Vinod Narayanan
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Associate Director of Thermal Energy Systems, Microproducts Breakthrough Institute
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A. Education and Employment Information

A1. Education

2001	Ph.D., Mechanical Engineering, Texas A&M University, College Station, Texas
1997	M.S., Mechanical Engineering, Texas A&M University, College Station, Texas
1995	B. E., Mechanical Engineering, Regional Engineering College (now National Institute of Technology), Surathkal, India

A2. Professional Experience

September 2008 - present	Associate Professor, School of Mechanical Industrial and Manufacturing Engineering, Oregon State University, Corvallis
2011-present	University Associate, Curtin Institute of Technology, Perth, Australia
June 2010-August 2010	ASEE Summer Faculty Fellow at the Air Force Research Labs/Edwards Air Force Base
Sept. 2001–August 2008	Assistant Professor, School of Mechanical, Industrial, & Manufacturing Engineering, Oregon State University, Corvallis
August1995 – August 2001	Graduate Research Assistant Texas A&M University Drying Research Center, Department of Mechanical Engineering, College Station, Texas
Jan. 1999-May 2000	Graduate Teaching Assistant Department of Mechanical Engineering, and Department of Engineering Technology and Industrial Distribution, Texas A&M University, College Station, Texas

A3. Research Expertise

1. Microscale flow and heat transfer (internal and external flows; single and phase-change) –as applied to energy efficiency, solar thermal, solar fuels, thermal management, chemical reactions, combustion, cryogenic heat transfer, absorption refrigeration, hydrogen storage, and phase-change heat transfer for space applications.
2. Passive means to augment heat and mass transfer – jet impingement heat transfer enhancement, micro/nanostructures for passively driven phase-change flows.

3. Experimental diagnostic techniques in heat transfer and fluid mechanics – infrared thermography and optical flow measurements.

B. Professional Activities

B1. Professional Society Membership

1. American Society of Mechanical Engineers, member (ASME)
2. American Society of Engineering Education, member (ASEE)
3. Sigma Xi, Member, (Honor Society)

B2. Service to the Heat Transfer Community

1. Chair, ASME K-13 Heat Transfer in Multiphase systems Committee (2013-2015), vice chair-(2011-2013), member since 2002
2. Associate editor of the Proceedings and member of the Regional Scientific Committee of USA, Mexico and Central America for the 15th International Heat Transfer Conference to be held 10-15 August 2014, Kyoto, Japan.
3. Heat Transfer Division representative on the International Conference on Nanochannels Microchannels and Minichannels (ICNMM) Planning committee
4. Conference co-chair (2013- Sapporo, Japan, 2014- Chicago, IL,USA), International Conference on Nanochannels Microchannels and Minichannels.
5. Conference chair 2015 International Conference on Nanochannels Microchannels and Minichannels
6. Track co-organizer, Heat Transfer in Multiphase Systems, ASME 2013 Summer Heat Transfer Conference, Minneapolis, MN
7. Topic Organizer, Heat Transfer in Multiphase Flow, 2013 IMECE, San Diego, CA
8. Session organizer or co-organizer for ASME K-13 technical sessions on (a) Phase-change heat transfer or Microchannel Boiling Heat Transfer at IMECE 2012, AJTEC 2011, SHTC 2009, SHTC 2008, IMECE 2007, IMECE 2006, IMECE 2005, IMECE 2004; (b) Spray and jet impingement heat transfer session in SHTC 2012, SHTC 2008; (c) Heat transfer in thin films in IMECE 2008; (d) Multiphase heat transfer in Industrial Systems in SHTC 2004
9. Session Chair, ILASS-Americas 2011, Diagnostics-II, Ventura, CA, May 16-19, 2011
10. Session organizer, Climate control session, Energy Sustainability Conference 2008
11. Organizing Committee (US side), Ninth ASME-ISHMT Heat and Mass Transfer Conference, Hyderabad, India, January 3-5, 2008

B3. Review Activities

1. Proposal review: NSF panels and ad-hoc proposal reviews, NASA, Department of Energy panels
2. Journal (sample): ASME Journal of Heat Transfer; International Journal of Heat and Mass Transfer; ASME Journal of Fluids Engineering; AIAA Journal of Thermophysics and Heat Transfer; International Journal of Heat and Fluid Flow; International Journal of Thermal Science; International Journal of Multiphase Flow; Journal of Physics D; Journal of Enhanced Heat Transfer; Heat Transfer Engineering; Experimental Heat Transfer; Nuclear Engineering Design; Experimental Thermal and Fluid Science
3. Conferences (sample): ASME conference proceedings; AIAA conference proceedings, ILASS conferences
4. Others- Thesis and Dissertation referee (Curtin University of Technology)
5. External Faculty Tenure Evaluation 2012, 2013
6. Book proposal reviews

C. Awards, Recognitions, Patents, and License Agreements

C1. Awards and Recognitions

1. James Welty Faculty Fellow, inaugural holder, 2013-current

2. International Collaboration Award, Australian Research Council on proposal titled "The phenomenology of unsteady impinging jets: fluid dynamics and heat transfer," with Curtin University of Technology, Perth, Project duration- 2013-2016.
3. ASEE Air Force Summer Faculty Fellowship 2010
4. CAREER award, National Science Foundation, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, 2008.
5. George W. Kunze Prize, Texas A&M University, "for excellence in scholarship and service to Texas A&M University and the community" (awarded annually to a single graduate student in the University), 2001.
6. Texas A&M University Graduate Fellowship, Department of Mechanical Engineering, Texas A&M University, September 1997-August 1998

Best Poster Awards (students)

1. *Thiagarajan, N.,* Strid, L., Narayanan, V., and Bhavnani, S. H., First Place in Fluid Physics Category, "Gravitational Effects on Bubble Dynamics in Pool Boiling on Asymmetric Surfaces," 2012 American Society of Gravitational and Space Research (ASGSR) Meeting, November 28-Dec 2nd, 2012, New Orleans, LA.
2. *Mani, P.,* Cardenas, R., and Narayanan, V., "Submerged Jet Impingement Boiling on a Non-uniformly Heated Polished Silicon Surface," Interpack2011-52042, ASME 2011 Pacific Rim Technical Conference and Exposition on Packaging and Integration of Electronic and Photonic Systems, Interpack 2011, Portland, OR, July 2011.

C2. Patents/ Provisional Patents

1. Narayanan, V., Strid, L., Bhavnani, S. H., Thiagarajan, N., and Natesh, S., 2013, "Passive Phase Change Heat Transport Using Meso and Micro Structures," Filed on October 23, 2013, Application No.: 61894780
2. Ghazvini, M., Narayanan, V., Drost, M. K., and Paul, B. K., 2013, "Microscale Combustor Heat Exchanger," U.S. Provisional Application No. 61/842,547, July 2013.
3. Bhavnani, S. H., and Narayanan, V., 2011, "Thermally Actuated Pumping Mechanism During Boiling by Asymetrically Located Cavities" US Provisional Patent Application No. 61/444,910
4. M. K. Drost, V. Narayanan, D. V. Pence, 2008, Droplet Desorption Process and System, US Patent # 7434411.

D. Publications

D1. Journal Publications (Published/ in print)

Refereed Books & Book Chapters

1. Narayanan, V., Liburdy, J. and Pence, D "Thermal Applications of Microchannel Flows" in Encyclopedia of Aerospace Engineering, eds R. Blockley and W. Shyy, John Wiley: Chichester.
DOI: 10.1002/9780470686652.eae613, Published 02nd December 2013.

