2000**.

75. Göb, R., Del Castillo, E., and Dräger, K.,"Run Length Analysis of Shewhart Charts Applied to Drifting Processes Under and Integrative SPC/EPC Model," **Metrika, International Journal of Theoretical and Applied Statistics**, 50, 2, pp. 137-161, (1999).

76. Fan, S.K., and Del Castillo, E., "Calculation of an Optimal Region of Operation for Dual Response Systems Fitted from Experimental Data," **Journal of the Operational Research Society**, 50, pp. 826-836, (1999).

77. Del Castillo, E., Fan, S.K., and Semple, J., "Optimization of Dual Response Systems: A Comprehensive Procedure for Degenerate and Nondegenerate Problems," **European Journal of Operational Research**, 112, pp. 174-186, (1999).

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79. Del Castillo, E., "Stopping Rules for Steepest Ascent in Experimental Optimization," **Communications in Statistics, Simulation and Computation**, 26,4, 1599-1615, (1997).

80. Del Castillo, E., Göb, R., and von Collani, E., "A Methodological Approach for the Integration of SPC and EPC in Discrete Manufacturing Processes," in *Statistical Process Monitoring and Optimization*, S. H. Park and G. G. Vining, eds., Marcel Dekker, (2000).

81. Del Castillo, E., "A Note on two Process Adjustment Models," **Quality & Rel. Eng. Int.,** 14, 23-28, (1998).

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84. Del Castillo, E., "A Multivariate Self-Tuning Controller for Run-to-Run Process Control Under Shift and Trend Disturbances," **IIE Transactions**, 28, 12, 1011-1021, (1996).

85. Del Castillo, E., and Montgomery, D.C., "A General Model for the Economic Optimal Design of $\overline{X}$ Charts Used to Control Short or Long Run Processes," **IIE Transactions**, 28, 193-201, (1996).

86. Del Castillo, E., Mackin. P., and Montgomery, D.C., "Multiple Criteria Optimal Design of $\overline{X}$ Charts," **IIE Transactions**, 28, pp. 467-474, (1996).

87. Del Castillo, E., and Hurwitz, A., "Run-to-Run Process Control: Literature Review and Extensions," **Journal of Quality Technology**, 29, 2, 184-196, (1997).

88. Del Castillo, E., Grayson, J., Runger, G., and Montgomery, D.C., "A Review of SPC Methods for Short Runs," **Communications in Statistics, Theory and Methods**, 25, 11, 2723-2737, (1996).

89. Del Castillo, E., "Run Length Distributions and Economic Design of $\overline{X}$ Charts with Unknown Process Variance," **Metrika, International Journal of Theoretical and Applied Statistics,** 43(3), 189-201, (1996).

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91. Keats, J.B., Del Castillo, E., Collani, E.v., and Saniga, E., "Economic Modeling for Statistical Process Control", **Journal of Quality Technology**, 29, 2, 144-147, (1997).

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93. Del Castillo, E., Montgomery, D.C., and McCarville, D., "Modified Desirability Functions for Multiple Response Optimization," **Journal of Quality Technology**, 23,3, 337-345, (1996).

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95. Del Castillo, E., and Cochran, J.K., "Optimal Short Horizon Distribution Operations in Reusable Container Systems," **Journal of the Operational Research Society**, 47, 48-60, (1996).

96. Del Castillo, E., and Montgomery, D.C., "Response to Dr. Quesenberry's Comments", **Qual. & Rel. Eng. Int.**, 12, 163-164, (1996).

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100. Del Castillo, E., and Montgomery, D.C., "A Kalman Filtering Process Control Scheme with an Application in Semiconductor Short-Run Manufacturing," **Quality & Rel. Eng. Int.**, 11, 101-105, (1995).

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TECHNICAL PAPERS AND PAPERS IN PREPARATION

103. Göb, R. and Del Castillo, E., "A Bivariate Deadband Adjustment Policy", Technical Paper, Engineering Statistics Laboratory, PSU, (2004).
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107. Del Castillo, E., Baretta, A., and Semeraro, Q., "Analysis and Optimal Targets Setup of a Multihead Weighing Machine", uploaded to arXiv: 1511.07504, Nov. 23, 2015, under second review in EJORS, (2015).

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2. Colosimo, B.M., and Del Castillo, E., "Modern numerical methods in Bayesian Computation", Chapter 2 in *Bayesian Process Monitoring, Control and Optimization*. CRC/Taylor nd Francis, 2007.
3. Del Castillo, E., Hurwitz, A., Moore, T., and Spagon, P., "Improve a Process" in **Handbook of Engineering Statistics**, edited by NIST–SEMATECH. The handbook is available electronically through the world wide web at http://www.itl.nist.gov/div898/handbook/index.html
4. Del Castillo, E., Yeh, J.Y., Moyne, J., and Solakhian, V., "Object-Oriented Design Methodology and Implementation of an Optimizing Adaptive Quality Controller for Semiconductor Manufacturing Processes", in *Run to Run Process Control for Semiconductor Manufacturing*, J. Moyne et al. eds., CRC Press, (2000).
5. Del Castillo, E., "Learning and Optimization Algorithms for an Optimizing Adaptive Quality Controller," in *Run to Run Process Control for Semiconductor Manufacturing*, J. Moyne et al. eds., CRC Press, (2000).
6. Del Castillo, E., "Process Recipe Optimization", in *Run to Run Process Control for Semiconductor Manufacturing*, J. Moyne et al. ed., CRC Press, (2000).
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BOOK REVIEWS

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2. Del Castillo, E., "Review of: Value-Added Management with Design of Experiments, by L.W. Condra", **IIE Transactions**, 29, pp. 519-520,(1997).
3. Del Castillo, E., "Review of: Statistical Aspects of Quality Control, by C. Derman and S. Ross" **The American Statistician**, 51, 4, p.374, (November 1997).

