Michael B. Pate
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EDUCATION

Ph.D. Mechanical Engineering, Purdue University, 1982
M.S. Mechanical Engineering, University of Arkansas, 1978
B.S. Naval Engineering, United States Naval Academy, 1970

ACADEMIC EXPERIENCE

Director, Riverside Energy Efficiency Laboratory, 2008-Present
Associate Director, Energy Systems Laboratory, 2008-Present
Professor, Mechanical Engineering, Texas A&M University, 2008 – Present
Director, Center for Building Energy Research, Iowa State University, 2000-2008
Professor, Mechanical Engineering, Iowa State University, 1990-2008
Associate Professor, Mechanical Engineering, Iowa State University, 1987-1990
Assistant Professor, Mechanical Engineering, Iowa State University, 1982-1987

INDUSTRIAL AND CENTER EXPERIENCE

Director of Riverside Energy Efficiency Laboratory (REEL), Texas A&M University. 2008-Present
A major university laboratory within the College of Engineering's Energy Systems Laboratory (ESL) organization. REEL focuses on research and testing of a wide range of HVAC and building energy technologies. The laboratory has extensive flow chamber facilities for evaluating the performance of residential and commercial sized fans, a reverberation chamber for evaluating the sound performance of HVAC equipment, and large-size psychrometric rooms for testing HVAC units up to 10 tons. The laboratory employs 2 to 3 full-time staff and up to 12 graduate and undergraduate students. Annual laboratory funding from all external sources is about $900,000.

Past Director and Co-founder of Center of Building Energy Research (CBER), Iowa State University. 2000-2008
A major university center focusing on all aspects of building energy issues with participation from colleges throughout ISU, including Engineering, Architecture, Agriculture, Business. Responsible for more than a million dollars of projects by CBER affiliates.

Engineer, Advanced Reactor Systems Department, General Electric, Sunnyvale, CA, 1981-1982
Analyzed two-phase thermal hydraulic transients in power plants. Modeled steam systems, spray cooling in steam drums and steam turbine startup.

Nuclear Submarine Officer, U.S. Navy, 1970-1975
Supervised and coordinated the operation, testing and maintenance of steam power plants, nuclear reactor plants, refrigeration units, distilling plants, oxygen generators, atmospheric burners and scrubbers, air compressors, hydraulic equipment and various other mechanical systems aboard a nuclear-powered submarine.

RESEARCH AREAS OF INTEREST

Energy Conservation and Efficiency---HVAC systems and components, compressed air systems, industrial processes, instrumentation

Green Building Technology and Sustainability---building envelopes, net-zero energy buildings, building energy computer models

Heat Transfer and Heat Exchangers---nano-particle refrigerant mixtures, capillary-tube two-phase flow, enhanced tubes and heat transfer, evaporators and condensers

Thermal Processes and Refrigeration Properties---transport properties, thermal properties, solubility/viscosity of refrigerant/oil mixtures

Alternative Energy--- photovoltaics, passive and active solar, wind systems, geothermal, biomass, nuclear energy

HONORS AND AWARDS

Distinguished Service Award, ASHRAE 2022
ME Professor of the Year Award, 2007
Louis Thompson Distinguished Undergraduate Teaching Award, University, 2006
Superior Engineering College Teacher Award 2005
Engineer's Week Outstanding Professor Award 2004
Outstanding Professor Award, Engineering Leadership Council 2004
Outstanding Faculty Member at Greek Week Recognition (2002, 2003, 2004)
ME Professor of the Year Award 2003
Best ASHRAE Technical Paper Award 1996
Best ASHRAE Symposium Paper Award 1996
Engineering College Outstanding Young Researcher Award, August 1992

ACADEMIC AREAS OF SPECIALIZATION

Courses Taught at Iowa State University (1982-2008)

