

January 2013

JULIO M. OTTINO
CURRICULUM VITAE

Personal

US citizen¹, born in La Plata, Argentina.
office: 847-491-3195, e-mail: jm-ottino@northwestern.edu

Education

Ph.D. in Chemical Engineering, University of Minnesota, 1979.
Chemical Engineering Diploma, National University of La Plata, Argentina, 1974.

Executive Program, Kellogg School of Management, 1995.

Current Position

Dean, R.R. McCormick School of Engineering and Applied Science, 2005-
R.R. McCormick Institute Professor, Northwestern University, 2000-
Walter P. Murphy Professor, Chemical Engineering, Northwestern University, 1991-
Professor (by courtesy), Mechanical Engineering, Northwestern University, 2000-

Teaching and Research Positions

Co-Director, the Northwestern Institute on Complex Systems, 2004-2005.
Chair, Department of Chemical Engineering, Northwestern University, 1992-2000.
Professor of Chemical Engineering, Northwestern University, 1991-
George T. Piercy Distinguished Professor, Department of Chemical Engineering and Materials
Sciences, University of Minnesota, 1998.
Senior Research Fellow, Center for Turbulence Research, Stanford University, 1990.
Professor, Department of Chemical Engineering, University of Massachusetts, Amherst, 1986-1991.
Chevron Visiting Associate Professor of Chemical Engineering, California Institute of Technology,
1986.
Associate Professor, Department of Chemical Engineering, University of Massachusetts, Amherst,
1983-1986.
Adjunct Professor, Department of Polymer Science and Engineering, University of Massachusetts,
Amherst, 1979-1991.
Assistant Professor, Department of Chemical Engineering, University of Massachusetts, Amherst,
1979-1983.
Instructor, Department of Chemical Engineering, University of Minnesota, Minneapolis, 1978-1979.

Honors and Significant Lectureships

2012 Distinguished Research Lecture in Chemical Engineering, Carnegie Mellon
University
2012 Eminent Lecturer, National Technical University Singapore
2012 TechniGraphicS Foundation Lecture, IIT Bombay, India
2012 ASME Design Automation Conference, Chicago
2011 ASME Dynamics Systems and Control Conference, Washington DC
2010 62nd Institute Lecture, American Institute of Chemical Engineers
2008 Fluid Dynamics Prize, American Physical Society

¹Naturalized March 21, 1991, Northampton, Massachusetts.

2008 Otto Laporte Lecture, American Physical Society
 2008 “One Hundred Engineers of the Modern Era”, American Institute of Chemical Engineers.
 2008 μ TAS (12th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Diego).
 2007 Pirkey Lecture, University of Texas, Austin
 2006 Dean’s Distinguished Lecture, College of Engineering and Mathematical Sciences, University of Vermont
 2006 Reilly Lectures University of Notre Dame
 2003 Member, American Academy of Arts and Sciences
 2002 Ernest W. Thiele Award (AIChE, Chicago section)
 2002 Robb Distinguished Lecture in Chemical Engineering Science, Penn State University
 2001 William H. Walker Award, American Institute of Chemical Engineers
 2001 John S. Guggenheim Fellowship
 2001 Paul J. Flory Lecturer, Stanford University
 1999 Danckwerts Memorial Lecture, London, England
 1997 Member, National Academy of Engineering
 1996 Fellow, American Association for the Advancement of Science
 1996 Sigma Xi Distinguished Lecturer (1997-1999)
 1996 SON Lecture (Foundation for Chemical Research, The Netherlands)
 1994 Alpha Chi Sigma Award, American Institute of Chemical Engineers
 1994 William N. Lacey Lectureship in Chemical Engineering, California Institute of Technology
 1994 College of Engineering Centennial Speaker, University of Maryland
 1993 Fellow, American Physical Society, Division of Fluid Mechanics
 1991 Fifth Stanley Corrsin Lectureship in Fluid Mechanics, The Johns Hopkins University
 1989 Finalist Scientific Prize, Art for Science, LV-MH, Paris, France
 1989 Merck Sharp & Dohme Lecturer, University of Puerto Rico
 1988 University Fellow, University of Massachusetts
 1987 Allan P. Colburn Memorial Lectureship, Chemical Engineering, University of Delaware
 1984 Presidential Young Investigator Award (NSF)
 1982 Outstanding Junior Faculty Scholar Award (University of Massachusetts)