Refereed Journal Publications

1. Ghazvini, M., and Narayanan, V., 2013, "A Microscale Combustor Recuperator and Oil Heat Exchanger-Design and Performance Analysis," *International Journal of Heat and Mass Transfer*, Vol. 64, pp. 988–1002, http://dx.doi.org/10.1016/j.ijheatmasstransfer.2013.05.032.
2. Drost, K.J., Eilers, B., Apte, S. V., Narayanan, V., and Schmitt, J., 2012, "Design of a Microchannel Based Solar Receiver/Reactor for Biofuel Processing," invited paper for special issue, *International Journal of Micro-Nano Scale Transport*, Vol. 3, No. 1-2, pp. 53-67.

3. Abishek, S., Narayanaswamy, R., and Narayanan, V., 2012, "Effect of Heater Size and Reynolds Number on the Partitioning of Surface Heat Flux in Subcooled Jet Impingement Boiling," *International Journal of Heat and Mass Transfer*, Vol. 59, pp. 247-261.

4. Cardenas, R., and Narayanan, V., 2012, "Comparison of Deionized Water and FC-72 in Pool and Jet Impingement Boiling Thermal Management," *IEEE Transactions on Components, Packaging and Manufacturing Technology*, Vol. 2, No. 11, pp. 1811-1823, http://dx.doi.org/10.1109/TCPMT.2012.2210717.

5. Cardenas, R., and Narayanan, V., 2012, "Critical Heat Flux in Submerged Jet Impingement Boiling of Water at Sub-atmospheric Conditions," *ASME Journal of Heat Transfer*, Vol. 134, 081502.

6. Thiagarajan, N., Kapsenberg, F., Narayanan, V., Bhavnani, S. H., and Ellis, C. D., 2012, "Development of a heat sink with periodic asymmetric structures using gray-scale lithography and deep reactive ion etching," *Electron Devices Letters*, EDL-2012-03-0571, http://dx.doi.org/10.1109/LED.2012.2197670, Vol. 33(7).

7. Cardenas, R., and Narayanan, V., 2012, "Heat Transfer Characteristics of Submerged Jet Impingement Boiling of Saturated FC-72," *International Journal of Heat and Mass Transfer*, Vol. 55 (15–16), pp. 4217–4231, http://dx.doi.org/10.1016/j.ijheatmasstransfer.2012.03.063.

8. Mani, P., Cardenas, R., and Narayanan, V., 2012, "Comparison of area-averaged and local boiling curves in pool and jet impingement boiling," *International Journal of Multiphase Flow*, Vol. 42 (June 2012), pp. 115-127, http://dx.doi.org/10.1016/j.ijmultiphaseflow.2012.02.002

9. Cardenas, R., and Narayanan, V., 2012, "Submerged Jet Impingement Boiling of Water Under Sub-atmospheric Conditions," invited paper for special issue, *ASME Journal of Heat Transfer*, 020909, Vol. 134, pp. 020909-1-9.

10. Cardenas, R., and Narayanan, V., 2011, "Heat and mass transfer characteristics of a constrained thin-film ammonia–water bubble absorber," *International Journal of Refrigeration,* Vol. 34(1), pp. 113-128.

11. Cardenas, R., and Narayanan, V., 2010, "A Numerical Model for Ammonia-water Absorption into a Constrained Microscale Film," *International Journal of Thermal Science,* Vol. 49(9), pp. 1787-1798.

12. Heymann, D., Pence, D., and Narayanan, V., 2010, "Optimization of fractal like branching microchannel heat sinks for single-phase flows," *International Journal of Thermal Science,* Vol. 49(8), pp. 1383-1393.

13. Shen, J., Liburdy, J. A., Pence, D. V., and Narayanan, V., 2009, "Droplet Impingement Dynamics: Effect of Surface Temperature During Boiling and non-Boiling Conditions," invited paper for special issue, *Journal of Physics: Condensed Matter*, special issue on Dynamics of Wetting, Vol. 21, 464133 (14 pages).

14. Krebs, D., Narayanan, V., Liburdy, J. A., and Pence, D. V., 2010, "Spatially-resolved Wall Temperature Measurements During Flow Boiling in Microchannels," invited paper for special issue, *Experimental Thermal and Fluid Science*, Vol. 34 (4), pp. 434-445.

15. Kwak, Y., Pence, D. V., Liburdy, J.A., and Narayanan, V., 2009, "Gas-liquid Flows in a Microscale Fractal-like Branching Flow Network," invited paper for special issue, *International Journal of Heat and Fluid Flow*, Vol. 30 (5), pp. 868-876.

16. Narayanan, V., Linke, H., and Taormina, M., 2009, "Visualization of Thermally Actuated Pumping in the Leidenfrost Regime by Surface Asymmetry," Heat Transfer Photogallery, *ASME Journal of Heat Transfer*, Vol. 131, p.080904-1

17. Shen, J., Graber, C., Liburdy, J.A., Pence, D.V., and Narayanan, V., 2009, "Simultaneous droplet Impingement Dynamics and Heat Transfer on Nano-structured Surfaces," *Experimental Thermal and Fluid Science*, Vol. 34(4), pp. 496-503.

18. Jain, K., Wu, C. L., Atre, S. V., Jovanovic, G., Narayanan, V., Kimura, S., and Sprenkle, V., 2009, "Synthesis of Silicon Nitride Nanoparticles in High Temperature Ceramic Microreactors: Design, Fabrication and Testing," invited paper for special issue, *International Journal of Applied Ceramic Technology*: Special Issue on Ceramic Microsystems, Vol. 6(3), pp. 410-419.

19. Jenks, J., and Narayanan, V., 2008, "Effect of Channel Geometry Variations on the Performance of a Constrained Microscale-Film Ammonia-Water Bubble Absorber," *ASME Journal of Heat Transfer*, Vol. 130, No. 11, 112402.

20. Narayanan, V., Kanury, A. M., and Jenks, J., 2008, "Heat Exchanger Analysis Modified to Account for a Heat Source," *ASME Journal of Heat Transfer*, Vol. 130, No. 12, 124502.

21. Shen, J., Graber, C., Pence, D. V., Liburdy, J. A., Narayanan, V., 2008, "Simultaneous Droplet Impingement Dynamics and Boiling Heat Transfer," Heat Transfer Photogallery, ASME *Journal of Heat Transfer*, Vol. 130, 080902.

22. Narayanan, V., 2007, "Oscillatory Thermal Structures in a Reattaching Jet Flow," *Journal of Visualization,* Vol. 10, No. 4, pp. 389-396.

23. Narayanan, V., and Patil, V. A., 2007, "Oscillatory Thermal Structures Induced by Unconfined Slot Jet Impingement," *Experimental Thermal and Fluid Science Journal*, Vol. 32, pp. 682-695.

24. Cullion, R., Pence, D. V., Liburdy, J. A., and Narayanan, V., 2007, "Void Fraction Variations in a Fractal-like Branching Microchannel Network," invited paper for special issue, *Heat Transfer Engineering,* Vol. 28(10), pp. 806-816.

25. Linke, H., Aleman, B., Melling, L., Taormina, M., Francis, M., Dow-Hygelund, C., Narayanan, V., Taylor, R. P., and Stout, A., 2006, "Self-propelled Leidenfrost Droplets", *Physical Review Letters,* Vol. 96, 154502.

26. Patil, V. A., and Narayanan, V., 2006, "Spatially Resolved Temperature Measurement in Microchannels," invited paper for special issue, *Microfluidics and Nanofluidics Journal,* Vol. 2(4), pp. 291-300.

27. Patil, V. A., and Narayanan, V., 2005, "Spatially Resolved Heat Transfer Rates in an Impinging Circular Microscale Jet," *Microscale Thermophysical Engineering Journal*, Vol. 9, pp. 183-197.