HON 322	Poetry and Conceptual Design
ME 231	Engineering Thermodynamics I
ME 332	Engineering Thermodynamics II
ME 335	Fluid Flow
ME 423	Creativity and Imagination for Engineering and Design
ME 436	Heat Transfer
ME 440	Principles of Heating and Air Conditioning
ME 433	Alternative Energy Conversion
ME 441	Refrigeration and Air Conditioning
ME 442	Heating and Air Conditioning Design
ME 443	Compressed Air Systems
ME 460	Experimental Engineering
ME 536	Advanced Heat Transfer
ME 636	Conduction Heat Transfer
ME 637	Convection Heat Transfer
ME 638	Radiation Heat Transfer
ME 639	Two-Phase Flow and Heat Transfer

Courses Taught at Texas A&M University (2008-present)

MEEN 315	Principles of Thermodynamics
MEEN 436	Principles of Heating, Ventilating and Air Conditioning
MEEN 437	Principles of Building Energy Analysis
MEEN 469	Alternative Energy Conversion (undergraduate)
MEEN 489	Compressed Air Systems
MEEN 489/689	Alternative Energy Conversion
MEEN 421	Thermo-Fluid Analysis and Design
MEEN 662	Energy Management in Industry
MEEN 669	Alternative Energy Conversion (graduate)
MEEN 435	Compressed Air Systems

Course Development (Created and Taught)

ME 436 (ISU) – Heat Transfer Laboratory (1999)

Co-organizer (with Ron Nelson) of laboratory setups, manuals, and assignments for the laboratory component of ME 436 Heat Transfer in which was introduced Fall 1999.

ME 433 (ISU) – Alternative Energy Conversion (2002)

Introduced new technical elective course in Fall 2002 that covers fundamentals, design and analysis of non-fossil type energy conversion techniques including fuel cells, wind power generation, nuclear fission and fusion, hydroelectric, tidal and wave energy conversion, geothermal, bioenergy, etc. (Steady enrollment of 100 students).

ME 443 (ISU) – Compressed Air Systems (2002)

Introduced new technical elective course in Spring 2002 that covers fundamentals, design and analysis of compressed air systems and components such as compressors, heat exchangers, dryers, filters, receivers, regulators, etc. (Steady enrollment of 60 to 80 students).

HON 322 (ISU) – Poetry and Conceptual Design (2006)

Introduced Honors Seminar course for honor students. Course focuses on using poetry writing exercises to promote creativity that can be used in conceptual design

ME 423 (ISU) – Creativity and Imagination for Engineering and Design (2007)

Introduced new technical elective course in Spring 2007 that uses creative arts, brain theory and psychology to promote and teach creativity and imagination for applications to problem solving, invention and design. (steady enrollment of 50 to 70 students)

MEEN 489/689 (Texas A&M) – Alternative Energy Conversion (2009)

Introduced special topic dual listed course (undergraduate and graduate) in Fall 2009 that covered a wide range of non-fossil fuel-based energy topics, taught for 3 years running and then again in Fall, 2015.

MEEN 469/669 (Texas A&M) – Alternative Energy Conversion (2016)

Introduced new technical elective course in Fall 2016 that covers fundamentals, design and analysis of non-fossil type energy conversion techniques including fuel cells, wind power generation, nuclear fission and fusion, hydroelectric, tidal and wave energy conversion, geothermal, bioenergy, etc. (Steady enrollment of 100 students).

MEEN 489 (Texas A&M) – Compressed Air Systems (2020)

Introduced new technical elective course in Fall 2020 that covers fundamentals, design and analysis of compressed air systems and components such as compressors, heat exchangers, dryers, filters, receivers, regulators, etc. (second enrollment of 49 students).

MEEN 435 (Texas A&M) – Compressed Air Systems (2022)

Technical elective course taught for the last two years as MEEN 489 has been accepted as permanent course MEEN 435 in the 2022-2023 University Catalog (see description above).