INVITED CONFERENCE PRESENTATIONS AND CONFERENCE SESSION CHAIRS

1. De[Castillo, E., "On the Use of Gaussian Processes for Surface and Profile Data". Invited talk, INFORMS 2015 annual meeting, Philadelphia, PA,
2. Del Castillo, E., "Geodesic Gaussian Processes for Modeling Free-Form Surfaces". Invited *Technometrics* conference, SRC-QPRC joint research conference, June 24-26, Seattle, WA (2014).
3. Del Castillo, E., "Statistical Feedback Adjustment in Production: from Box & Jenkins to Our Days", International Society of Bayesian Statisticians–George Box Research Workshop on Frontiers of Statistics, George Washington University, Washington DC, May 21-22, (2014).
4. Del Castillo, E., "Bayesian Modeling and Robust Optimization of Functional Responses affected by Noise Factors", invited Journal of Quality Technology session, 2012 INFORMS Annual meeting, Phoenix, AZ.
5. Vanli, O. A., Patel, N. S., Janakiram, M. and Del Castillo, E. (2007), ?Model Context Selection for Run to Run Control?, In Proceedings of the 19th Sematech Advanced Equipment Control/Advanced Process Control (AEC/APC) Symposium, September 15-20, 2007, Indian Wells, CA.
6. Vanli, O.A., and Del Castillo, E., "A Bayesian Approach to Robust Parameter Design", 2006 INFORMS Annual meeting, Pittsburgh, PA.
7. Santiago, E., and Del Castillo, E., "Continuous Evolutionary Experiments for Robust Parameter Design", 2006 INFORMS annual meeting, Pittsburgh, PA.
8. Chair, Journal of Quality Technology session, 2006 ASQ/ASA Fall Technical Conference, Columbus, OH.
9. Rajagopal, R., and Del Castillo, E., "Model Robust Process Optimization", Invited Technometrics session, 2005 INFORMS annual meeting, San Francisco, 2005.
10. Del Castillo, E., Invited Panel Speaker, Intel Advanced Process Control/Fault Detection Analysis Meeting, Albuquerque, NM, 2004.
11. Miro, G., and Del Castillo, E., "A Dual-Response Approach to the Multivariate Robust Parameter Design Problem", Technometrics invited session, INFORMS annual meeting, Denver, CO, 2004.
12. Lian, Z., and Del Castillo, E., "Optimal Adjustment of a process subject to unknown setup errors under quadratic off-target and fixed adjustment costs", 2003 Quality & Productivity Research Conference, New York, 2003.
13. Cahya, S., Peterson, J.J., and Del Castillo, E., "A General Approach for Optimal Factor Levels of Response Surfaces," Spring Research Conference, University of Dayton, 2003.
14. Peterson, J.J., Miro, G., and Del Castillo, E., "A Bayesian Reliability Approach to Multiple Response Surface Optimization", 2002 Quality & Productivity Research Conference, Tempe, AZ.
15. Del Castillo, E., "Closed-loop Identification and Controller Tuning for Discrete-part Manufacturing", Technometrics Session, Fall Technical Conference, King of Prussia, PA, 2002.
16. Peterson, J.J., Cahya, S. and Del Castillo, E., "An Approach for Computing Confidence Regions for the Optima of Single and Multiple Response Surface Systems," *2001 Joint Statistical Meetings*, Atlanta, GA.
17. Del Castillo, E. "Long run and transient analysis of a double EWMA Quality Controller,", IIE Transactions Best Paper of the Year Session, Industrial Engineering Research Conference, Dallas, TX (2001).
18. Del Castillo, E., "Some Properties of EWMA Feedback Quality Adjustment Methods and Extensions", invited Journal of Quality Technology Session, INFORMS San Antonio, 2000.
19. Del Castillo, E., and Rajagopal, R., "Analysis of a Multivariate EWMA Feedback Process Controller", 2000 Joint Statistical Meetings, Indianapolis, IN.
20. Del Castillo, E., "Analysis of EWMA Feedback Controllers for Drifting Processes", 1999 Joint Statistical Meetings, Baltimore, MD.

21. Session Chair, "Quality Engineering in Semiconductor Manufacturing," *1999 IE Research Conference*, Phoenix, AZ, (1999).

22. Invited session Chair, "Multiple Responses in Designed Experiments," *14th Annual Quality & Productivity Research Conference*, Orlando, FL, (1997).

23. Del Castillo, E., "Optimization of Multiresponse Processes: Confidence Regions and Desirability Functions," *SEMATECH's Statistical Methods Symposia*, San Antonio, TX, (April 1996).

24. Del Castillo, E., "Optimizing Control of Semiconductor Manufacturing Processes" *NSF Dynamics and Controls Workshop*, Washington D.C. (1995).

25. Del Castillo, E., "Short Run Statistical Process Control," *12th Annual Quality & Productivity Research Conference*, Scottsdale, AZ, (1995).

INTERNATIONAL WORKSHOPS, CONFERENCES AND CONFERENCE PROCEEDINGS

1. Song, W., Han, K., Wang, Y., Friesz, T., and Del Castillo, E., "Application of Statistical Learning to Efficient Dynamic Network Loading Procedures", *9th Triennial Symposium on Transportation Analysis (TRISTAN) 2016*, Oranjestad, Aruba, 2016. (reviewed by abstract)

2. Song, W., Han, K., Wang, Y., Friesz, T., and Del Castillo, E., "Application of Statistical Learning to Efficient Dynamic Network Loading Procedures", *6th International Symposium on Dynamic Traffic Assignment (DTA)*, Sydney, Australia, 2016. (reviewed by abstract)

3. Del Castillo, E., "Recent Developments in Gaussian Random Field Modeling and their Application in Manufacturing", Invited keynote presentation, ENBIS-European Network of Business and Industrial Statisticians, Linz, Austria, September 22-24, (2014).

4. Colosimo, B.M., Pagani, L., Semeraro, Q., and Del Castillo, E., , "Geodesic Gaussian Process for the Reconstruction of Micro-Pins Surfaces", *SCO 2013 Conference on Complex Data Modeling and Computationally Intensive Statistical Methods*, Milano, Italy, September 2013.

5. Strano, M., Colosimo, B.M., and Del Castillo, E., "Improved design of a three roll tube bending process under geometrical uncertainties", *ESAFORM 2011*, Queen's University, Belfast, Northern Ireland, April 2011.

6. Gil A., Fernandez, J., del Castillo, E., San Emeterio, M., Urizar, J.L., Azcarate, S., Lejarraga, M., and Veiga, F., "Estrategia para la valoracion en tiempo real de la calidad de las roscas durante la ejecucion de un proceso de roscado de fundicion nodular con machos de acero rapido", XVII Congreso de Maquinas-Herramienta y Tecnologias de Fabricacion, Donostia - San Sebastian, Spain, October 2008.

7. Tanco, M., del Castillo, E., and Viles E., "Robustness evaluation of Three Level Designs against Loss of Data", International Symposium on Business and Industrial Statistics (ISBIS), Prague, Czech Republic, July 2008.

8. Rajagopal, R. and Del Castillo, E., "A Design for Six Sigma Example for Multiple Criteria Decision Making", *Seventh International Conference on Operations and Quantitative Management (ICOQM-7)*, Jaipur, India, August 2006.

9. Del Castillo, E., "Introduction to Industrial Experimental Design", course given at the University of Navarra, Spain, May 2006.

10. Del Castillo, E., "Workshop on Bayesian Statistics and Process Optimization", University of Tilburg, Operations Research & Econometrics faculty, The Netherlands, Spring 2005.

11. Del Castillo, E., "Advanced Process Control", workshop given at the University of Amsterdam, The Netherlands, April 2005.

12. Del Castillo, E., "Bayesian Approaches for Process Optimization and Design Robustness", Politecnico di Milano, Department of Technology of Production, Milan, Italy, May 2005.

13. Del Castillo, E., "Some Statistical Methods for Process Optimization and Design Robustness", presentation given at the University of Tilburg (Netherlands, February 2005), University of Eindhoven (Netherlands), April 2005, University of Wüerzburg (Germany), May 2005, and Politecnico di Milano (Italy), May 2005.

14. Del Castillo, E., "Some Problems in Process Adjustment and Process Optimization", Politecnico di Milano, Department of Technology of Production, Milan, Italy, 2003.

15. Del Castillo, E., "Analysis of EWMA-based Feedback Controllers", *Workshop on SPC/EPC integration*, University of Würzburg, Würzburg, Germany, 1999.

16. Hurwitz, A.M., and Del Castillo, E., "An Adaptive Run-to-run Optimizing Controller for Linear and Nonlinear Processes", *Proceedings of the International Conference on Quality Manufacturing*, Stellenbosch, South Africa, 1999.

17. Atichartakarn, S., and Del Castillo, E., "Design Methods for Quality Control Charts Under Unknown Variance", *Proceedings of the 1st International Conference on Engineering Design and Automation*, pp. 495-498, Bangkok, Thailand, (1997).

18. Del Castillo, E., "Some Aspects of Process Control in Semiconductor Manufacturing," *Proceedings of the 4th Würzburg-Umeå Conference in Statistics*, Universität Würzburg, pp. 37-52, (1996), Würzburg, Germany.

19. Huang, H.H., Del Castillo, E., and Lewis, F.L., "Design of an FMS Controller for Job-Shop Scheduling and Production Control," *Proceedings of the 3th IEEE Mediterranean Symposium on New Directions in Control and Automation*, Vol. I, pp. 195-202, (1995), Limassol, Cyprus.

INVITED DEPARTMENT SEMINARS

1. Del Castillo, E., "Geodesic Gaussian Process for the Reconstruction of a 3D free From Surface", Penn State University, SMAC Seminar, Dept. of Statistics, Fall 2013.

2. Del Castillo, E., "A Geodesic Gaussian Process model for the reconstruction of 3D surfaces in manufacturing", Miami University of Ohio Dept. of Statistics seminar, Spring 2013.