Main professional activities last ten years

- Co-Chair (with John Guckenheimer, Mathematics, Cornell University) “*Foundations for Complex Systems: Research in the Physical Sciences and Engineering*” (report from an NSF Workshop September, 2008).
- Member NRC Benchmarking Committee, US Chemical Engineering (2007).
- Member International Review of Engineering in the UK –EPSRC/Royal Academy of Engineering (2004).
- Chair NAE Peer Committee Chemical Engineering, 2002
- Member NAE Committee on Membership (2003-2006)
- Founding Editor, *AIChE Journal*, Perspectives (1999-2006); Associate Editor (1994-2006)

Boards and advising activities last ten years

- Scientific Board, AkzoNobel, 2010-
- Noribachi LLC, Albuquerque, New Mexico, 2008-2010
- Member, International Advisory Board, UC Santa Barbara (2005-2010)
- Unilever, Technical Advisor (1997-2008)
- Dow Chemical (Engineering Sciences Technical Advisory Board, 2000-2004).
- Member program reviews at Cornell, Houston, etc.

Significant University Committees at Northwestern prior to Dean's appointment

- *Co-Chair*, Reorganization of Basic Industrial Research Laboratory (BIRL), Northwestern's Research Park (1995-1996)
- *Member*, Provost Search Committee (1995)
- *Chair*, Long-Range Planning Committee for the Geology Department, Northwestern University (1996-1997)
- *Member*, Honorary Degree Committee (1997-2001)
- *Member* “*Highest Order of Excellence*” (*HOE I* 1998, *HOE II* 2003)
- *Chair* – ad hoc group on Reducing Administrative Complexity at Northwestern, reporting to Provost
- *Member*, Great Debates Committee, 2000-2001
- Task Force on Cross School Hiring (reporting to Provost), 2000
- *Member*, Dean of Weinberg College Arts and Sciences Search Committee, 2001
- *Member*, Dean of Medical School, Search Committee, 2011

CURRENT AREAS OF RESEARCH

Granular Dynamics, Mixing – Fluid Dynamics, Segregation and Coarsening, Complex Systems.

Publications in Refereed Journals: Over 200 publications in refereed journals; *h*-index: 52; book “*The Kinematics of Mixing*” has been cited over 2,000 times. Publications have appeared or are in press in the following journals:

1. *Advances in Chemical Engineering*
2. *Advances in Complex Systems*
3. *American Institute of Chemical Engineers Journal*
4. *American Journal of Physics*
5. *Annuals Reviews of Fluid Mechanics*
6. *Archives for Rational Mechanics and Analysis*
7. *Biotechnology Progress*
8. *Chaos*
9. *Chaos, Solitons and Fractals*
10. *Chemical Engineering Communications*
11. *Chemical Engineering Education*
12. *Chemical Engineering Science*
13. *European Journal of Physics*
14. *European Phys. Letters*
15. *Exp. Thermal Fluid Sci.*
16. *Geophysical Research Letters*
17. *Granular Matter*
18. *Industrial Engineering Chemistry Fundamentals*
19. *Industrial Engineering Chemistry Research*
20. *International Journal of Multiphase Flow*
21. *Int. J. Bifurcations and Chaos*
22. *Journal of Chemical Physics*
23. *Journal of Colloid and Interface Science*
24. *Journal of Fluid Mechanics*
25. *Journal of Non-Newtonian Fluid Mechanics*
26. *Lectures in Applied Mathematics*
27. *Macromolecules*
28. *Nature*
29. *Nature Physics*
30. *New Journal of Physics*
31. *Philosophical Transactions of the Royal Society of London*
32. *Physica D*
33. *Physical Review A*

34. *Physical Review E*
35. *Physical Review Letters*
36. *Physics of Fluids and Physics of Fluids A*
37. *Polymer*
38. *Polymer Engineering Science*
39. *Powder Technology*
40. *Proceedings of the National Academy of Sciences of the US*
41. *Proceedings of the Royal Society of London*
42. *Soft Matter*
43. *Science*
44. *Tribology Letters*

Publications in Magazines

45. *CHEMTECH*
46. *INGENIA*
47. *Scientific American*

PUBLICATIONS

Books

J.M. Ottino, *The Kinematics of Mixing: Stretching, Chaos, and Transport*, Cambridge University Press, Cambridge, England 1989 (xiv, 364 pp., illus., + plates), reprinted 1990, 1997; 2004.