GRANTS AND CONTRACTS

1. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $890,200., Sponsor: HVI, Energy Star Program, and HVAC industries, Jan 1, 2022-Dec 31, 2023
2. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $943,400., Sponsor: HVI, Energy Star Program, and HVAC industries, Jan 1, 2021-Dec 31, 2021
3. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $1,268,289., Sponsor: HVI, Energy Star Program, and HVAC industries, Jan 1, 2020-Dec 31, 2020
4. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $555,237, Sponsor: HVI, Energy Star Program, and HVAC industries, Jan 1, 2019-Dec 31, 2019
5. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $807,730, Sponsor: HVI, Energy Star Program, and HVAC industries, Jan 1, 2018-Dec 31, 2018
6. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $867,016, Sponsor: HVI, Energy Star Program, and HVAC industries, Jan 1, 2017-Dec 31, 2017
7. Principal Investigator, " A capture Efficiency Test Faculty Based on Carbon Dioxide Monitoring", $25,000 HVI, June 1,2017 to Jan 31, 2018
8. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", $732,580, Sponsor: HVI, Energy Star Program, and HVAC industries, 2016.
9. Co-Principal investigator, "Molecular Membrane Air Conditioner/Dehumidifier", $2,877,669 (prorated share $959,223), DOE ARPA-E Program, April, 2016-April, 2018 (PI: Dr. Culp, and co-PIs: Dr. Claridge and Dr. Pate).
10. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", Home Ventilating Institute (HVI), $43,335, Energy Star Program, $85,525, and miscellaneous industries $367,440 (total $495,300), 2015.
11. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", Home Ventilating Institute (HVI), $41,200, Energy Star Program, $59,420, and miscellaneous industries $293,200 (total $393,820), 2014.
12. Co-Principal Investigator, "Novel Membrane Dehumidification-Enabled Air Cooling", ADMA Products, Inc., $320,000, 1-year project, May, 2013 to July, 2014.
13. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", Home Ventilating Institute (HVI), $42,900, Energy Star Program, $77,240, and miscellaneous industries $315,220 (total 435,360) 2013.
14. Principal Investigator, "Develop Alternate Setup Guidelines for Unitary Air Conditioners which cannot Adhere to ASHRAE 37/ASHRAE 116 Specified Duct Dimensions and External Pressure Tap Locations", ASHRAE, $93,440. 1-year project, April, 2012 to March, 2013.
15. Principal Investigator, "Duct Deflection Investigation for Spiral Ducting", Spiral Duct Manufactures Association (SPIDA), $96,200, 1 year project, May, 2012.
16. Co-Principal Investigator, "Dehumidification Membrane ERV/Air Conditioning System Development", PNNL - DOE Pacific Northwest National Laboratory, $200,000, Oct, 2011 to April, 2013.
17. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", Home Ventilating Institute (HVI), $33,800, Energy Star Program, $41,900, miscellaneous industries $220,800 (Total $296,500), 2012.
18. Principal Investigator, "HVAC Performance Studies and Sound Evaluations, Home Ventilating Institute (HVI), $37,200, Energy Star Program, $50,680, miscellaneous industries $350,600 (Total $446,480), 2011.
19. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", Home Ventilating Institute (HVI), $78,400, Energy Star Program, $22,850, miscellaneous industries $358,200 (Total $459,450), 2010.
20. Principal Investigator, "HVAC Performance Studies and Sound Evaluations", Home Ventilating Institute (HVI), $29,300, Industrial/manufacturers $194,600 (Total-223,900), 2009.
21. Co-Principal Investigator, "Solar Decathlon," US Department of Energy, $250,000, January 2008 to December 2009.
22. Co-Principal Investigator, "An Innovative Drying System for DDGS in Ethanol Production," SBIR United States Department of Agriculture, $48,500, July 2007 to June 2009.