3. Del Castillo, E., "Statistical Shape Analysis Methods in Manufacturing", Georgia Institute of Technology Dept. of Industrial and Systems Engineering, Statistics Seminar, Spring 2010.

4. Del Castillo, E., "Handling model and parameter uncertainty in process optimization", Penn State Operations Research Seminar, School of Business, 2007.

5. Del Castillo, E., "Some Statistical Methods for Process Optimization and Design Robustness", General Motors R&D Corporate Center, Vehicle Development Research Laboratory, 2003.

6. Del Castillo, E., "Closed-Loop Identification for Process Control in Discrete-Part Manufacturing," Statistics Department Seminar, Penn State University, Fall 2002.

7. Del Castillo, E., "Confidence Region Inferences on the Optimum Response Settings of a Process", Faculty of Mathematics and Statistics Seminar, University of Würzburg, Germany, Summer 2002.

8. Del Castillo, E., "An Unifying View of Some Process Adjustment Techniques", Department of Industrial Engineering seminar, National University of Singapore, Singapore, Summer 2002.

9. Del Castillo, E., "Inferences on the Optimal Settings of a Process", Department of Industrial Engineering seminar, National University of Singapore, Singapore, Summer 2002.

10. Del Castillo, E., "Statistical Inference in Response Surface Optimization, Rutgers University IE Department Seminar, March 2002.

11. Del Castillo, E., "Confidence Regions for the Optimum of a Constrained Response Surface", Seminar, IE Department, Arizona State University, Spring 2001.

12. Del Castillo, E., "Process Adjustment Methods based on the EWMA Statistic", U. of Wisconsin-Madison IE Seminar, Center for Quality and Productivity, Fall 2000.

13. Del Castillo, E., "Some Problems in Control of Semiconductor Processes", U. of Michigan IOE Department Seminar Series, Spring 1999.

NATIONAL CONFERENCES AND CONFERENCE PROCEEDINGS (non-refereed)

1. Song, W., Han, K., Wang, Y., Friesz, T., and Del Castillo, E., "Statistical Metamodeling of Dynamic Network Loading", *International Symposium on Transportation and Traffic Theory (ISTTT22)*. July 2016.
2. Tajbakhsh, S., and Del Castillo, E., "Gaussian Process Modeling of Large Datasets", 2013 INFORMS Conference, Minneapolis, MN.
3. Alshraideh, H., and Del Castillo, E., "Modeling and Robust Parameter Optimization of Profile Response Experiments", Quality and Productivity Research Conference, Roanoke, VA, 2011.
4. Smucker, B., Del Castillo, E., and Rosenberger, J., "Multiresponse Exchange Algorithms for Model-robust Experimental Designs" 2009 ASA/ASQ Fall Technical Conference, Indianapolis, IN.
5. Del Castillo, E. and Vanli, O. A., "Bayesian Approaches for On-line Robust Parameter Design", Industrial Engineering Research Conference (IERC), Miami, FL, 2009.
6. Conner, W., Cavalier, T., and Del Castillo, E., "Solving the minimax sensor location problem for border protection", INFORMS 2006 annual meeting, Pittsburgh, PA.
7. Vanli, O.A., and Del Castillo, E., "Closed-loop System Identification for Small Samples with Constraints", INFORMS 2006 annual meeting, Pittsburgh, PA.
8. Zielinksi, S., Ruth, R. Je., Del Castillo, E., Vanli, O.A., and R. Rajagopal, "Bayesian Multiresponse Optimization of Car Door Systems", 2005 SIAM Conference, October.
9. Conner, W., Cavalier, T., Del Castillo, E., and Brown, S., "Solving the Minimax Sensor Location Problem: Towards the Largest Peak", INFORMS 2005 annual meeting, San Francisco.
10. Lian, Z., Colosimo, B., and Del Castillo, E., "Setup Error Adjustment of Multiple Lots using a Sequential MC Method", INFORMS Annual Meeting, Denver, CO., 2004.
11. Iyer, P.S. Height, J., and Del Castillo, E., "Leading indicator research: understanding industrial safety programs and optimizing their component intervention strategies", Proceedings of the American Safety Engineering Conference, Las Vegas, 2004.
12. Rajagopal, R., and Del Castillo, E., "A Bayesian Approach for Model-Robust Process Optimization", INFORMS Annual conference, Atlanta, GA, 2003.
13. Govind, N., Del Castillo, E., Runger, G., "Multivariate Deadband Process Adjustment", INFORMS Annual conference, Atlanta, GA, 2003.
14. Pan, R., and Del Castillo, E., "Scheduling Methods for the Statistical Setup Adjustment Problem", ASQ/ASA Fall Technical Meeting, El Paso, TX, 2003.
15. Peterson, J.J., Miro, G., and Del Castillo, E., "A General Approach to Multiple Response Surface Optimization Based Upon Posterior Predictive Distributions", ASQ/ASA Fall Technical Meeting, El Paso, TX, 2003.
16. Pan, R., and Del Castillo, E., "Process Adjustment Methods for Discrete-Part Manufacturing Methods: an Unifying View", INFORMS Annual conference, San Jose, CA, (2002).
17. Cahya, S., Del Castillo, E., and Peterson, J, "A Confidence Region for the Most Desirable Settings in a Multiple Response Process", ASA-ASQ Fall Technical Conference, Valley Forge, PA, (2002).
18. Peterson, J., Miro, G., and Del Castillo, E., "A Bayesian Reliability Approach to Multiple Response Surface Optimization," Quality & Reliability Research Conference, Tempe, AZ, (2002).
19. Pan, R., and Del Castillo, E., "Identification and Fine Tuning of Closed-Loop Processes under EWMA or PI Adjustments,", 2002 Spring Research Conference on Statistics in Industry and Technology, Ann Arbor, MI.

20. McGarvey R.G., Del Castillo E, Cavalier T.M., Lehtihet E.A., "Four Parameter Beta Estimation - A Manufacturing Engineering Motivation", *Proceedings of the 6th Annual International Conference on Industrial Engineering Theory, Applications and Practice*, San Francisco, CA, November 2001.

21. Pan, R., and Del Castillo, E., "Comparisons of Some Process Adjustment Methods and their Integration with SPC Charts," INFORMS 2001, Miami,FL.

22. Cavalier T.M., Del Castillo E, Lehtihet E.A., McGarvey R.G., "Probabilistic Sequential Tolerance Control: Frequency and Location of Set Point Adjustments", Proceedings of the 2001 NSF Design and Manufacturing Grantees Conference, Tampa, FL, January 2001 (electronic publication).

23. Del Castillo, E., "Univariate and Multivariate Process Adjustment Methods for Quality Control in Semiconductor Manufacturing", *Proceedings of the 2001 NSF Design and Manufacturing Grantees Conference*, Tampa, FL (poster presentation and electronic publication).

24. Del Castillo, E., "Identification and Tuning of PI and EWMA Feedback Adjustment Methods Operating in Closed Loop", invited talk, *INFORMS San Antonio*, 2000.

25. Del Castillo, E., "EWMA and Constrained PI process Adjustment Techniques for Semiconductor Manufacturing", *2000 NSF Design and Manufacturing Grantees Conference*, Vancouver, Canada (poster presentation).

26. Rajagopal, R., and Del Castillo, E., "Analysis of Multivariate EWMA Feedback Adjustment Techniques", 1999 INFORMS Fall Meeting, Philadelphia, PA.

27. Del Castillo, E., "On Properties of EWMA Run to Run Feedback Controllers", *IERC Conference Proceedings* (CD-ROM), 1999, Phoenix, AZ.

28. Del Castillo, E., "Statistical Process Control and Statistical Optimization", *2nd Annual Manufacturing Technology Showcase*, State College, PA, (1999).