R. Sturman, J.M. Ottino, and S. Wiggins, *Mathematical Foundations of Mixing: The Linked Twist Map as a Paradigm in Applications – Micro to Macro, Fluids to Solids*, Cambridge University Press, Cambridge, England, 2006

Publications in Refereed Journals, Technical Papers

J.M. Ottino, W.E. Ranz, and C.W. Macosko, A lamellar model for analysis of liquid-liquid mixing, *Chem. Eng. Sci.*, **34**, 877-890 (1979).

J.M. Ottino and C.W. Macosko, An efficiency parameter for batch mixing of viscous liquids, *Chem. Eng. Sci.*, **35**, 1454-1457 (1980).

J.M. Ottino, Lamellar mixing models for structured chemical reactions and their relationship to statistical models; Macro- and micro-mixing and the problem of averages, *Chem. Eng. Sci.*, **35**, 1377-1391 (1980).

L.J. Lee, J.M. Ottino, W.E. Ranz, and C.W. Macosko, Impingement mixing in reaction injection molding, *Polym. Eng. Sci.*, **20**, 868-874 (1980).

J.M. Ottino, Efficiency of mixing from data on fast reactions in multi-jet reactors and stirred tanks, *AIChE Journal*, **27**, 184-192 (1981).

J.M. Ottino, C.W. Macosko, and W.E. Ranz, Framework for the description of mechanical mixing of fluids, *AIChE Journal*, **27**, 565-577 (1981).

- J.M. Ottino and H.T. Davis, Pressure tensor in lamellarly structured fluids, *J. Chem. Phys.*, **74**, 6388-6393 (1981).
- J.M. Ottino, Description of mixing with diffusion and reaction in terms of the concept of material interfaces, *J. Fluid Mech.*, **114**, 83-103 (1982).
- K.K. Mohanty, J.M. Ottino, and H.T. Davis, Reaction and transport in disordered composite media: Introduction of percolation concepts, *Chem. Eng. Sci.*, **37**, 905-924 (1982).
- R. Chella and J.M. Ottino, Simplified model for mechanical mixing, diffusion, and reaction in a single screw extruder, *ACS Symp. Ser.*, **196**, 567-578 (1982).
- J.M. Ottino, A mechanical mixing parameter for continuous mixing systems, *AIChE Journal*, **29**, 159-161 (1983).
- R. Chella and J.M. Ottino, Modeling of rapidly-mixed fast-crosslinking exothermic polymerizations I: Adiabatic temperature rise, *AIChE Journal*, **29**, 373-382 (1983).
- J.E. Sax and J.M. Ottino, Transport of small molecules in polymer blends: Application of effective medium theory, *Polym. Eng. Sci.*, **23**, 165-176 (1983).
- J.M. Ottino and R. Chella, Mixing of polymeric liquids: A brief review and recent theoretical developments, *Polym. Eng. Sci.*, **23**, 357-379 (1983).
- J.M. Ottino and N. Shah, Analysis of transient sorption and permeation of small molecules in multiphase polymer systems, *Polym. Eng. Sci.*, **24**, 153-162 (1984).
- R. Chella and J.M. Ottino, The fluid mechanics of mixing in a single screw extruder, *Ind. Eng. Chem. Fundam.*, **24**, 170-180 (1985).
- R. Chella and J.M. Ottino, Conversion and selectivity modifications due to mixing in unpremixed Reactors, *Chem. Eng. Sci.*, **39**, 551-567 (1984).
- J.E. Sax and J.M. Ottino, Influence of morphology on the transport properties of polystyrene/polybutadiene blends: Experimental results, *Polymer*, **26**, 1073-1080 (1985).
- N. Shah, J.E. Sax, and J.M. Ottino, Influence of morphology on the transport properties of polystyrene/polybutadiene blends: Modeling results, *Polymer*, **26**, 1229-1246 (1985).
- R. Chella and J.M. Ottino, Stretching in some classes fluids motions and asymptotic mixing efficiencies as a measure of flow classification, *Arch. Rat. Mech. Anal.*, **90**, 15-45 (1985).
- D.J. Lin, J.M. Ottino, and E.L. Thomas, A kinetic study of the activated anionic polymerization of ϵ -Caprolactam, *Polym. Eng. Sci.*, **25**, 1155-1163 (1985).
- N. Shah and J.M. Ottino, Effective transport properties of random multi-phase composites: Application of renormalization Theory, *Chem. Eng. Sci.*, **41**, 283-296 (1986).
- D.V. Khakhar and J.M. Ottino, A note on the linear vector model of Olbricht, Rallison, and Leal as applied to the breakup of slender axisymmetric drops, *J. Non-Newtonian Fluid Mech.*, **21**, 127-131 (1986).