28. Patil, V. A., and Narayanan, V., 2005, "Application of Heated-Thin-Foil Thermography Technique to External Convective Microscale Flows," *Measurement Science and Technology*, Vol.16, pp. 472-476.

29. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 2004, "Transient Thermal Structure, Turbulence, and Heat Transfer in a Reattaching Slot Jet Flow," *International Journal of Heat and Mass Transfer,* Vol. 47(24), pp. 5219-5234.

30. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 2004, "An Experimental Study of Fluid Mechanics and Heat Transfer in an Impinging Slot Jet Flow," *International Journal of Heat and Mass Transfer,* Vol. 47, pp. 1827-1845.

31. Narayanan, V., Page, R. H., and Seyed-Yagoobi, J., 2003, "A Technique to Visualize Air Flow Using Infrared Thermography," *Experiments in Fluids*, Vol. 34, pp. 275 - 284.

32. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 1998, "Heat Transfer Characteristics of a Slot Jet Reattachment Nozzle," *ASME Journal of Heat Transfer*, Vol. 120, pp. 348-356.

33. Seyed-Yagoobi, J., Narayanan, V., and Page, R. H., 1998, "Comparison of Heat Transfer Characteristics of Radial Jet Reattachment Nozzle to In-Line Impinging Jet Nozzle," *ASME Journal of Heat Transfer*, Vol. 120, pp. 335-341.

34. Alam, S. A., Seyed-Yagoobi, J., Narayanan, V., and Page, R. H., 1998, "Drying Characteristics of Slot Jet Reattachment Nozzle and Comparison with a Slot Jet Nozzle," *Drying Technology*, Vol. 16, No. 8, pp. 1585-1607.

D2. Peer-reviewed Conference Publications

1. Abishek, S., Narayanaswamy, R., Narayanan, V., 2013, "Experimental Study of Low Frequency Pulsating Liquid Jet Impingement Cooling in a Confined Planar Geometry," *accepted*, 22nd National and 11th ISHMT-ASME Heat and Mass Transfer Conference, Indian Institute of Technology, Kharagpur, India, December 2013.

2. Truong, E.D., Rasouli, E., and Narayanan, V., 2013, "Cryogenic Single-phase Heat Transfer in a Microscale Pin Fin Heat Sink," Paper HT2013-17660 (13 pages), Proceedings of the ASME 2013 Summer Heat Transfer Conference, Minneapolis, MN, July 2013.

3. Ghazvini, M., and Narayanan, V., 2013, "Design of a Microscale Combustor-Heat Exchanger for Low Temperature Applications," HT2013-17543 (12 pages), Proceedings of the ASME 2013 Summer Heat Transfer Conference, Minneapolis, MN, July 2013.
4. Rymal, C., Apte, S. V., Narayanan, V., and Drost, K., 2013, "Design of a High- Flux Microchannel Solar Receiver," ES-FuelCell2013-18353 (9 pages), Proceedings of the ASME 2013 7th International Conference on Energy Sustainability, Minneapolis, MN, July 2013.
5. Mani, P., and Narayanan, V., 2012, "Thermal and Flow Visualization of Submerged Jet Impingement Boiling with FC-72," HT2012-58384 (12 pages), Proceedings of the ASME 2012 Summer Heat Transfer Conference, Rio Grande, Puerto Rico, USA, July 2012.
6. Cardenas, R., and Narayanan, V., 2012, "A Correlation for Critical Heat Flux in Submerged Jet Impingement Boiling," HT2012-58376 (14 pages), Proceedings of the ASME 2012 Summer Heat Transfer Conference, Rio Grande, Puerto Rico, USA, July 2012.
7. Abishek, S., Narayanaswamy, R., and Narayanan, V., 2012, "Effect of Heater Size on Confined Subcooled Jet Impingement Boiling," HT2012-58205 (10 pages), Proceedings of the ASME 2012 Summer Heat Transfer Conference, Rio Grande, Puerto Rico, USA, July 2012.
8. Kapsenberg, F., Thiagarajan, N., Narayanan, V., and Bhavnani, S. H., 2012, "Lateral Motion of Bubbles From Surfaces with Mini-ratchet Topography Modifications During Pool Boiling- Experiments and Preliminary Model," Itherm- Paper 3062 (11 pages), San Diego, CA, May 2012.
9. Drost, K., Apte, S. V., Schmitt, J., and Narayanan, V., 2011," Design of a Microchannel Based Solar Receiver/Reactor for Biofuel Processing," ISHMT_USA_018 (7 pages), 21st National and 10th ISHMT-ASME Heat and Mass Transfer conference, Chennai, India, December 2011.
10. Abishek, S., Narayanaswamy, R., and Narayanan, V., 2011, "Transient Characteristics of confined Submerged Laminar Jet Impingement Heat Transfer from a Vibrating Heater," (12 pages), 21st National and 10th ISHMT-ASME Heat and Mass Transfer conference, Chennai, India, December 2011.
11. Haley, D. B., and Narayanan, V., 2011, "Performance Characterization of a Microscale Hydrogen Combustor Recuperator and Oil Heat Exchanger," IMECE2011-64176 (11 pages), Proceedings of the ASME 2011 IMECE, Denver CO, November 2011.
12. Thiagarajan, N., Kapsenberg, F., Narayanan, V., Bhavnani, S. H., and Ellis. C., 2011, "On the Lateral Motion of Bubbles Generated from Reentrant Cavities Located on Asymmetrically Structured Surfaces," Interpack2011-52056, ASME 2011 Pacific Rim Technical Conference and Exposition on Packaging and Integration of Electronic and Photonic Systems, Interpack 2011, Portland, OR, July 2011.
13. Mani, P., Cardenas, R., and Narayanan, V., 2011, "Submerged Jet Impingement Boiling on a Non-uniformly Heated Polished Silicon Surface," Interpack2011-52042, ASME 2011 Pacific Rim Technical Conference and Exposition on Packaging and Integration of Electronic and Photonic Systems, Interpack 2011, Portland, OR, July 2011.
14. Cardenas, R., and Narayanan, V., 2011, "Critical Heat Flux During Submerged Jet Impingement Boiling of Saturated Water at Sub-atmospheric Conditions," Interpack2011-52043, ASME 2011 Pacific Rim Technical Conference and Exposition on Packaging and Integration of Electronic and Photonic Systems, Interpack 2011, Portland, OR, July 2011.
15. Cardenas, R., Mani, P., and Narayanan, V., 2011, "Sub-atmospheric Mini-jet Impingement Boiling of Water Under Saturated and Subcooled Conditions," AJTEC2011-44388, Proceedings of the ASME/JSME 2011 8th Thermal Engineering Joint Conference, Honolulu, Hawaii, March 2011.
16. Eilers, B., Narayanan, V., Apte, S., and Schmitt, J., 2011, "Steam-methane Reforming in a Microchannel Under Constant and Variable Axial Surface Temperature Conditions," AJTEC2011-44390, the Proceedings of the ASME/JSME 2011 8th Thermal Engineering Joint Conference, Honolulu, Hawaii, March 2011.
17. Ghazvini, M., and Narayanan, V., 2011, "Performance Characterization of a Microscale Integrated Combustor, Recuperator Oil Heat Exchanger," AJTEC2011-44633, the Proceedings of the ASME/JSME 2011 8th Thermal Engineering Joint Conference, Honolulu, Hawaii, March 2011.
18. Drost, K., Eilers, B., Peterson, D., Apte, S., Narayanan, V., and Schmitt, J., 2011, "Detailed Numerical

Modeling of a Microchannel Reactor for Methane-steam Reforming," AJTEC2011-44664, the Proceedings of the ASME/JSME 2011 8th Thermal Engineering Joint Conference, Honolulu, Hawaii, March 2011.