29. Del Castillo, E., "A PI Feedback Controller that Tunes Itself", *1999 INFORMS Spring Meeting*, Seattle, WA.

30. Del Castillo, E., "Run-to-run Optimization and Control Algorithms", *1999 NSF Design and Manufacturing Grantees Conference*, Long Beach, CA, (poster presentation).

31. Del Castillo, E., "Multivariate Quality Controllers for Semiconductor Manufacturing Processes", *1998 NSF Design and Manufacturing Grantees Conference*, Monterrey, Mexico, (poster presentation).

32. Ning, Z., Boning, D., Del Castillo, E., Hurwitz, A., Moyne, J., Smith, T., and Yeh, J.Y."A Comparative Analysis of Run-to-Run Control Algorithms in the Semiconductor Manufacturing Industry," *Proceedings of the 7th Annual SEMI/IEEE Advanced Semiconductor Manufacturing Conference and Workshop*, 375-381, Cambridge, Mass., (November 1996)

33. Grayson, J., Del Castillo, E., Montgomery, D.C., and Runger, G., "Short Run SPC: A Comparison of Methods," *Central Regional Meeting of the IMS Honoring the 70th Birthday of Bob Hogg*, (1995).

34. Del Castillo, E., "Some Aspects of Run-by-Run Process Control," *3th International Applied Statistics in Industry Conference Proceedings*, p. 140-147, Dallas, TX, (1995).

35. Del Castillo, E., "Process Shifts and Sampling Rates for Statistical Process Control of Autocorrelated Data," *Third Industrial Engineering Research Conference*, Atlanta, Georgia, (1994).

36. Del Castillo, E., and Montgomery, D.C., "Methods for Finite-Horizon Process Control: Q Charts and Alternative Techniques", *37th Annual ASQC-ASA Fall Technical Conference*, Rochester, NY, (1993).

37. Del Castillo, E., and Nuño, P., "Micro-Scheduler: A PC-Based Decision Support Scheduling System", *Production and Operations Management Society Annual Meeting*, New York, (1991).

INDUSTRIAL AND CONSULTING EXPERIENCE

- 2004: Eli Lilly Corporate Headquarters, Indianapolis, Training Course in Statistical Process Adjustment.
- 2002: TECH Semiconductor, Singapore. Training Courses in run-to-run process adjustment.

- 1999-2004: Statistical Productivity Consultants. Training courses in Applied Statistics to Industry (Lucent Technologies).
- 1997-2003: Qualtech Productivity Consultants. Development of adaptive financial forecasting models.
- 1997: Stat Ease Corporation. Beta Tester of the Design Expert Statistical software package.
- 1994-1995: SEMATECH's statistical methods group. Collaborated in projects J88-D and J-142 on run-to-run process control and optimization. Emphasis was characterization and optimization of CMP processes.
- 1990: Kenworth Truck Company. Development of a computer integrated manufacturing system (ASU-Kenmex project).
- 1989: Pepsi Bottling Company. Development and implementation of production and distribution simulation and optimization systems. The work in this project resulted in one publication (ref. [95]).
- 1988: General Stores, Cornell University. Design of an inventory control and warehouse space allocation system (Master's thesis project).
- 1987: Cuproquim S.A. *Manager*, Systems Engineering Department. Cuproquim is an agrochemical company located in Mexico City.
- 1985-1986: Cuproquim S.A. *Systems Engineer*, Systems Engineering Department.
- 1985: Mennen. Development of an optimization system for salesmen assignment and optimal route design. (Bachelor's thesis project).

CURRENT FUNDED RESEARCH

- *Collaborative Research: Active Statistical Learning: Ensembles, Manifolds, and Optimal Experimental Design* co-PI with George Runger (ASU) and Eugene Tuv (Intel), ($350,000, 8/15/2015 to 7/31/2018), recommended for funding July 2015, **National Science Foundation**. A non-parametric approach to the Active Learning (AL) problem called Stochastic Query-by-Forest (SQRF) is proposed. The algorithm is based on a batch diversification strategy applied to an ensemble of decision trees. Successful preliminary work with this approach focused in binary classification problems. In this research we propose to consider more general models including regression and multi-class problems, along with other challenging innovations. Furthermore, a novel AL strategy that incorporates the geometric structure of the unlabeled data is proposed. In many applications, unlabeled data exists only in a lower dimensional nonlinear manifold. Our expectation is that incorporating the geometric properties of the data will result in more informative samples/solutions. There are many similarities between AL and optimal experimental design. As a secondary goal of the proposed research, AL methods will be used to explore open questions in optimal design of experiments.

PAST FUNDED RESEARCH GRANTS (from most recent)

- *On-line Profile-to-Profile Process Adjustment for Robust Parameter Design Scenarios.* **National Science Foundation**, Principal Investigator ($230,000, 8/15/2008 to 7/31/2012). The goal of this research was to solve a new class of on-line Robust Parameter Design (RPD) problems for functional data responses (or *profiles*). In many areas of manufacturing or during the operation of numerous processes, the response of interest does not consist simply in a single observation measured at each of the experimental conditions. Instead, a whole function of some variable is measured over an interval, and the goal is to model the sampled function. Optimization of these functional response systems needs to be performed by selecting values of controllable factors in the presence of uncontrollable noise factors. A typical examples of a RPD problem for functional responses occurs in manufacturing, where machining results in geometric profiles of parts that are measured at several positions over some dimension, and a target geometry needs to be achieved by varying the machine conditions in the presence of uncontrollable sources of variability. We studied the analysis of experimental design data obtained from a machining process where the responses are the part profiles. Statistical Shape Analysis techniques were developed [16]. The ultimate goal of this project was to develop on-line methods for

the optimization of RPD problems when a functional exists, allowing the "profile to profile" control of parts in manufacturing. Collaboration with researchers from Politecnico di Milano, Italy, took place. Two Ph.D. students were funded by this grant.

- *Modeling Customer Transfer Functions* , **General Motors R&D Corporate Center**, 1/2008 to 12/2008, ($93,839).

- *Minimax Sensors Location and Bayesian Estimation of Probability of Detection*, **National Science Foundation**, Co-Principal Investigator with Tom Cavalier (PSU). ($269,620, June 2004–May 2007). The main concern of this grant was how to optimally locate a set of sensors over a line, plane or space with the objective of minimizing the maximum probability of nondetection of some event that occurs at random. Mathematical optimization techniques were investigated to study this problem. A Spatial Bayesian Statistics model was used to estimate the probabilities of events in the region. One Ph.D. student was funded by this grant.

- *Statistical Adjustment for Short Run Manufacturing: Parametric Optimization, Robustness Analysis, and Ensemble Control using Gibbs Sampling*, **National Science Foundation**, Principal Investigator ($193,000, June 2002–May 2005). A problem located at the foundations of the Statistical Process Control (SPC) field is how to adjust a manufacturing process that is suspected to be operating in a malfunctioning mode. The setup adjustment problem was first analyzed by F. Grubbs who derived a simple sequential scheme. We proposed to utilize a Bayesian formulation for process adjustment we had developed based on Kalman filters. The formulation unifies several adjustment rules including Grubbs' scheme which is shown to be a simple instance of Stochastic Approximation (SA). Our second research thrust dealt with finding the ensemble-optimal adjustment policy over all classes of adjustment policies. We proposed to use Markov Chain Monte Carlo techniques, and in particular, Gibbs Sampling, applied to the problem of estimating the mean of a sequentially-adjusted process that experiences errors in the setups according to some stable distribution. This research was one of the very first to suggest the use of Sequential Monte Carlo Methods (now considerably popular) for estimation and feedback control. One PSU Ph.D. student (Zilong Lian) was funded as part of this grant. A one year no-cost extension was granted.

- *Intel R&D Gift* ($13,000) to support research activities at the Engineering Statistics Laboratory (2005).

- *Single and Multiple Step Empirical Modeling of Semiconductor Manufacturing*, **Intel Corp.**, $ 50,000. 7/2005-5/2006.