- D.V. Khakhar and J.M. Ottino, Deformation and breakup of slender drops in linear flows, *J. Fluid Mech.*, **166**, 265-285 (1986).
- W.L. Chien, H. Rising, and J.M. Ottino, Laminar and chaotic mixing in several cavity flows, *J. Fluid Mech.*, **170**, 355-377 (1986).
- D.V. Khakhar, H. Rising, and J.M. Ottino, An analysis of chaotic mixing in two model systems, *J. Fluid Mech.*, **172**, 419-451 (1986).
- D.V. Khakhar and J.M. Ottino, Fluid mixing (stretching) by periodic sequences for weak flows, *Phys. Fluids*, **29**, 3503-3505 (1986).
- S.D. Fields, E.L. Thomas, and J.M. Ottino, Visualization of interfacial urethane polymerizations by means of a new microstage reactor, *Polymer*, **27**, 1423-1432 (1986).
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- N. Shah and J.M. Ottino, Transport and reaction in evolving, disordered composites: II. Coke deposition in a catalytic pellet, *Chem. Eng. Sci.*, **42**, 73-82 (1987).
- S.D. Fields and J.M. Ottino, Mixing effects during polymerizations by the adiabatic temperature rise technique, *AIChE Journal*, **33**, 157-160 (1987).
- D.V. Khakhar and J.M. Ottino, Breakup of liquid threads in linear flows, *Int. J. Multiphase Flow*, **13**, 71-86 (1987).
- S.D. Fields and J.M. Ottino, Effect of striation thickness distribution on the course of an unpremixed polymerization, *Chem. Eng. Sci.*, **42**, 459-465 (1987).
- S.D. Fields and J.M. Ottino, Effect of stretching path on the course of polymerizations: applications to idealized unpremixed reactors, *Chem. Eng. Sci.*, **42**, 467-477 (1987).
- D.J. Kinning, E.L. Thomas, and J.M. Ottino, Effect of morphology on the transport of small molecule gases in block copolymers, *Macromolecules*, **20**, 1129-1133 (1987).
- S.D. Fields and J.M. Ottino, Effects of segregation on the course of unpremixed polymerizations, *AIChE Journal*, **33**, 959-975 (1987).
- M. Serrano, W.J. MacKnight, E.L. Thomas and J.M. Ottino, Transport-morphology in polybutadiene polyurethanes. 1: Experimental results, *Polymer*, **28**, 1667-1673 (1987).
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- D.V. Khakhar, J.G. Franjione, and J.M. Ottino, A case study of chaotic mixing in deterministic flows: The partitioned pipe mixer, *Chem. Eng. Sci.*, **42**, 2909-2926 (1987).
- J.G. Franjione and J.M. Ottino, Feasibility of numerical tracking of material lines and surfaces in chaotic flows, *Phys. Fluids*, **30**, 3641-3643 (1987).