19. Cardenas, R., Mani, P., and Narayanan, V., 2010, "Saturated Mini-Jet Impingement Boiling," FEDSM2010-ICNMM2010, ASME 2010 3rd Joint US-European Fluids Engineering Summer Meeting and 8th International Conference on Nanochannels, Microchannels, and Minichannels, Montreal, CA, August 2-4, 2010.
20. Peterson, D., Apte, S., Narayanan, V., and Schmitt, J., 2010, "Design of a Microchannel-Based Receiver and Development of Scalable Catalytic Microchannel Reactors for Biofuels Processing," ASME 2010 3rd Joint US-European Fluids Engineering Summer Meeting and 8th International Conference on Nanochannels, Microchannels, and Minichannels, Montreal, CA, August 2010.
21. Cardenas, R., and Narayanan, V., 2008, "A Numerical Study of Ammonia-water Absorption into a Constrained Microscale Film," IMECE2008-67021, 2008 IMECE, Boston, MA, November 2008.
22. Liburdy, J., Pence, D., and Narayanan, V., 2008, "Flow Boiling Characteristics in a Fractal-like Branching Microchannel Network," IMECE2008-69239, 2008 IMECE, Boston, MA, November 2008.
23. Krebs, D., Narayanan, V., Liburdy, J., and Pence, D., 2008, "Local Wall Temperature Measurements in Microchannel Flows using Infrared Thermography," Paper #HT2008-56253, ASME Heat Transfer Summer Conference, Jacksonville, FL, August 2008.
24. Shen, J., Liburdy, J., Pence, D., and Narayanan, V., 2008, "Single Droplet Impingement: Effect of Nanoparticles, Paper #FEDSM2008-55192, ASME Fluids Engineering Division Summer Conference, Jacksonville, FL, August 2008.
25. Cardenas, R., Jenks, J., Jo, M-C., and Narayanan, V., 2008, "Performance of a Microscale Film Bubble Absorber Under System Operating Conditions," ES2008-54125, ASME Energy Sustainability Conference, Jacksonville, FL, August, 2008.
26. Jo, M-C., and Narayanan, V., 2008, "Thermally-actuated Pumping by Rayleigh-Bernard Convection Using Surface Asymmetry," FEDSM2008-55118, ASME Fluids Engineering Division Summer Conference, Jacksonville, FL, August, 2008.
27. Jenks, J., and Narayanan, V., 2008, "Ammonia/Water Bubble Absorption into a Constrained Microscale Liquid Film," Paper no. HMTC-2008-HMT-15, 19th National and 8th ISHMT-ASME Heat and Mass Transfer Conference, JNTU Hyderabad, India, January 2008.
28. Kwak, Y., Pence, D., Liburdy, J., and Narayanan, V., 2007, "Liquid and Gas-Phase Velocity Measurements for Two-Phase Flow in a Branching microchannel network," Paper No. IMECE 2007-41621, Proceedings of the ASME International Mechanical Engineering Congress and Exposition, Seattle, Washington, USA, November 2007.
29. Jenks, J., and Narayanan, V., 2007, "Effect of Channel Geometry Variations on the Performance of a Microscale Bubble Absorber," Paper # HT2007-33445, Proceedings of the 2007 ASME-JSME Thermal Engineering Summer Heat Transfer Conference, Vancouver, British Columbia, Canada, July 2007.
30. Heymann, D., Kwak, Y., Edward, L., Narayanan, V., Liburdy, J., and Pence, D., 2007, "Void Fraction Analysis of Flow Boiling in a Microscale Branching Channel Network," Paper # HT2007-33517, Proceedings of the 2007 ASME-JSME Thermal Engineering Summer Heat Transfer Conference, Vancouver, British Columbia, Canada July 2007.
31. Narayanan, V., Kanury, A. M., and Jenks, J., 2007, "Modified Heat Exchanger Analysis Accounting for Heat Generation," Paper # HT2007-33444, Proceedings of the 2007 ASME-JSME Thermal Engineering Summer Heat Transfer Conference, Vancouver, British Columbia, Canada, July 2007.
32. Jenks. J., and Narayanan, V., 2006, "An Experimental Study of Ammonia-Water Bubble Absorption in a Large Aspect Ratio microchannel," Proceedings of 2006 ASME International Mechanical Engineering Congress and Exposition, Paper # IMECE2006-14036, Chicago, IL, November 2006.
33. Narayanan, V., and Patil, V. A., 2006, "Analysis of Temperature Fluctuations Induced by Slot Jet Impingement," Proceedings of the AIAA/ASME Summer Heat Transfer Conference, Paper # AIAA-2006-3267-305, San Francisco, CA, July 2006.

34. Patil, V. A., and Narayanan, V., 2005, "Measurement of Near-Wall Liquid Temperatures in Single Phase Flows Through Silicon Microchannels," 3rd International Conference on Microchannels and Minichannels (ICMM 2005), Toronto, Ontario, Canada, June 2005.
35. Narayanan, V., 2003, "Time-resolved thermal flow structures in impinging slot jet flows," HT2003-47493, Proceedings of the 2003 Summer Heat Transfer Conference, Las Vegas, Nevada, July 2003.
36. Narayanan, V., 2003, "Temperature measurements and surface visualization in microchannel flows using infrared thermography," Proceedings of the 1st International Conference on Microchannels and Minichannels, Ed. S. G. Kandlikar, Paper ICMM2003-1117, pp. 879-886, April 2003.
37. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 2001, "Experimental Flow Field and Heat Transfer Study of a Slot Jet Reattachment Nozzle Impinging on a Flat Plate," 2001 ASME IMECE, New York, NY, November 2001.
38. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 1998, "Representation of Local Heat Transfer Coefficient for Slot and Radial Jet Reattachment Nozzles," ASME Proceedings of the IMECE, Anaheim, CA, HTD-Vol. 361(1), pp. 229- 236, November 1998.
39. Alam, S. A., Seyed-Yagoobi, J., Narayanan, V., and Page, R. H., 1998, "Drying Characteristics of Slot Jet Reattachment Nozzles," Proceedings of the 11th International Drying Symposium, IDS '98, Halkidiki, Greece, Drying '98, Vol. A., pp. 565-572, August 1998.
40. Narayanan, V., Seyed-Yagoobi, J., Page, R. H., and Alam, S. A., 1997, "Effect of Exit Angle on the Heat Transfer Characteristics of a Slot Jet Reattachment Nozzle," ASME Proceedings of the 32nd National Heat Transfer Conference, Baltimore, MD, 1997, HTD-Vol. 347(9), pp. 119-127, August 1997.
41. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 1996, "Comparison of Heat Transfer Characteristics of a Slot Jet Reattachment Nozzle and a Conventional Slot Jet Nozzle," ASME Proceedings of the ICEME/WAM, Anaheim, CA, Vol. 2, pp. 151- 157, November 1996.
42. Seyed-Yagoobi, J., Narayanan, V., Page, R. H., and Wirtz, J. W., 1996, "Comparison of Heat Transfer Characteristics of Radial Jet Reattachment Nozzle to In-Line Impinging Jet Nozzle," ASME Proceedings of the 31st National Heat Transfer Conference, Houston, TX, HTD-Vol. 324, pp. 85-92, August 1996.