- *Minitab Inc. Corporate Gift* ($23,000) to support research activities at the Engineering Statistics Laboratory (2006).

- *Fulbright Scholarship* (12,000 euros) to conduct research and lectureship in The Netherlands, Spring 2005.

- *Intel R&D Gift* ($25,000) to support research activities at the Engineering Statistics Laboratory (2004).

- *General Motors R&D Corporate Center Gift* ($20,000) for supporting research at the Engineering Statistics Laboratory (2004).

- *Bayesian Predictive Models with Application to Door Systems*, Principal Investigator, **General Motors R&D Corporate Center**, Vehicle Development Laboratory, ($71,000), January 2004–December 2004.

- *Optimization Techniques in Response Surface Methodology for Quality Improvement*, **National Science Foundation**, Principal Investigator ($150,000, Sept. 2000–Aug. 2003). The objective of this research was to develop new and efficient optimization techniques for use in Response Surface Methodology (RSM). RSM is a set of Statistical and optimization techniques aimed at improving the quality characteristics of a manufacturing process via the sequential application of designed experiments and model building techniques. Specific goals of this research included 1) the development of new statistical search methods under the presence of large sampling variability; 2) development of new algorithms for the global optimization of the type of quadratic programming problems frequently arising in RSM studies, including the case of multiple secondary responses. Methods were studied for finding a confidence region for the best operational settings of a manufacturing process that is modeled using polynomial regression techniques. Finally, 3) a Rapid Response Surface Methodology was developed to allow for fast optimization of multiple response processes. Two Ph.D. students (Suntara Cahya and Guillermo Miro) were funded by this grant at Penn State.

- *General Motors R&D Corporate Center Gift* ($20,000) for supporting research at the Engineering Statistics Laboratory (2003).

- *Adjustment and Monitoring Methods for Multiple-Stream and Process-Oriented Quality Control*, **National Science Foundation**, co-PI with R. Barton ($223,532, Sept. 2000–Aug. 2003, GOALI grant in collaboration with engineers and researchers at Intel and Arizona State University.). Multivariate statistical process control research has produced tools that can be used to identify when irregularities in production occur and to characterize the components of this variation. The diagnosis and control actions, in the sense of process adjustment, are not modeled and it is up to the process engineer to interpret and correct causes of variation. For these reasons, interest exists on integrating process adjustment techniques with statistical process monitoring tools. The process-oriented basis representation (POBREP) analysis uses process knowledge to decompose quality data into cause-associated components. The main goal of this research was to investigate adjustment and monitoring methods in process were a POBREP framework is adequate. The work resulted in new contributions in optimal statistics for process monitoring in POBREP [32] and on optimal Bivariate deadband adjustment schemes [103], a type of control technique which results when there are fixed adjustment costs. One Ph.D. Student (N. Govind, now Analytics manager at Netflix) was funded with this grant.

- **CAREER***: Multivariate Quality Controllers for Semiconductor Manufacturing Processes*, **National Science Foundation**, Principal investigator, ($200,000, Sept. 1996–Aug. 2001); Research Experiences for Undergraduates Extension ($5000, 1999-2000). Equipment Supplement ($10,000, 2000). This project was aimed at developing effective multivariate Quality Control methods for advanced semiconductor manufacturing processes. In many of these processes, the quality characteristics of a batch or run of silicon wafers are regulated with automatic controllers of the PID type. However, due to process dynamics, disturbances, and changes in wafer specifications, automatic controller setpoints have to be adjusted or tuned from run to run. Semiconductor process dynamics such as drifts or autocorrelation in the quality characteristics (outputs), multiple controllable factors (inputs), and non-linear input-output relations make Quality Control a challenging task. The *research component* of this grant was concerned with the development and implementation of a novel multiple-input–multiple-output quality controller for supervisory control of semiconductor manufacturing processes based on the idea of optimizing adaptive control. The proposed optimizing adaptive quality controller (OAQC) provides a recipe of PID setpoints at each run by the on-line estimation and optimization of a non-linear transfer function model. The *educational component* of this project related to developing a course on Time Series Control (an SPC class with a stronger emphasis on control engineering), developing class notes for such course that resulted in a textbook on the subject [2], and transferring real world experiences and case studies to the classroom. Collaboration with D. Boning (MIT EE Dept.), J. Moyne (U. of Michigan EE Dept.), and Arnon Hurwitz (SEMATECH) took place for this research. A book on run to run control for semiconductor manufacturing (co-written with J. Moyne and A. Hurwitz) appeared in 2000 [2]. One Ph.D. student (Rong Pan, now tenured Associated Prof. at Arizona State U.) was funded at PSU from this grant.

- *Probabilistic Sequential Tolerance Control* **National Science Foundation**, co-PI wih T. Cavalier and A. Lehtihet, ($153,690, August 1999-July 2001). This research proposed to make effective use of real-time measurement data to develop a comprehensive framework for a probabilistic approach to sequential tolerance control. The research utilized distribution information, as it becomes available, to maximize the expected yield in a manufacturing process that consists of a sequence of operations on a part. A statistical data processing module identified the distribution of measurement data acquired during the production process. This information is then used to determine a predictive model for yield useful for determining optimum frequency and location of measurement and setpoint adjustments along the sequence. Four publications resulted from this research [67,64,65,51]. One Ph.D. Student (Ron McGarvey) was funded as part of this project. A one year no-cost extension was granted by NSF for 2001-2002.

- *Integration of Statistical and Automatic Control Techniques for Economic Quality Control*, Principal investigator, **National Science Foundation**, ($6000, March 1996-March 1998) and **North Atlantic Treaty Organization** (**NATO**) ($6000, 1998-1999). This grant allowed Dr. Castillo to do collaborative research with Dr. Elart von Collani and his group (University of Würzburg, Germany) in the field of process control. The University of Würzburg houses the Würzburg group on Quality Control, one of the most active research groups in this area in Europe. The two grants funded travel to Germany during 1996, 1997, and 1999. As part of this grant, Dr. Rainer Göb (University of Würzburg) visited Penn State in 1998.

AWARDS, SCHOLARSHIPS, AND HONOR SOCIETIES

- National Science Foundation CAREER Award, 1996-2000.
- Fulbright Scholarship to visit The Netherlands, January to May 2005.
- IIE Transactions Best Paper of the Year Award, (2000).
- Listed, Who's Who in Science and Engineering, 1998-1999.
- Research Enhancement Award, University of Texas at Arlington, (1995).
- Graduate Academic Scholarship, Arizona State University, 1990-1992.
- Graduate Tuition Scholarship, Arizona State University, 1990-1992.
- Phi Kappa Phi
- National Council of Science and Technology of Mexico Scholarship (1989-1992).
- Bank of Mexico Scholarship (1988).
- Member, National System of Investigators of Mexico, (1993).

INTERNATIONAL ACTIVITIES AND COLLABORATIONS

- Research and Lectureship visits to foreign universities:
  1. Research visit to the Department of Technology of Production, Mechanical Engineering Dept., Politecnico di Milano, Italy, Summer of 2003, 2004, 2005, 2008 and 2009 (funded by Politecnico di Milano).
  2. Research visit, University of Navarra, Spain, Dept. of Mechanical Engineering, Summer 2009.
  3. Short course on Bayesian Statistics, Operations Research Department, Tilburg University, The Netherlands, Spring 2005.
  4. Invited professor, University of Navarra (Spain), Summer 2004, Summer 2005, Summer 2006 and Summer 2007 (courses in Design of Experiment and Response Surface Methods).
  5. Short course on Time Series Control, Dept. of Mathematics, University of Amsterdam, The Netherlands, Spring 2005.

6. Research visits to the Institute of Applied Mathematics and Statistics, University of Würzburg, Germany, in 1996, 1997, 1999, 2002, and 2005.
7. Visiting Scientist, National University of Singapore, Summer 2002.