23. Principal Investigator, “Fan Performance and Sound Evaluation”, Home Ventilating Institute (HVI), $79,400, Industrial/manufacturers $150,400 (Total-229,800), 2008.
24. Principal Investigator, “Implementing an Ammonia Economy,” Iowa Energy Center, $43,833, August 2007 to June 2008.
25. Principal Investigator, “Center for Building Energy Research Administration,” IPRT, $35,706, July 2007 to June 2008.
26. Principal Investigator, “Installation and Testing of Photovoltaic Energy Systems”, Iowa Energy Center, $49,458, July 2007 to June 2008.
27. Co-Principal Investigator, “Technical and Research Support for Iowa Energy Center Building Energy Efficiency Program”, Iowa Energy Center, $253,440, July 2007 to June 2008.
28. Principal Investigator, “Alternative Energy Laboratory Setup”, ISU Miller Grant, $24,800, July 2006 to June 2007.
29. Principal Investigator, “Installation and Testing of Photovoltaic Energy Systems”, Iowa Energy Center, $47,740, July 2006 to June 2007.
30. Co-Principal Investigator, “Technical and Research Support for Iowa Energy Center Building Energy Efficiency Program”, Iowa Energy Center, $310,110, July 2006 to June 2007.
31. Principal Investigator, “The Impact of Household Refrigerator Storage Conditions on the Shelf- life of Fruits and Vegetables, (RP-1320)” ASHRAE, (TC 8.9) $126,580, Sept 2005 to Feb 2009.
32. Principal Investigator, “Installation and Testing of Photovoltaic Energy Systems” Iowa Energy Center, $47,000, July 2005 to June 2006.
33. Co-Principal Investigator, “Technical and Research Support for Iowa Energy Center Building Energy Efficiency Program”, Iowa Energy Center, $272,093, July 2005 to June 2006.
34. Co-Principal Investigator, “Duct Rumble Noise Resulting From Aerodynamic System Effects in the Discharge of Centrifugal Fan, (RP-1219)” ASHRAE, (TC 2.6) $118,656, Sept 2004 to Feb 2008.
35. Co-Principal Investigator, “Technical and Research Support for Iowa Energy Center Building Energy Efficiency Program”, Iowa Energy Center, $242,795, July 2004 to June 2005.
36. Co-Principal Investigator, “Technical and Research Support for Iowa Energy Center Building Energy Efficiency Program”, Iowa Energy Center, $242,546, March 2003 to June 2004.
37. Co-Principal Investigator, “A Cost Analysis Study of the Benefits of Building Energy Code Upgrades in Iowa,” Iowa Department of Natural Resources, $24,000, March 2003 to February, 2004.
38. Principal Investigator, “Graduate Student Support for Compressed Air System Textbook Development,” Iowa Energy Center, $19,550, April 2003 to March 2004.
39. Principal Investigator, “Graduate Student Support (EPA Project),” Iowa Energy Center, $21,062, October 2002 to September 2003.
40. Principal Investigator, “Humidity Sensors Natural Building Controls Information Program – Phase II,” EPA, $66, 405, October 2002 to September 2003.
41. Principal Investigator, “Development of a University-Level Engineering Textbook on Compressed Air Systems,” DOE, $79,273, October 2002 to September 2003.
42. Principal Investigator, “Humidity Sensors Natural Building Controls Information Program – Phase I,” EPA, $91,246, October 2001 to September 2002.
43. Principal Investigator, “Compressed Air Systems,” Compressed Air Challenge and Iowa Energy Center, $38,000, April 2001 to June 2002.
44. Principal Investigator, “Air Evaluation and Comparison of R-410A Refrigeration Compressor Performance for both Miscible and Immiscible Lubricants”, Henkel Corporation, $37,283, July 1999 to July 2000.
45. Principal Investigator, “Performance of a Suction - Line/Capillary-Tube Heat Exchanger with Alternate Refrigerants (94%-TRP)”, ASHRAE, $79,793, September 1997 to August 1999.
46. Principal Investigator, “Development of a Sensor for Monitoring the Packaged-Meat Freezing Process,” Millard Refrigerated Services, August 1998 to August 1999.
47. Principal Investigator, “Development of a Sensor for Monitoring the Packaged-Meat Freezing Process,” Millard Refrigerated Services, $69,275, August 1998 to August 1999.
48. Principal Investigator, “Heat Transfer Performance Evaluation of R-407C and R-410A with New

Lubricants," Copeland Corporation, $9000, November 1996 to June 1997.