D3. Other Conference Publications

1. Abishek, S., Narayanaswamy, R., and Narayanan, V., 2012, "Effect of Standoff Distance on the Partitioning of Surface Heat Flux During Confined Subcooled Boiling of an Impinging Turbulent Water Jet," (4 pages), 18th Australian Fluid Mechanics Conference, Launceston, Tasmania, Australia, December 2012.
2. Cardenas, R., Mani, P., Narayanan, V., Dokken, C., 2012, "On the elimination of temperature overshoot during jet impingement boiling of highly wetting fluids," Paper 1466 (9 pages), ECI 8th International Conference on Boiling and Condensation Heat Transfer, Ecole Polytechnique Federale de Lausanne, Switzerland, June 2012.
3. Lightfoot, M. D. A., Narayanan, V., Kastengren, A., Schumaker, A., and Danczyk, S. A., 2012, " Development of Non-uniformities in Swirling Rocket Injectors," (12 pages), ILASS Americas, 24th Annual Conference on Liquid Atomization and Spray Systems, San Antonio, TX, May 2012; also report A264175, http://www.stormingmedia.us/26/2641/A264175.html
4. Lightfoot, M. D. A., Narayanan, V., Schumaker, S. A., Danczyk, S. A., and Eilers, B., 2011, "Injector-wall Interactions in Gas-centered Swirl Coaxial Injectors," JANNAF 8th Modeling and Simulation / 6th Liquid Propulsion / 5th Spacecraft Propulsion Joint Subcommittee Meeting, Huntsville, AL, December 2011.
5. Lightfoot, M. D. A., Danczyk, S. A., Eilers, B., Narayanan, V., Schumaker, S. A., 2011, "The Impact of a Single Wall on the Stability of the Spray Produced by a Gas-centered Swirl Coaxial Injector," ILASS Americas, 23rd Annual Conference on Liquid Atomization and Spray Systems, Ventura, CA, May 2011.
6. Narayanan, V., Lightfoot, M. D. A., Schumaker, S. A., Danczyk, S. A., and Eilers, B., 2011, "Use of Proper Orthogonal Decomposition Towards Time-resolved Image Analysis of Sprays," ILASS Americas, 23rd Annual Conference on Liquid Atomization and Spray Systems, Ventura, CA, May 2011.

7. Kwak, Y., Pence, D., Liburdy, J., and Narayanan, V., 2008, "Gas-Liquid Flows in Fractal-Like Branching Flow Networks," Engineering Conference International Heat Transfer and Fluid Flow in Microscale III, Whistler, BC, Canada, September 2008.
8. Heymann, D., Enfield, K., Pence, D., and Narayanan, V., 2008, "Gradient-Based Optimization of Single-Phase Microscale Fractal-like Branching Channel Heat Sinks," Engineering Conference International Heat Transfer and Fluid Flow in Microscale III, Whistler, BC, Canada, September 2008.
9. Graber, C., Shen, J., Liburdy, J., Narayanan, V., and Pence, D., 2008, "Simultaneous Droplet Impingement Dynamics and Heat Transfer using Nanofluids and Nanostructures," Engineering Conference International Heat Transfer and Fluid Flow in Microscale III, Whistler, BC, Canada, September 2008.
10. Krebs, D., Narayanan, V., Pence, D., and Liburdy, J., 2008, "Transient Surface Temperature Measurements during Flow Boiling in Microchannels," Engineering Conference International Heat Transfer and Fluid Flow in Microscale III, Whistler, BC, Canada, September 2008.
11. Atre, S. V., Jain, K., Wu, C., Kimura, S., Sprenkle, V., Jovanovic, G., and Narayanan, V., 2007, "Synthesis of Nanoparticles in High Temperature Ceramic Microreactors: Design, Fabrication and Testing," Proceedings of Acers/IMAPS 3rd International Conference and Exhibition of Ceramic Interconnect and Ceramic Microsystems Technology, April 2007.
12. Jain, K., Wu, C., Atre, S., Kimura, S., Sprenkle, V., Jovanovic, G., and Narayanan, V., 2007, "Design, Fabrication, and Testing of a Ceramic Microreactor for Nanoparticle Synthesis," Nano Science and Technology institute (NSTI) Bio Nano 2007 Conference, Santa Clara, California, May 2007.
13. Cullion, R., Pence, D. V., Liburdy, J. A., and Narayanan, V., 2006, "Void Fraction Variations in a Fractal-like Branching Microchannel Network," ECI International Conference on Boiling Heat Transfer, Spoleto, Italy, May 2006.
14. Tobias. J., and Narayanan, V., 2006, "Characterization of the Near-field Flow Structure of an Acoustically Self-Excited Jet Using PIV," 12th International Symposium on Flow Visualization, Paper # 92, German Aerospace Center, Gottingen, Germany, September 2006.
15. Narayanan, V., and Page, R. H., 2006, "Analysis of Surface Temperature Fluctuations in Reattaching Slot Jets," 12th International Symposium on Flow Visualization, Paper # 100, German Aerospace Center, Gottingen, Germany, September 2006.
16. Narayanan, V., and Patil, V. A., 2005 "Temperature Measurement In Internal Microscale Flows Using Infrared Thermography," ECI Conference on Heat Transfer and Fluid Flow in Microscale, Castelvecchio Pascoli, Barga, Lucca, Italy, September 2005.
17. Enfield, K., Pence, D. V., and Narayanan, V., 2005, " Optimization of Single Phase Microscale Fractal-Like Branching Flow Heat Sinks," ECI Conference on Heat Transfer and Fluid Flow in Microscale, Castelvecchio Pascoli, Barga, Lucca, Italy, September 2005.
18. Narayanan, V., Seyed-Yagoobi, J., and Page, R. H., 2002, "Combined Fluid Mechanics and Heat Transfer Measurements in Normally Impinging Slot Jet Flows," Proceedings of the 5th International Symposium on Engineering Turbulence Modelling and Experiments - 5, W. Rodi and N. Fueyo, Eds., Mallorca, Spain, pp. 495-504, September 2002.

D4. Submissions in review

1. Cardenas, R., and Narayanan, V., "A Generalized Critical Heat Flux Correlation for Jet Impingement Boiling," under consideration upon revision, ASME Journal of Heat Transfer, May 2013
2. Strid, L., Thiagarajan, N., Narayanan, V., Bhavnani, S. H., and Linke, H., "Self-propelled Slug Flow in an Open Channel Using Asymmetrically Textured Surfaces," submitted to Applied Physics Letters, January 2013.
3. Kapsenberg, F., Strid, L., Thiagarajan, N., Narayanan, V., and Bhavnani, S. H., "On the Lateral Fluid Motion During Pool Boiling via Asymmetrically Located Cavities," submitted to Applied Physics Letters, January 2013.

4. Thiagarajan, N., Strid, L., Narayanan, V., and Bhavnani, S. H., "Bubble Growth During Pool Boiling of FC-72 on Asymmetric Silicon Micro-structured Surfaces with Re-entrant Cavities," submitted to International Journal of Heat and Mass Transfer, October 2013.
5. Bhavnani, S. H., Narayanan, V., Qu, W., Jensen, M., Kandlikar, S., Kim, J., and Thome, J., "Boiling Augmentation with Micro- and Nano-structured Surfaces-Current Status and Research Outlook," opinion paper based on the International Workshop on Micro- and Nano-structured surfaces for Phase Change Heat Transfer, MIT Endicott House, Boston, invited submission to Journal of Nanoscale and Microscale Thermophysical Engineering, November 2013.