- International External Reviewing and Consultancy:

1. External Ph.D. thesis reviewer, Indian Institute of Technology, Bombay, India, 2012.
2. External proposal reviewer, Hong Kong Research Grants Council, Hong Kong, 2012.
3. Member of the International Advisory Board, 2nd International Symposium of Quality Management Organizing Committee, Yuan Ze University, Taiwan, (2009).
4. Member of the Editorial Advisory Board, *Chinese Journal of Quality*, 2005-present.
5. External Ph.D. thesis reviewer for Tilburg University, The Netherlands, Management Science Department, 2004.
6. External M.S. thesis reviewer for Athens University of Economics and Business, Greece, (Statistics dept.), 2001.
7. External Ph.D. thesis reviewer for the National University of Singapore, Industrial and Systems Engineering Department, 2003-2004.
8. Proposal reviewer, National Science and Technology Council of Mexico (Conacyt), 2001.
9. Consultant, Universidad Panamericana campus Guadalajara, Mexico. Design of an MS curriculum in Quality Engineering (2000).

- International collaborators as co-authors of research papers: Bianca M. Colosimo, Alessia Baretta and Quirico Semeraro (Milan, Italy), R. Göb and E. von Collani (Würzburg, Germany), M. Xie (Singapore), B. Bentovil and J. Kleijnen (Tilburg, The Netherlands), J. Fernandez, A. Gil, M. Tanco, L. Izarbe, M.J. Alvarez and E. Viles, (Navarra, Spain).
- Postdoctoral advisor and host of Dr. Bianca Colosimo (Politecnico di Milano, Italy), 2002.

PROFESSIONAL AND SCIENTIFIC SOCIETIES

- ASQ, American Society for Quality (formerly ASQC) (member)
- ASA, American Statistical Association (member)
- IIE, Institute of Industrial Engineers (senior member)
- INFORMS, Institute for Operations Research and Management Science (member).

PROFESSIONAL SERVICE

- External Review Committee member, Georgia Institute of Technology's School of Industrial and Systems Engineering, 2013.
- Editor-in-chief, *Journal of Quality Technology*, 2006-2009.
- Member of the editorial board, *Journal of Quality Technology* (1994-present).
- Associate Editor, *Technometrics* (2004-2008).
- Advisory Board member, Quality, Statistics and Reliability (QSR) section, INFORMS (2007-present).
- Process Optimization Department Area Editor, *IIE Transactions on Quality & Reliability Engineering* (2001-2005).
- Associate Editor, Institute of Industrial Engineers Transactions *(IIE Transactions)* on Quality and Reliability Engineering (1996-2000).
- Associate Editor, Institute of Industrial Engineers Transactions *(IIE Transactions)* on Industrial Engineering Research (1993-1996).

- Member of the Editorial Advisory Board, *Chinese Journal of Quality* (2006-present).
- Technical manuscript reviewer for John Wiley & Sons, (Applied Statistics), Prentice Hall, and for Kluwer Academic Publishers.
- Secretary and Treasurer, INFORMS Quality, Statistics, and Reliability (QSR) section (1999).
- Associate Editor, *Quality technology & Quantitative management*, 2003-2013.
- Ad-hoc referee for:
  - *Journal of the American Statistical Association*
  - *Technometrics*
  - *Operations Research*
  - *SIAM/ASA Journal on Uncertainty Quantification*
  - *ASME Journal of Manufacturing Science & Engineering*
  - *Journal of Quality Technology*
  - *European Journal of Operational Research*
  - *Journal of Applied Statistics*
  - *Statistical Methodology*
  - *IEEE Transactions on Semiconductor Manufacturing*
  - *IEEE Transactions on Components, Packaging, and Manufacturing Technology*
  - *IIE Transactions on Quality and Reliability Engineering*
  - *IIE Transactions on Industrial Engineering Research*
  - *IIE Transactions on Operations Engineering*
  - *IIE Transactions on Design & Manufacturing*
  - *Int. J. of Production Research*
  - *Control Engineering Practice*
  - *Omega*
  - *Journal of Manufacturing Systems*
  - *Journal of Manufacturing Processes*
  - *Quality & Rel. Eng. Int.*
  - *International Journal of Operations Management*
  - *Computers and Industrial Engineering*
  - *Engineering Design and Automation*
  - *IE Research Conference.*
- Proposal reviewer, National Science Foundation, Engineering Division, 1997, 1998, 2000, 2001, 2002, 2004, 2009, 2011, and 2013.
- Proposal reviewer, Texas Higher Education Coordination Board, ARP/ATP programs, 2001.
- Proposal reviewer, National Science and Technology Council of Mexico (Conacyt), 2001.
- Research Quality Evaluator, National Agency for the Evaluation of Universities and Research Institutes of Italy (2012-present).

SERVICE TO THE UNIVERSITY

- Promotion and tenure committee, IME Dept., 2004-2011 and 2013-present.
- College of Engineering, Promotion and tenure committee, First Alternate (2013-today).
- Undergraduate committee, IME dept., 2011-2013.

- Faculty search committee, IME dept., 2007-2008.
- Engineering Faculty Council, August 2002-Dec. 2004, College of Engineering, PSU.
- Faculty Advisor, International Futbol (Soccer) Club, August 2004-2008, PSU.
- Faculty Advisor, Society of Hispanic Professional Engineers, 2001-2008, PSU
- University Senate (Elected, First alternate Engineering Senator), 2001, PSU.
- HUB-Robeson Advisory Board Member, August 2002-2004, PSU.
- Engineering Faculty Senate Nominating Committee, 2002, PSU.
- Candidacy exam committee, IME dept., Spring 2004-January 2005.
- Executive committee, IME dept., 2003-2004, PSU.
- Industrial Relations committee, IME dept., 2001-2002, PSU.
- Graduate Policy (graduate admissions) committee, IME dept. 1998-2002, PSU.
- Scholarships committee, 1999-2001, IE dept. PSU.
- Quality and Manufacturing Management (QMM) Faculty Associate, PSU.
- Faculty Senate, 1996 (UT-Arlington).
- University Senate Equity committee, 1996 (UT-Arlington).

Ph.D. STUDENTS (from most recent)

1. Hang Li, IME Dept., PSU
2. Wenjing Song, IME Dept., PSU, (co-advised with Prof. T. Friesz).
3. Sam D. Tajbakhsh (Penn State, IME). *On Sparse Optimization Methods for Spatial Statistical Modeling*, co-advised with S. Aybat. December 2015. *Assistant Professor, Industrial Engineering, Ohio State University.*
4. Hussam Alshraideh (Penn State, IME). *Statistical Shape Analysis and Robust Profile Optimization Methods*, August 2011. *Assistant Professor, Dept. of Industrial Engineering, Jordan University of Science and Technology.*
5. Eduardo Santiago (Penn State, IME). *Topics in design of experiments and robust process optimization.* December 2010. *Statistician, Minitab Inc.*
6. Byran Smucker (Penn State Statistics Dept., co-advised with J. Rosenberger, Stats. dept., PSU). *Multiresponse and Model-Robust Experimental Design*, August 2010. *Associate Professor (with tenure), Dept. of Statistics, Miami University, OH.*
7. O. Arda Vanli (Penn State, IME). *Problems in Short Run Manufacturing Feedback Adjustment: Identification and Control*, July 2007. *Associate Professor (with tenure), Dept. of Industrial & Manufacturing Engineering, Florida State University.*
8. Zilong Lian (Penn State, IME), *Statistical Process Adjustment Under Unknown Parameters*, August 2005. *President, Beijing Oriental RayZer Technology Inc., Beijing, China.*
9. Ramkumar Rajagopal (Penn State, IME), *Bayesian Methods for Robustness in Process Optimization*, August 2004. *Advanced Controls Group, Intel Corporation R&D, Chandler, AZ.*
10. Guillermo Miro (Penn State, IME), *Topics in the Optimization of Response Surface and Parameter Design Problems*, May 2003. *Principal Scientist at MedImmune.*
11. Rong Pan (Penn State, IME), *Statistical Process Adjustment Methods for Quality Control in Short-Run Manufacturing*, May 2002. *Associate Professor (with tenure), Industrial Engineering Dept., Arizona State University.*