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- J. M. Ottino, C.W. Leong, H. Rising, and P.D. Swanson, Morphological structures produced by mixing in chaotic flows, *Nature*, **333**, 419-425 (1988) (*cover article*).
[reprinted in “*Chaos and Nonlinear Dynamics*” edited by R.C. Hilborn and N.B. Tufillaro, American Association of Physics Teachers, College Park, Maryland, 1999.]
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- E.M. Sevick, P.A. Monson, and J.M. Ottino, Clustering and percolation in assemblies of anisotropic particles: Perturbation theory and Monte Carlo simulation, *Phys. Rev. A.*, **38**, 5376-5383 (1988).
- J.M. Ottino, The mixing of fluids, *Scientific American*, **260**, 56-67 (1989) (*cover article*).
[translations appeared in *Pour la Science*, Le mélange des fluides, mensuel **137**, 32-42, Mars 1989, and *Investigacion y Ciencia*, Mezcla de Fluidos, Número **150**, 44-55, Marzo (1989); *Le Scienze*, Il Mescolamento dei Fluidi, n° **247**, 152-161 (1989); *Mischen zäher Flüssigkeiten*, Spektrum der Wissenschaft, März (1989), S66 - 77].
- E.M. Sevick, P.A. Monson, and J.M. Ottino, Morphology and transport using the Ising lattice as a morphology description, *Chem. Eng. Sci.*, **44**, 21-32 (1989).
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- F. J. Muzzio and J.M. Ottino, Evolution of a lamellar system with diffusion and reaction: A scaling approach, *Phys. Rev. Lett.*, **63**, 47-50 (1989).
- C.-W. Leong and J.M. Ottino, Experiments on mixing due to chaotic advection in a cavity, *J. Fluid Mech.*, **209**, 463-499 (1989).
- J.G. Franjione, C.W. Leong, and J.M. Ottino, Symmetries within chaos: a route to effective mixing, *Phys. Fluids A.*, **1**, 1772-1783 (1989).
- F. J. Muzzio and J.M. Ottino, Dynamics of a lamellar system with diffusion and reaction: Scaling analysis and global kinetics, *Phys. Rev. A.*, **40**, 7182-7192 (1989).
- J.M. Ottino, Mixing, Chaotic advection, and turbulence, *Ann. Revs Fluid Mech.*, **22**, 207-54 (1990).
- C.-W. Leong and J.M. Ottino, Increase in regularity by polymer addition during chaotic mixing in two-dimensional flows, *Phys. Rev. Lett.*, **64**, 874-877 (1990).
- P.D. Swanson and J.M. Ottino, A comparative computational and experimental study of chaotic mixing of viscous fluids, *J. Fluid Mech.*, **213**, 227-249 (1990).