D5. Invited Seminars and Talks

1. University of Wisconsin, Madison, Lindbergh Lecture, "Self-propelled Fluid Motion in Pool and Open Channel Configurations during Boiling Heat Transfer," November 7th 2013.
2. NASA Johnson Space Center, Houston, TX, "Surface Asymmetry Effects on Boiling and Condensation," October 23rd 2013 (with S. H. Bhavnani)
3. Worcester Polytechnic Institute, Worcester, MA, "Thermal Transport in Microchannels," April 24th 2013.
4. University of Nevada, Reno, Nevada, "Mini Jet Impingement Boiling Thermal Management," April 5th 2013.
5. Oregon NASA Space Grant Affiliates Meeting, Portland, OR, 2011, "Thermally-actuated Phase Change Pumping Using Passive Surface Modifications," September 9th 2011.
6. Portland State University, Portland, Oregon, "High Flux Thermal Management Using Jet Impingement Boiling," April 1st 2011.
7. Air Force Research Laboratory, Edwards Air Force Base, California, "Characterization of Spray-wall Interactions in a Gas-Centered Swirl-Coaxial Atomizer," August 31st 2010 (with Benn Eilers).
8. Micro-Nano Technology and Engineering Development Workshop, Corvallis, Oregon, "Heat Transfer and Energy Transformation in Microchannels", co-organized by the ONAMI Microproducts Breakthrough Institute and OSU, 2009.
9. GE Global Research Division, Bangalore, India, "Enhancement of Mixing and Thermal transport Using Passive Methods and Microscale Flows," June 21, 2007.
10. Illinois Institute of Technology, Chicago, Illinois, "Quantitative Characterization of Microchannel Heat and Mass Transfer," November 8, 2006
11. Wieland Werke, Ulm, Germany, "Quantitative Characterization of Heat and Mass Transfer in Macro- and Micro-scales," September 15, 2006.
12. Technical University, Braunschweig, Germany, "Overview of Microscale Heat Transfer Research Activities at Oregon State University," September 8, 2006.
13. InFocus Corporation, Wilsonville, OR, "Jet Impingement Cooling/Electronics Cooling", December 2001.

D6. Participation at Invitational Workshops

1. One of three moderators for the Boiling session and Breakout session lead- International Conference on Nano and Micro Structures for Phase-change Heat Transfer, MIT Endicott House, Boston, MA, April 22-23 2013.
2. Presenter on the topic , "Heat Transfer and Energy Transformation in Microchannels", at the Micro-Nano Technology and Engineering Development Workshop, co-organized by the ONAMI Microproducts Breakthrough Institute and OSU, July 23 2009.
3. Participant, "ASME Nanotechnology Bootcamp," Northwestern University, Evanston, Illinois, July 8-11, 2003.

4. Participant, "New Century Scholars- Teaching, Learning, and Your Academic Career," Workshop, sponsored by NSF, Stanford University, Stanford, California, July 28-August 2, 2002.
5. Participant, Workshop on Design of Experiments, Air Academy Associates, Colorado Springs, CO, August 16-19, 2002.
6. Participant, Graduate Teaching Academy Workshop (2 semester workshop), Fellow of the Texas A&M University Graduate Teaching Academy, 1999.

D7. Poster Presentations at Workshops and Conferences (presenter indicated in *italics*)

1. *Rasouli, E.*, L'Estrange, T., Truong, E. D., Rymal, C., Narayanan, V., Apte, S. V., and Drost, M. K., 2013, "High Flux Microchannel Solar Receivers," Oregon Built Environment and Sustainable Technologies (Oregon BEST) Center FEST, September 11-12 2013.
2. *Ghazvini, M.*, and Narayanan, V., 2013, "Ultra-compact and Efficient Heater," Oregon Built Environment and Sustainable Technologies (Oregon BEST) Center FEST, September 11-12 2013.
3. *Narayanan, V., and Bhavnani, S. H.*, 2013, "Lateral Fluid Motion During Boiling Via Surface Microtexturing," International Workshop on Micro and Nanostructures for Phase Change Heat Transfer, MIT Endicott House, Dedham, MA, April 22-23 2013.
4. *Narayanan, V.,* 2012, "0748249: CAREER: Enhanced Two Phase Thermal Management Using Flow Oscillations at the Microscale," NSF CBET Conference, Baltimore, MD, June 6-7, 2012.
5. *Narayanan, V., and Bhavnani, S. H.*, 2012, "Collaborative Research: Thermally Actuated Pumping Mechanism During Boiling on an Asymmetrically Structured Surface," NSF CBET Conference, Baltimore, MD, June 6-7, 2012 .
6. Cardenas, R., Mani, P., *Narayanan, V.*, and Dokken, C., 2012, "On the elimination of temperature overshoot during jet impingement boiling of highly wetting fluids," Paper 1466, ECI 8th International Conference on Boiling and Condensation Heat Transfer, Ecole Polytechnique Federale de Lausanne, Switzerland, June 3-7, 2012.
7. Jenks, J., and *Narayanan, V.,* 2008, "Ammonia/Water Bubble Absorption Into a Constrained Microscale Liquid Film," Paper no. HMTC-2008-HMT-15, 19th National and 8th ISHMT-ASME Heat and Mass Transfer Conference, JNTU Hyderabad, India, January 3-5, 2008.
8. *Narayanan, V.*, Linke, H., Taormina, M., and Jo, M-C., 2008, "Visualization of Thermally Actuated Pumping by Surface Asymmetry," Heat Transfer Photogallery, Boston MA, Oct. 31-Nov. 8, 2008.
9. Patil, V. A., and *Narayanan, V.*, 2005, "Spatially-Resolved Temperature Measurement in External and Internal Microscale Flows," Poster paper, 2005 Micro Nano Breakthrough Conference, Portland State University, July 26-28 2005.
10. *Narayanan, V.*, Seyed-Yagoobi, J., Page, R. H., Heat Transfer Picture Gallery, IMECE 2002, New Orleans, Louisiana, Nov. 17-21, 2002.
11. *Narayanan, V., Alam, S. A.*, and Seyed-Yagoobi, J., Heat Transfer Picture Gallery, IMECE 1997, Dallas, Texas, Nov. 16-21, 1997.

E. Grant and Contract Support

E1. Externally Funded Proposals (total Narayanan share of ~$2M)

1. PI, "Materials and Fabrication Research for Next Generation Supercritical CO_2 boilers and Heat Exchangers," URS Energy and Construction Inc. (on behalf of National Energy Technology Laboratory), co-PIs: Kevin Drost (OSU), Omer Dogan, Paul Jablonski (NETL), $89,000, December 1st 2014-November 1st 2014.
2. Partner Investigator, "The phenomenology of unsteady impinging jets: fluid dynamics and heat transfer," with Lucey, T., Narayanaswamy, R., Jewkes, J., and Chung, Y. M., Total: AU $260,000, 2013-2015 (Narayanan share- ~$8000 for visit to Curtin through the International Collaboration Award)