12. Suntara Cahya (Penn State, IME), *Sampling Properties of Optimal Operating Conditions of Single and Multiple Response Surface Systems*, December 2001. *Senior Statistician, Eli Lilly Research & Development Laboratory, Indianapolis, IN.*

13. Jinn-Yi Yeh (UT-Arlington, IE), *Object-Oriented Design of an Optimizing Adaptive Quality Controller for Semiconductor Run-to-run Manufacturing Processes*, August 1997. *Associate Professor, Dept. of Management Information Systems, National Chiayi University, Taiwan.*

14. Shu-Kai Fan (UT-Arlington, IE), *Optimization of Dual and Multiresponse Systems*, co-advised with J. Semple, SMU, October 1996. *Professor, Dept. of Industrial Engineering & Management, National Taipei University of Technology, Taipei, Taiwan.*

15. Suebpong Atichartakarn (UT-Arlington, IE), *Design Methods for Shewhart Quality Control Charts Under Unknown Process Variance*, November 1996. *Vice President at Bangkok Bank PCL, Thailand.*

16. H. H. Huang (UT-Arlington, IE), *Reconfigurable Intelligent Control for Reentrant Flow Lines and Job Shops*, co-advised with F.L. Lewis, August 1995. *Professor, Dept. of Industrial Management, National Pingtung University of Science and Technology, Taiwan.*

POST DOCTORAL SCHOLARS

Bianca M. Colosimo, Department of Mechanical Engineering, Politecnico di Milano, Italy, January-August, 2001. *Full Professor, Mechanical Eng. Dept., Politecnico di Milano, Italy..*

Gerardo Avendano, Associate Professor, Dept. of Industrial Engineering, La Salle University, Colombia, 2007.

MASTERS STUDENTS (from most recent)

1. S.D. Tajbakhsh (Penn State, Statistics Department), *A Bayesian Approach to the Expected Improvement Optimization Method*, September 2012.

2. C. de Toffol (Penn State, IME).

3. A.K. Miranda (Penn State, IME), *Robust Parameter Design in Simulation Optimization Using a Simultaneous Perturbation Stochastic Approximation Method*, May 2008.

4. Y. Zhang (Penn State, IME), *An Analysis of factors predicting click-through rate during Web searching using Neural Networks*, May 2008.

5. E. Santiago (Penn State, IME), *Genetic optimization for response model designs*, December 2006.

6. T. N. Pandi, (Penn State, IME), *Modeling and Optimization of Field Sensor Probes*, December 2004.

7. N. Gattani (Penn State, IME), *Modelling and Control of a Woods Products Manufacturing Operation*, co-advised with Chuck Ray, School of Forest Resources, PSU, December 2003.

8. P. S. Iyer (Penn State, IME), *A Transfer Function Analysis of Work Injury and Training Data*; co-advised with Dr. Joel Haight, Dept. of Energy and Geo-Environmental Engineering, PSU, December 2003.

9. R. Rajagopal (Penn State, IME), *Analysis and Extensions of EWMA Feedback Controllers for Semiconductor Manufacturing*, May 2000.

10. I. T. Salcedo (Penn State, IME), *A Model for the Integration of Statistical Process Control and Inventory Management*, August 1999.

DESCRIPTION OF RESEARCH TOPICS

Spatial models for large cloud point datasets and their use in manufacturing. Our most recent (circa 2013-2014) work deals with developing a new model for cloud point data acquired with a non-contact

sensor. A parametric surface model was develop in which correlation between points are modeled as a function of the geodesic distance on the surface modeled as opposed to previous spatial models that consider correlation on the x-y Euclidean space. This was shown to provide considerable better predictions, reconstructing the surface considerable better than with earlier methods. The parametric surface model is compatible with CAD models, and was started during a sabbatical stay at Politecnico di Milano, in collaboration with Prof. Bianca Colosimo from Polimi. Publication [4] resulted from these efforts. This investigation has been complemented recently (2014) with the development of a new method to fit a Gaussian Random Field model to very large datasets. The method is based on finding a Gaussian Markov Random Model approximation to the GRF since for a GMRF model the precision matrix is sparse. We showed this approximation is very good and amenable to be solved using modern convex optimization l1 regularization methods, work reported in publication [1]. This work is a collaboration with Prof. S. Aybat (IME dept.) and forms the basis of a Ph.D. student thesis.

Sampling Error in Experimental-based Optimization and their applications in Genetics. (Funded by NSF). Another current (2014) research topic relates to a renewed interest in prior work I conducted in Response Surface Methodology (RSM) in the mid 2000's. In RSM, a system of fitted polynomials is solved to find the process parameters that are expected to achieve some given target response values. It is of interest to consider sampling variation, in such a way that confidence regions can be found for the solution of the system of equations, e.g., finding a confidence region for the location of the maximum of a function. Recent collaboration with Prof. John Hunt, from the Dept. of Biosciences of the University of Exeter, is aimed at developing methodology for the determination of a confidence region for the maximum of a fitness function as used by geneticists in experimental evolutionary biology. The goal is to test hypothesis regarding the evolution of diets in insects and propose new evolutionary mechanisms that explain the observed evolutionary divergence from the expected behavior. An R package is under development for the computation of constrained confidence regions. New methodology where the region is computed based on non-parametric bootstrapping and the concept of data depth is being pursued. This current work is therefore related to earlier work [63,58,49] done in collaboration with Dr. John Peterson, Director of Statistics at Glaxo-SmithKline R&D labs. A related line of investigation was to implement non-linear programming models that use the confidence regions as constraints. [90] has resulted from this research. Procedures for steepest ascent under experimental error are also of great value in RSM. There is no clear rule, however, that indicates when a relative maximum has been achieved along the search direction for a response that experiences large experimental errors. Recent research has provided a new steepest ascent procedure that allows an experimenter to efficiently stop and detect the point of maximum mean response along the steepest ascent direction [79]. Some of this work took place during a sabbatical visit in Spring 2005 (Prof. Jack Kleijnen, host) to Tilburg University, The Netherlands. The statistical test of the KKT optimality conditions was studied. One paper resulted from this collaboration. [25]

Process adjustment methods based on "big" 3D voxel tomography data for additive manufacturing. Another previous research area that has received renewed interest at the present (2014) time is statistical process adjustment, and in particular, its potential application for the setup adjustment of a 3D printer or additive manufacturing system. An on-going collaboration with Prof. Tim Simpson (ME) is taking place for this endeavor where the ultimate goal is to use Computed Tomography scans of metal parts produced in sequence by a 3D printer to modify the input file of the printer in order to improve the dimensions of the parts. This problem relates to a very high dimensional version of the *Setup Adjustment Problem*, which my group studied in detail throughout the 2000's. The new work relates to problems in sparse multivariate regression, for which new methodology is needed. The aim of the original work in this field (initially funded by a CAREER grant) was to develop real-time controllers for each run of wafers produced in semiconductor manufacturing process steps that exhibit drifting behavior. By extension, the work considered the study of process adjustment methods in more general manufacturing processes. Problems related to use of the so-called EWMA statistic, PI controllers, and closed-loop estimation were investigated. Research was directed at finding the robustness and sensitivity of EWMA, PI and related controllers and to derive tuning approaches for finding the weights of the EWMA statistic [74,70]. Collaboration with Dr. B. Colosimo (Politecnico di Milano, Italy) took place in 2001, when Dr. Colosimo spent a sabbatical stay in the Engineering Statistics Laboratory, and in Summer 2003. This resulted in work related to setup adjustment under asymmetric loss functions [43.] Other work involves the study of multivariate "deadband" adjustment policies, where there is a fixed adjustment cost that reduces the frequency of the adjustment [103,3]. Other

past work entailed consideration of the context information associated with each lot or batch (tool, chamber, operator, operation, etc.) under which each production lot is produced, rather than simply neglecting all this valuable information. This "context-based" control problem is of increasing importance to semiconductor manufacturers, given their data-rich production environment. Other process adjustment problem where we have worked is on closed-loop identification problems for discrete part manufacturing control. Constrained estimation methods that add information and improve the closed-loop estimability and small sample identifiability of the process were explored. One Ph.D. student (O. Arda Vanli) was funded in this area.