- T.J. Danielson and J.M. Ottino, Structural stability in two-dimensional model flows: Lagrangian and Eulerian turbulence, *Phys. Fluids A*, **2**, 2024-2035 (1990).
- F.J. Muzzio and J.M. Ottino. Diffusion and reaction in a lamellar system: Self-similarity with finite rates of reaction, *Phys. Rev. A*, **42**, 5873-5884 (1990).
- J.M. Ottino, Unity and Diversity in Mixing: Stretching, diffusion, breakup, and aggregation in chaotic flows, *Phys. Fluids A*, **5**, 1417-1430 (1991).
- F.J. Muzzio, P.D. Swanson, and J.M. Ottino, The statistics of stretching and stirring in chaotic flows, *Phys. Fluids A*, **5**, 822-834 (1991).
- T.J. Danielson, F.J. Muzzio, and J.M. Ottino, Aggregation and structure formation in chaotic and regular flows, *Phys. Rev. Lett.*, **66**, 3128-3131 (1991).
- K. Shariff, T.H. Pulliam, and J.M. Ottino, A dynamical systems analysis of kinematics in the time-periodic wake of a circular cylinder, *Lectures in Applied Mathematics*, **28**, 613-646 (1991).
- J.G. Franjione and J.M. Ottino, Stretching in duct flows, *Phys. Fluids A.*, **3**, 2819-2821 (1991); *erratum*, *Phys. Fluids*, **6**, 3501 (1991).
- M. Tjahjadi and J.M. Ottino, Stretching and breakup of droplets in chaotic flows, *J. Fluid Mech.*, **232**, 191-219 (1991).
- F.J. Muzzio, M. Tjahjadi, and J.M. Ottino, Self-similar drop size distributions produced by breakup in chaotic flows, *Phys. Rev. Lett.*, **67**, 54-57 (1991).
- H.A. Kusch and J.M. Ottino, Experiments on mixing in continuous chaotic flows, *J. Fluid Mech.*, **236**, 319-348 (1992).
- S.C. Jana and J.M. Ottino, Chaos-enhanced transport in cellular flows, *Proc. Roy. Soc. London A.*, **338**, 519-532 (1992). Also published in *Nonlinear Dynamics of Engineering Systems*, edited by J.M.T. Thompson and W. Schliehler, London: The Royal Society (1992).
- F.J. Muzzio, P.D. Swanson, and J.M. Ottino, Mixing distributions produced by multiplicative stretching in chaotic flows, *Int. J. Chaos and Bifurcations*, **2**, 37-50 (1992) (*cover article*).
- J.G. Franjione and J.M. Ottino, Symmetry concepts for the geometric analysis of mixing flows, *Phil. Trans. Roy. Soc. Lond.*, **338**, 301-323 (1992).
- F.J. Muzzio, C. Meneveau, P.D. Swanson, and J.M. Ottino, Scaling and multifractal properties of mixing in chaotic flows, *Phys. Fluids A*, **4**, 1439-1456 (1992).
- J. M. Ottino, F. J. Muzzio, M. Tjahjadi, J. G. Franjione, S. C. Jana, H. A. Kusch, Chaos, Symmetry, and self-similarity: Exploiting order and disorder in mixing processes, *Science*, **257**, 754-760 (1992).
- M. Tjahjadi, H.A. Stone, and J.M. Ottino, Satellite and sub-satellite formation in capillary breakup, *J. Fluid Mech.*, **243**, 297-317 (1992).

- T. Shinbrot and J.M. Ottino, Geometric method to create coherent structures in chaotic flows, *Phys. Rev. Lett.*, **71**, 843-846 (1993).
- T.C. Niederkorn and J.M. Ottino, Mixing of viscoelastic fluids in time-periodic flows, *J. Fluid Mech.* **256**, 243-268 (1993).
- J.M. Ottino, S.C. Jana, and V.J. Chakravarthy, From Reynolds's stretching and folding to mixing studies using horseshoe maps, *Phys. Fluids A.*, **6**, 685-699 (1994).
- M. Tjahjadi, H.A. Stone, and J.M. Ottino, Estimating interfacial tension via relaxation of drops shapes and filament breakup, *AIChE Journal*, **40**, 385-394 (1994).
- G. Metcalfe and J.M. Ottino, Autocatalytic processes in chaotic flows, *Phys. Rev. Lett.*, **72**, 2875-2878 (1994); erratum, *Phys. Rev. Lett.*, **73**, 21 (1994).
- S.C. Jana, G. Metcalfe, and J.M. Ottino, Experimental and computational studies of mixing in complex Stokes flows: The vortex mixing flow and multicellular cavity flows, *J. Fluid Mech.* **256**, 199-246 (1994).
- S.C. Jana, M. Tjahjadi, and J.M. Ottino, Chaotic mixing of viscous fluids by periodic changes of geometry: The baffle-cavity system, *AIChE Journal*, **40**, 1769-1781 (1994).
- T.C. Niederkorn and J.M. Ottino, Mixing of shear thinning fluids in time-periodic flows, *AIChE Journal*, **40**, 1782-1793 (1994).
- J.M. Ottino, Mixing and chemical reactions: A tutorial, *Chem. Eng. Sci.* **49** (24A), 4005-4027 (1994).
- T. Shinbrot and J.M. Ottino, Maps, PDE's and solitary waves, *Int. J. Bifur. Chaos*, **5**, 955-970 (1995).
- G. Metcalfe, J.M. Ottino, C.R. Bina, Kinematical considerations for mantle mixing, *Geophys. Rev. Lett.*, **22**, 743-746 (1995).
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- G. Metcalfe, T. Shinbrot, J.J. McCarthy, and J.M. Ottino, Avalanche mixing of granular materials, *Nature*, **374**, 39-41 (1995) (cover article).
- V.J. Chakravarthy and J.M. Ottino, Mixing studies using horseshoes, *Int. J. Bifurcation and Chaos*, **5**, 519-530 (1995).
- J. M. Ottino, A. Souvaliotis, and G. Metcalfe, Chaotic mixing processes: New problems and computational issues, *Chaos, Solitons, and Fractals*, **6**, 425-438 (1995).
- S. Hansen and J.M. Ottino, Agglomerate Erosion: A non-scaling solution to the fragmentation equation, *Phys. Rev. E*, **53**, 4209-4212 (1996).
- S. Hansen and J.M. Ottino, Aggregation and cluster size evolution in non-homogenous flows, *J. Colloid and Int. Sci.*, **179**, 89-103 (1996).