3. PI, "Enabling self-propelled condensate flow during phase-change heat rejection using surface texturing," with S. H. Bhavnani, Auburn University, *NASA Early Stage Innovation Award*, January 2013-December 2014, Total: $499,749 over two years (Narayanan share:~$258,600)
4. Co-PI (Technical lead at OSU), "High Flux Microchannel Solar Receiver Development with Adaptive Flow Control," with K. Drost (PI, OSU), S. Apte (OSU), R. Wegeng (PNNL), and P. Humble (PNNL), *Department of Energy Sunshot Concentrated Solar Power R&D*, August 2012-July 2014, Total: $1,000,243 (Narayanan share: ~$300,000)
5. NASA Fluid Physics microgravity flight experiment- May 3-4, 2012 (Narayanan share $0)
6. PI, "Collaborative Research: Thermally Actuated Pumping Mechanism During Boiling on an Asymmetrically Structured Surface," with Sushil Bhavnani, Auburn University, *National Science Foundation***,** June 01st 2009- May 31st 2013, Total: $185,378 (Narayanan share: $101,101)
7. PI, "Boiling Heat Transfer Mechanism During Thermally Actuated Pumping by Asymmetric Surface Structures," with Sushil Bhavnani, Auburn University, *NASA Fluid Physics Division*, June 01st, 2009- September 30, 2013, Total: $185,000 (Narayanan share: $97,791)
8. PI, "CAREER: Enhanced Two-phase Thermal Management Using Self-sustained Flow Oscillations at the Microscale," *National Science Foundation*, Award ID # 0748249, June 15th 2008 – May 31st 2013, Total: $400,001 (Narayanan share: $400,001)
9. PI, REU for "CAREER: Enhanced Two-phase Thermal Management Using Self-sustained Flow Oscillations at the Microscale," 2009, $5,000, *National Science Foundation*
10. Co-PI, "Microscale Enhancement of Heat and Mass Transfer for Hydrogen Energy Storage", with Kevin Drost (PI), Goran Jovanovic, Brian Paul, and Joe Zaworski, *Department of Energy***,** member of the *Hydrogen Storage Engineering Center of Excellence*, June 2011- May 2015, Total: $2,048,935 (Narayanan share: $535,000)
11. PI, "Microchannel Reactor for Optimal Production of Solar Fuels," with S. Apte, US Army through the *ONAMI TES Program*, July 2010-June 2011, Total: $96,116 (Narayanan share: ~50,000).
12. Co-PI, "Design and Control of a Microchannel-based Solar Receiver and Development of Scalable Catalytic Microchannel Reactors for Biofuels Processing," with Sourabh Apte (PI), John Schmitt, Chih-hung Chang, and Brian Paul $75,000 (Narayanan share: $12,000), *Oregon BEST Center*
13. Co-PI (with Dave Johnson (PI), Deborah Pence, James Liburdy, and Richard Peterson), "Characterization of Spray Cooling Enhancement Using Nanofluids and Nanostructures," *ARO/CERDEC ONAMI Nanotechnology Center* Proposal, November 2006- Summer 2008, Total: $262,702 (Narayanan share ~ $70,000).
14. Task PI (Project Manager: Kevin Drost), "Development and Characterization of a 2 kW Bubble Plate Absorber," part of the Tactical Energy Systems Development proposal, *US Army*, Grant No. W909MY-06C0052, technical monitor: CECOM located at Ft Belvoir, February 2007 – September 2008 (Narayanan share: $101,155).
15. Task PI (Project Manager: Kevin Drost), "Development of a Validated Model for a Microchannel Bubble Plate Ammonia/Water Absorber,", part of the Tactical Energy Systems Development proposal, *US Army*, Grant No. W909MY-06C0052, technical monitor: CECOM located atFt. Belvoir, January 2007 - September 2008 (Narayanan share: $22,847).
16. co-PI (with Sundar Atre, Shoichi Kimura, Goran Jovanovic, and Jim Hutchinson (PI)), "Environmentally Conscious Bulk Production and Processing of Ceramic Nanoparticles: An Integrated Approach ," part of the *Safer Nanomaterials and Nanomanufacturing Initiative*, Air Force Research Laboratory, 09/05 - 12/07; Total: $140,000 (no expenditure charged by Narayanan).
17. Task PI (Project Manager: Kevin Drost), "Concept Validation of a Mechanically-Constrained Bubble Plate NH_3/H_2O Absorber," part of the Tactical Energy Systems Proposal, *US Army*, Grant No. W909MY-05C0024, technical monitor: CECOM located at Ft Belvoir, June 2005 – May 2007; (Narayanan share: $102,571).
18. Co-PI (with Deb Pence (PI) and Jim Liburdy), "Characterization of Convective Boiling in Branching

Channel Networks," *Office of Naval Research*, October 2005 - September 2008; Total: $493,301 (Narayanan share ~164,000)

19. Task PI (Project Manager: Kevin Drost), "Microscale Droplet Desorber Development for LiBr/H_2O Heat Actuated Heat Pump," part of the proposal titled Heat Actuated Heat Pump Development For Soldier Cooling Applications, Natick Soldier Systems Center, *US Army*, September 2002 - August 2003; (Narayanan share: $113,446).

E2. Grant Awards Internal to OSU (total Narayanan share of $286,980)

1. PI, "PetiteXtreme- An Ultra-compact Cooker and Heater," OSU Venture Development Fund, $120,880, November 15th 2013- October 30th 2014.
2. PI, "High-speed, High-sensitivity camera," OSU Research Office, Research Equipment Reserves Fund Fall 2009 Competition, $21,675, December 2009.
3. co-PI (with Sourabh Apte and John Schmitt), "Multimode, Multiphase, Multicomponent Heat Transfer in Oxy-fuel Combustors: Modeling and Experiments," OSU School of Mechanical, Industrial and Manufacturing Engineering Seed Grant, $25,000 (VN share ~ 8,000), December 2007-November 2008.
4. PI, "High-Frequency Infrared Detector System", OSU Research Office, Research Equipment Reserves Fund Fall 2005 Competition, $10,710, November 2005.
5. PI, "CCD Camera and Integration Module for Measurement of Scalar Transport at the Microscale," OSU Research Office, Research Equipment Reserves Fund Fall 2003 Competition, $ 38,720, November 2003.
6. PI, "Dual-head Nd:YAG Laser System and Digital Delay Generator," OSU Research Office, Research Equipment Reserves Fund Fall 2002 Competition, $ 24,400, November 2002.
7. PI, "Microscope System for an Infrared Radiometric Imaging System," OSU Research Office, Research Equipment Reserves Fund Spring 2002 Competition, $17,750, April 2002.
8. PI, "Radiometric Infrared Temperature Imaging System with Live Digital Imaging Recorder," OSU Research Office, Research Equipment Reserves Fund Fall 2001 Competition, $44,845, November 2001.

F. University Service

F1. University-level Service

1. Associate Director of Thermal Energy Systems, Microproducts Breakthrough Institute, 2013-current
2. Member of Search Committee, Associate Dean of Graduate School, 2012
3. Member of Search Committee, Director of Academic Programs, Assessment and Accreditation, 2012
4. OSU Graduate Council, Member 2008-12
5. Judge, University Honors College Thesis Fair, 2008, 2009
6. OSU Research Council, Member 2007-08
7. Faculty Panels for Hearing Committees, Alternate member (Committee B), Fall 2004-06
8. Graduate Council Representative on several MS and PhD committees
9. Reviewer for Oregon NASA Space Grant Scholarships

F2. School-level Service

1. Mechanical Engineering Program ABET co-ordinator, May 2009-present
2. Mechanical Engineering Undergraduate Program Committee, 2009-10
3. Awards Committee, Chair, 2006 – 2008; Member, 2005 - 2006
4. Search Committee, Thermal-Fluid Sciences, February-May 2005, April-May 2004
5. Space Use Committee, Fall 2004 – August 2005
6. Search Committee, Mechanical Engineering Operations Manager; Fall 2004
7. Equipment Committee, Chair from 2002 to 2003; Member from 2001 to 2002.