49. Principal Investigator," An Evaluation & Comparison of Compressor Performance with Ten Different Lubricants," Henkel Corporation, $38,585, January 1996 to June 1998.
50. Principal Investigator," In-Tube Evaporation Heat Transfer Study of Alternative Refrigerant Mixture & Selective Lubricants," Copeland Corporation, $25,000, March 1995 to April 1996.
51. Principal Investigator, "Shell-Side Condensation & Evaporation of R-236fa," U.S. EPA, $25,000, September 1995 to June 1997.
52. Principal Investigator, "Refrigerant/Lubricant Characteristics of R- 236fa & Three Lubricants," U.S. EPA, $25,000, October 1995 to June 1997.
53. Principal Investigator, "An Evaluation of R-236fa as a Working Fluid for Refrigeration Systems," U.S. EPA, $250,000, October 1994 to June 1997.
54. Principal Investigator, "In-Tube Evaporation Heat Transfer of R-134a with Four Different Lubricants," Witco Corporation, $12,000, October 1994 to February 1995.
55. Principal Investigator, "Capillary Tube Performance with Alternative Refrigerants - RP 762," ASHRAE, $82,088, September 1, 1993 to August 1995.
56. Principal Investigator, "Miscibility of Lubricants with Refrigerants, Phase II," Air-Conditioning and Refrigeration Technology Institute, Inc., $67,060, January 1993 through January 1994.
57. Principal Investigator, "An Evaluation of an Alternative Refrigerant for Replacement of CFC- 114 in Shipboard Chillers," U.S. Environmental Protection Agency, $528,300, August 1992 through January 1994.
58. Principal Investigator, "Alternative Refrigerants Evaluation program (AREP), Subproject A: Evaporator, Inside Tube (EIT) Project RFP3412-50," Electric Power Research Institute, $77,765, August 1992 through May 1997.
59. Co-Principal Investigator, "Review and Evaluation of Supermarket Design," U.S. Environmental Protection Agency, $57,070, September 1992 through August 1993.
60. Principal Investigator, "Evaporation and Condensation Heat Transfer of Non-CFC Refrigerant Mixtures", E.I. DuPont Nemours and Company, $33,165, May 1992 - June 1993.
61. Principal Investigator, "Miscibility of Lubricants with Refrigerant, Phase I", Air Conditioning and Refrigeration Technology Institute, Inc., $46,390, January 1992 through January 1993.
62. Principal Investigator, "Experimental Determination of Shell-side Condenser Bundle Heat Transfer Design Factors for Refrigerants R-123 and R-134a," ASHRAE, $128,550, April 1, 1991- August 1, 1994.
63. Principle Investigator, "Heat Transfer and Fluid Flow in Spray Evaporators with Applications to Reducing Refrigerant Inventory," ASHRAE, $117,120, April 1, 1991 to August 1, 1994.
64. Co-Principal Investigator, "Review and Evaluation of Alternative Refrigeration Configurations and Technologies", Environmental protection Agency, $99,950, October 1991 - May 1993.
65. Principal Investigator, "Thermal analysis and modeling of switches," Honeywell - $36,310, January 1, 1991 - December 31, 1991.
66. Principal Investigator, "Alternative refrigerant design data for capillary tube-suction line heat exchangers," Admiral Company - $44,460, December 15, 1990 - March 1, 1993.
67. Principal Investigator, "Refrigerant-lubricant properties for three alternative refrigerants," Mobil Research and Development Corporation - $12,000, December 15, 1990 - April 1, 1991.
68. Co-Principal Investigator, "Center for the advancement of refrigeration and air-conditioning technology," Genesis Center Funding from ISU President's Excellence Fund - $24,000, July 1, 1990 - June 30, 1991.
69. Principal Investigator, "Determination of solubility and viscosity of refrigerant/lubricant solutions," General Electric Appliances - $25,000, May 1, 1990 - January 31, 1991.
70. Co-Principal Investigator, "Energy conservation training for school building operators," Iowa Department of National Resources - $24,000, April 1, 1990 - January 1, 1991.
71. Co-Principal Investigator, "Review of technical engineering analysis reports and technical education efforts for improving energy efficiency in Iowa buildings, Phase I," Iowa Department of Natural Resources - $100,000, April 1, 1990 -January 1, 1991.
72. Principal Investigator, "Heat transfer and pressure drop during condensation and evaporation of R-