- V.J. Chakravarthy and J.M. Ottino, Mixing of two viscous fluids in a rectangular cavity, *Chem. Eng. Sci.*, **51**, 3613-3622 (1996).
- L. Bresler, T. Shinbrot, and J.M. Ottino, Control of transport in chaotic lattice, *Physica D*, **93**, 191-209 (1996).
- J.J. McCarthy, T. Shinbrot, G. Metcalfe, J.E. Wolf, J.M. Ottino, Mixing of granular materials in slowly rotated containers, *AIChE Journal*, **42**, 3351-3363 (1996).
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- D.V. Khakhar, J.J. McCarthy, T. Shinbrot, and J.M. Ottino, Transverse flow and mixing of granular materials in a rotating cylinder, *Phys. Fluids*, **9**, 31-43 (1997).
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- J.M. Ottino, Kinematical views of mixing of fluids and granular materials: A brief review and open questions, *Rev. Mex. Fis.* **44**: (3) 215-221 (1998).
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- J.J. McCarthy and J.M. Ottino, Particle dynamics simulations: A hybrid technique applied to granular mixing, *Powder Technol.* **91**, 91-99 (1998).
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Rutgers State University, Department of Chemical & Biochemical Engineering
Shell Development Company, Westhollow Research Center, Houston, Texas
Sigma Xi Research Society Annual Meeting, University of Puerto Rico, Mayagüez, Puerto Rico
Sigma Xi Spring Lecture, Northwestern University
Stanford University, Paul Flory Symposium
Stanford University, Center for Turbulence Research
Stanford University, Department of Chemical Engineering
Stanford University, Department of Chemical Engineering, Stanford, California
Stanford University, Seminar in Fluid Mechanics
Stanford University, Stanford, Summer Course, Center for Turbulence Research, Department of
Mechanical Engineering
State University of New York at Buffalo, Chemical Engineering
Symposium on Contemporary Applications of Mathematics, The Five College Applied Mathematics
Program, Mount Holyoke College, South Hadley, Massachusetts
Syracuse University, Department of Chemical Engineering
Tennessee Eastman, Kingsport, Tennessee
Terex, Westport, Connecticut
Texas A&M University, College Station, Department of Chemical Engineering
The Johns Hopkins University, Chemical Engineering
The Pennsylvania State University, Department of Chemical Engineering
The University of Akron, Department of Chemical Engineering,
Tufts University, Department of Chemical Engineering, Medford, Massachusetts
Tulane University, Chemical Engineering
UCLA, Department of Chemical Engineering
Unilever Research, Port Sunlight, UK
Unilever, Colworth, UK