G. Students Supervised (past and current)

Graduate Students

Completed: Kurt Fackrell (MS), Vishal Patil (MS), Jason Tobias (MS), Jeromy Jenks (MS), Daniel Krebs (MS), Myeong Chan Jo (MS), Christof Graber (MS, with Dr. D. V. Pence), Ruander Cardenas (MS), Benn Eilers (MS, with Dr. S. Apte), Florian Kapsenberg (MS), David Haley (MS), Ruander Cardenas (PhD), Mohammad Hadi Tabatabee (MEng), Preeti Mani (PhD), Mohammad Ghazvini (PhD), Logan Strid (MS)

Current: Mohammad Ghazvini (Post-Doctoral researcher); Bryan Kilgore (MS, expected March 2014), Aaron Wilson (MS, expected September 2014), Erfan Rasouli (PhD, expected December 2014), Shashank Natesh (PhD, expected September 2016), Danylo Oryshchyn (PhD, since September 2012), Thomas L'Estrange (MS, since summer 2013)

Associate Supervisor at Curtin University of Technology, Perth, Australia for: Abishek Sridhar (expected December 2013), Thangam Natarajan (beginning September 2013), Vishal Chaugule (beginning September 2013)

Undergraduate Honors Theses Students: Completed- Stephen Sedler (2009), Eric Truong (2013)

Current- Mitchell Daniels (expected 2014), Eric Walters (expected 2014)

H. Teaching

H1. Courses Taught (past and current)

1. Mechanical Engineering Laboratory-senior undergraduate, writing intensive (taught 4 times; Fall 2001-Fall 2004)- 4 credit, lecture/lab
2. Introduction to Instrumentation and Measurement Systems, senior undergraduate (taught 1 time; Fall 2007)- 4 credit, lecture/lab
3. ME 332 Heat Transfer- junior undergraduate (taught 7 times; Winter 2003-ongoing)- 4 credit lecture; taught an Honors section of 332 in Fall 2012
4. Instrumentation- senior/1st year graduate level (taught 4 times; Winter 2002- Winter 2005)- 3 credit, lecture/lab
5. ME 452 Thermal and Fluid Sciences Laboratory- senior undergraduate elective (taught 6 times; Winter 2006-ongoing)- 4 credit lecture/lab
6. ME 552 Measurements in Heat Transfer and Fluid Mechanics- graduate (taught 3 times); 4 credit lecture/lab
7. ME 546 Convective Heat Transfer- graduate (taught 5 times; Fall 2007-ongoing); 3 credit lecture
8. ME 549 Special Topics in Heat Transfer- Simultaneous Heat and Mass Transfer (taught 2 times; Spring 2002, Spring 2008)
9. ME 549 Special Topics in Heat Transfer- Thermophysics of Phase Change Heat Transfer (Spring 2011, Fall 2012)
10. ME 499 Solar Energy two-week module for the Renewable Energy senior level ME course (Spring 2012)
11. Advisor for ten capstone senior design projects from 2001-2011

H2. Teaching Evaluations over the past 5 years

Course No.	Term	Enrollment	# Responding	Student Evaluation (#1/#2)	College Averages[@] (#1/#2)	Δ	Required /Elective
ME 452	W09	16 (Lec) 12 (Lab 1) 4 (Lab 2)	16	5.1/5.2	4.5/4.8	+0.6/+0.4	E
ME 552	W09	9 (Lec) 9 (Lab)	9	4.9/5.1	5.0/5.2	-0.1/-0.1	R
ME/NE 332	S09	65	22	4.1/4.0	4.4/4.8	-0.3/-0.8	R
ME 546	F09	14	12	5.3/5.3	4.7/4.9	+0.6/+0.4	R
ME 452	W10	13 (Lec)	10	5.5/5.5	4.5/4.8	+1.0/+0.8	E

		13 (Lab)					
ME 552	W10	16 (Lec) 16 (Lab)	15	4.5/5.1	5.0/5.3	-0.5/-0.2	R
ME/NE 332	S10	69	40	4.3/4.6	4.6/4.9	-0.3/-0.3	R
ME 546	F10	23		5.1/5.0	4.9/5.2	+0.2/-0.2	R
ME 452	W11	30 (Lec) 15 (Lab 1) 15 (Lab 2)	23	5.0/5.1	4.6/4.9	+0.4/+0.2	E
ME 552	W11	12 (Lec) 12 (Lab)		Data missing	4.6/4.9		R
ME 549	S11	6	5	5.0/5.3	5.0/5.2	0.0/+0.1	E
ME 452	W12	20 (Lec) 12 (Lab)	18	5.1/5.7 5.0/5.5	4.6/4.8	+0.45/+0.8	E
ME 452H	W12	8 (Lab)	8	4.2/4.5[+]			E
ME 552	S12	16 (Lec) 16 (Lab)	14	5.2/5.3	4.7/4.9	+0.5/+0.4	R
ME 546	S12	12	11	5.2/5.5	4.7/4.9	+0.5/+0.6	E
ME 499[*]	S12	15	10	5.0/4.9	4.7/4.9	+0.3/0.0	E
ME/NE 332H	F12	11	11	5.6/5.7	4.6/4.8	+1.0/+0.9	R
ME 499[*]	S13	25	16	4.8/4.5			E

*ME499- Special topics- Renewable Energy Systems- I taught the Solar Thermal module of this team-taught course

H- denotes Honors section of classes

[+] Honors course evaluation is on a different scale of 1- strongly disagree; 2- disagree; 3- neither agree nor disagree; 4- agree; and 5 – strongly agree. Average rating was 4.2; On the question of "The professor was dedicated to teaching and Honors level learning, the SET was 4.5.

H3. Course and Curriculum Development

Over the past 12 years at OSU, I have been involved in significant curriculum development as summarized below.

H3.1 New course and lab development: (Courses that did not exist at OSU)

1. ME 549- Special Topics in Heat Transfer- Simultaneous Heat and Mass Transfer
2. ME 549- Special Topics in Heat Transfer- Thermophysics of Phase Change Heat Transfer
3. ME 552- Measurements in Fluid Mechanics and Heat Transfer
4. ME 452- Thermal and Fluid Sciences Laboratory
5. ME 499- Renewable Energy Technologies – This is a team taught class. I developed only the Solar Thermal module of this course

H3.2 Significant course development:

1. ME 451 Mechanical Laboratory- A new section on Design of Experiments (DoE) was added to ME 451 in Fall 2002. This involved attending a workshop on DoE, creating new lecture notes, designing a new experiment and working closely with industry experts in this field.
2. ME 546 Convection Heat Transfer- course notes
3. ME 452/552 Instrumentation- course notes and new lab experiments, ABET course co-ordinator
4. ME 332 Heat Transfer- course notes and design projects, ABET course co-ordinator

H3.3 Broader participation on curricular issues within MIME and OSU

Within the School, I have been on the Undergraduate Program Committee (UPC) for a year and have been the ABET coordinator for the ME program over the past three years. In the latter role, I am in charge of

summarizing and interpreting exit student survey and alumni surveys and compiling reports on the perception of the program in the eyes of the above stakeholders. I work with the UPC to present results and we jointly suggest ways to address deficiencies cited in the reports.

At the University level, I was a member of the Graduate Council for four years (2008-12) representing the College of Engineering. In this role, I was involved with the following major activities

- Review of Category I and category II proposals relevant to graduate studies
- Review and follow-on review of graduate programs
- Evaluation of scholarships for graduate students
- Evaluation of awards relevant to graduate education for faculty
- Development of Graduate student Learning Objectives (GLOs) for MS and PhD students
- Member of search committees at the University level for opening relevant to the Graduate School
- Providing input on graduate education towards the University's accreditation

H3.4 Team or Collaborative Efforts

1. Partnered with Infocus professionals to incorporate design of experiments in ME 451 curriculum (Summer – Fall 02)
2. Team taught ME499 Renewable Energy Technologies with Professors Liburdy, Pence and Sharp in 2012 and 2013.
3. Participated in the Thermal and Fluid Sciences seminar series including attending seminars and inviting guest speakers from industry and academia.