Manifold Learning, Active Learning, and Optimal experimental design for non-convex, non-linear manifolds (Funded by NSF). In recent years a number of machine learning authors have noticed the similarities between Active Learning (AL) used for models linear in the parameters and the optimal experimental design problem. AL methods based on Random Forests (RF's) for regression assume unlabeled data occurs in $\mathbb{R}^p$ (Euclidean p-dimensional space). There may be practical instances where the data does not cover all of $\mathbb{R}^p$ but is instead located in a lower dimensional manifold $\mathcal{M} \subset \mathbb{R}^p$ with $\dim(\mathcal{M}) = r < p$. It is said then the data meets a *manifold condition*. It is our conjecture that if unlabeled data satisfies the manifold condition, a RF fit on the manifold variables $\mathbf{u} \in \mathcal{M}$ (as opposed to the usual RF analysis fit on the original data $\mathbf{x} \in \mathbb{R}^p$) may increase the predictive performance of the model. While it is not possible to rule linear manifolds (such as obtained by classical Principal Component Analysis) it is safer to consider the manifold as nonlinear, endowed with a geodesic metric $d_{\mathcal{M}}$ (i.e., distances in $\mathcal{M}$ are not Euclidean). Furthermore, the AL strategies can recommend the original variables $\mathbf{x}_i$ which correspond to the highest ranked candidates $\mathbf{u}_i \in \mathcal{M}$ by the RF. By considering the geometric structure of the data, the resulting AL method should promote faster learning. We also wish to investigate cross-fertilization of ideas between the AL field and the optimal design of experiments field. In this task we plan to focus on learning based on a linear model as opposed to based on RFs. Most of the exact optimal design and computer experiments literature (including the optimization of computer experiments literature) assumes a connected uniform region over which there is uniform interest. There exist complex design problems in mixture and mixture-amount designs and more generally in computer experiments where the region of interest may not be convex or connected. It is an open problem how to deal with complex (non-convex, not connected specially if higher dimensional) experimental regions R or how to deal with problems where there is *no* uniform interest in the response in all of R. To handle a non-convex, non-connected region R, perhaps of non-uniform interest, we propose to incorporate the geometry of R by a novel Manifold D-optimal design.

Optimization and control of functional and shape-based processes (Funded by NSF). The analysis of systems that generate functions as responses is an increasingly important topic both in manufacturing and non-manufacturing. A machining process, for example, generates geometries for the shape of the part which may be difficult to control or optimize, particularly if these are of the "free form" type. Our goal is to study techniques for the solution of optimization and control problems for this type of profile-response systems. Statistical shape analysis techniques are being utilized [16]. The ultimate goal of this research was to provide a method for solving on-line optimization and control problems for profile-response systems. This included the important case where not all factors affecting the functional response are controllable. One Ph.D. student (Hussam Alshraideh) and two master students were funded from this grant.

Bayesian analysis in process adjustment and process optimization (funded by NSF and General Motors R&D). A major thrust of our current research consists in developing and applying Bayesian Statistical techniques for process control and optimization purposes. In particular, the setup control problem and its relation to Kalman filtering and Stochastic approximation techniques is a recent area where we have concentrated, focusing on Markov Chain Monte Carlo (MCMC) methods, and, more recently, on Sequential Monte Carlo methods as a Bayesian estimation method for control. Using Bayesian techniques we are currently working on deadband adjustment policies where the parameters of the process are unknown [37]. In the area of process optimization, we (in collaboration with Dr. John Peterson, from Glaxo SmithKline) have been developing Bayesian methods for multiple response optimization. Current work also involves using Bayesian model averaging techniques to obtain model-robust solutions of a process, i.e., solutions that are insensitive to the assumed form of the fitted model [41]. This includes the case of noise factors, that is, robust parameter design problems.

Robust Parameter Design Problems in Response Surface Methodology (Funded by NSF). In the

statistical optimization of industrial processes it is common to encounter multiple responses of interest in the experimental designs. If the responses exhibit adequate quadratic fit, the resulting quadratic programming problem can be solved only under strong convexity assumptions. In references [82,77], EDC and Dr. John Semple (Management Science Dept., SMU) co-advising a Ph.D. student in this area (S.K. Fan), developed a new algorithm for the computation of a global optimal solution in quadratic Dual Response systems. The algorithm does not require any convexity assumption and finds the global optimum rapidly. The algorithm has also been used to generate confidence regions for the global optimum by means of successive Monte Carlo simulations/optimizations [76]. In the case of a single objective function, the dual response approach considers both the mean and the variance of the response. We have also extended this methodology to the case of multiple responses [48]. The estimated variance of the predicted response (as opposed to the variance of the response) was proposed as the function to optimize, and it was shown that this considers both the variability due to the unmodelled errors and the variability due to parameter uncertainty given the model form [53]. Other line of work that was investigated were steepest ascent for robust parameter design (RPD) problems [35] and the use of genetic algorithms for experimental designs in RPD [29].

OTHER INFORMATION

- **U.S.A. Citizen**.
- Born: May 9, 1963, in Mexico City, Mexico (fluent in Spanish).
- Marital Status: Married (1990). Wife's name: Monica Septién; two sons, Enrique (born 10/3/96) and Fernando (born (9/29/99).

PROFESSIONAL REFERENCES

1. Dr. Douglas C. Montgomery (Ph.D. thesis advisor), Regents Professor, School of Computing, Informatics, and Decision Systems Engineering, Arizona State University, Tempe, AZ 85287-5906. Ph: (602) 965-3836, e-mail: doug.montgomery@asu.edu
2. Dr. Lawrence M. Seiford, Professor, Industrial and Operations Engineering, The University of Michigan, 1205 Beal Avenue, Ann Arbor, MI 48109-2117, Ph: 734-764-9422, e-mail: seiford@engin.umich.edu.
3. Professor George Runger, Chair, Dept. of Bioinformatics, Arizona State University, Tempe, AZ 85287-5906, e-mail: George.Runger@asu.edu
4. Dr. Kwok Tsui, Head Chair Professor of Industrial Engineering, City University of Hong Kong, email: kltsui@cityu.edu.hk
5. Dr. William Woodall, Professor, Department of Statistics, Virginia Tech, Blacksburg, VA 24061 Ph: (540) 231-7792 Fax: (540) 231-3863, e-mail: bwoodall@vt.edu.
6. Dr. E. A. Elsayed, Professor, Industrial Engineering Department, Rutgers, The State University of New Jersey, 96 Frelinghuysen Road, Piscataway, NJ 08854-8018, Ph: (732) 445-3654, Fax (732) 445-5467, e-mail: elsayed@rci.rutgers.edu.
7. Dr. Ronald G. Askin, Professor & Chair, School of Computing, Informatics, and Decision Systems Engineering, Arizona State University, Tempe, AZ, 85287-5906, e-mail: ron.askin@asu.edu.
8. Professor Quirico Semeraro, Dept. of Mechanical Engineering (Production Engineering Section), Politecnico di Milano, Milan, Italy. email: quirico.semeraro@polimi.it
9. Dr. Frank L. Lewis, Moncrief-O'Donnell Chair Professor, Department of Electrical Engineering, The University of Texas at Arlington, Arlington, TX 76019. Ph: (817) 496-8258, e-mail: Lewis@uta.edu