Unilever, Port Sunlight, England
 Union Carbide Corporation, Bound Brook, New Jersey
 Union Carbide Corporation, Weston Canal Center, Somerset, NJ
 University of Akron, Department of Chemical Engineering
 University of Akron, Department of Polymer Engineering
 University of Arizona, Chemical Engineering
 University of California at Irvine (Aerospace Engineering)
 University of California at Irvine (Chemical and Biochemical Engineering)
 University of California at Los Angeles, Department of Chemical and Nuclear Engineering
 University of California Davis, Department of Chemical Engineering, Davis, California
 University of California, Berkeley, Department of Chemical Engineering,
 University of California, Berkeley, Mechanical Engineering
 University of California, Davis, Department of Chemical Engineering,
 University of California, Los Angeles, Department of Chemical Engineering
 University of California, Santa Barbara, Chemical Engineering
 University of California, Santa Barbara, Department of Chemical and Nuclear Engineering
 University of Cambridge
 University of Chicago (James Frank Institute)
 University of Cincinnati, Department of Chemical Engineering
 University of Colorado (Boulder), Chemical Engineering
 University of Delaware, Department of Chemical Engineering
 University of Florida
 University of Hawaii, Department of Oceanography, School of Earth Science and Oceanography
 Northwestern University, Department of Physics
 University of Houston, Department of Chemical Engineering,
 University of Illinois at Chicago, Chemical Engineering
 University of Illinois at Urbana-Champaign, Chemical Engineering
 University of Illinois at Urbana-Champaign, Workshop on Scientific Issues in Multiphase Flows
 University of Illinois, Chemical Engineering, Chicago
 University of Illinois, Chicago
 University of Massachusetts, Amherst, Condensed Matter Seminars, Department of Physics and Astronomy
 University of Massachusetts, Amherst, Department of Food Engineering
 University of Massachusetts, Amherst, Department of Physics
 University of Massachusetts, Amherst, Department of Polymer Science and Engineering
 University of Massachusetts, Amherst, Massachusetts, Applied Mathematics Seminars, Department of
 Mathematics
 University of Massachusetts, Amherst, Massachusetts, Department of Polymer Science and Engineering
 University of Michigan, Department of Chemical Engineering,
 University of Michigan, Department of Mechanical Engineering and Applied Mechanics
 University of Minnesota, Chemical Engineering and Materials Sciences
 University of Minnesota, Department of Aerospace and Mechanics (Mechanics Seminars), Minneapolis,
 Minnesota
 University of Minnesota, Institute for Mathematics and its Applications
 University of Minnesota, Minneapolis, Department of Chemical Engineering and Materials Science
 University of Notre Dame, Department of Chemical Engineering
 University of Notre Dame, Reilly Lectures
 University of Pennsylvania, Department of Chemical Engineering
 University of Pittsburgh, Chemical and Petroleum Engineering
 University of South Carolina, "Images in Nanotechnology" Conferences
 University of South Carolina, Chemical Engineering
 University of Southern California, Department of Chemical Engineering
 University of Tennessee, Department of Chemical Engineering
 University of Texas, Austin, Department of Chemical Engineering
 University of Texas, Austin, Nonlinear Dynamics
 University of Vermont, Dean's Distinguished Lecture
 University of Virginia, Chemical Engineering

University of Washington, Seattle, Department of Chemical Engineering
University of Wisconsin, Madison, Department of Chemical Engineering
Washington University, Department of Chemical Engineering
World Congress of Chemical Engineering (*plenary*), Glasgow, Scotland
XL National Congress of Physics; Monterrey, Mexico (*plenary talk*)
Yale University, Department of Mechanical Engineering

Consulting

3M (1994-2000), DSM, Netherlands (1992-1998), Rohm & Haas (1993), Gardner, Carton & Douglas (1994), B.F. Goodrich (1996-97), Unilever (1997-2008), Helene Curtis (1997), Intellicoat (1998), Dow Chemical (2000-2004), Merck (2000), Abbott (2001), Baxter (2002-3), Resodyn Corp. (2004-), SC Johnson (2004), Brookwood Pharmaceuticals (2006), Swagelok (2008), AkzoNobel (2010-).

Funding and Advising

Supervised 45 Ph.D. students – from chemical engineering, mechanical engineering, polymer science, physics, and applied mathematics – currently working in industry and academia (of these 30 have been singly advised by JMO). Federal funding sources have included NSF, DOE, AFOSR, and the U.S. Army. Industrial sources have included ALCOA, 3M, Exxon, Xerox, Dow Chemical, Owens Corning, Union Carbide, Rohm & Haas, du Pont, and others. Other sources have included The Petroleum Research Fund and the Dreyfus Foundation.