134a/oil mixtures in smooth and micro-fin tubes," ASHRAE - $135,740, April 1, 1990 - September 30, 1992.

73. Principal Investigator, "Evaporation tests of different micro-fin tubes," Sundstrand Heat Transfer, Inc. - $12,000, February 1, 1990 - April 1, 1990.
74. Principal Investigator, "Evaluation of R-134a and an alternative blend (DuPont) as drop-in substitutes for R-12 in refrigeration systems," E. I. DuPont de Nemours and Company, Inc. - $24,000, January 1, 1990 - December 31, 1990.
75. Principal Investigator, "A comparison of R-11 and R-123 shell-side evaporation and condensation heat transfer coefficients," Wolverine Tube Company - $15,000, December 1, 1989 – November 30, 1990.
76. Principal Investigator, "Determination of refrigerant-lubricant solution properties," Mobil Research and Development Corporation - $28,625, December 1, 1989 - November 30, 1990.
77. Co-Principal Investigator, "Development of a computer-based methodology for performing technical analyses of energy management projects and review of technical engineering analyses," Iowa Department of Natural Resources - $44,880, October 1, 1989 - March 31, 1991.
78. Co-Principal Investigator, "Center for the advancement of refrigeration and air-conditioning technology," Genesis Center Funding from ISU President's Excellence Fund - $24,000, August l, 1989-June 30, 1989.
79. Principal Investigator, "In-tube condensation and evaporation of alternative refrigerants and oil mixtures," E. I. DuPont de Nemours and Company - $32,000, March 1, 1989 - March 1, 1990.
80. Co-Principal Investigator, "Post-implementation study of energy conservation measures," Iowa Department of Natural Resources - $20,000, November 1, 1988 - December 15, 1989.
81. Principal Investigator, "Testing refrigeration cycle components," Amana - $35,700 plus $100,000 for equipment, May 1, 1988 - April 30, 1989.
82. Principal Investigator, "An experimental evaluation of micro-fin tubes for use in heat pipe air-to-air heat exchangers," ASHRAE Grant-in-Aid - $6,000, July 1, 1988 - June 30, 1989.
83. Principal Investigator, "Methods of measuring the solubility and viscosity of lubricating oil/refrigerant mixtures at high discharge pressures and temperatures (RP-580)," ASHRAE - $85,280, June 1, 1988 - May 31, 1990.
84. Principal Investigator, "Vapor-compression refrigeration cycle research," ISU Research Mini- grant - $800, November 30, 1987 - June 30, 1988.
85. Principal Investigator, "Design and development of a compact refrigeration unit for cooling detachable containers," Cygnus Appliance - $23,360, April 1, 1988 - December 31, 1989.
86. Co-Principal Investigator, "Evaluation of energy audits," Iowa Department of Natural Resources - $15,500, February 15, 1988 - July 30, 1988.
87. Co-Principal Investigator, "Evaluation and review of technical analysis dealing with energy management opportunities in public buildings," Iowa Department of Natural Resources - $33,486, December 15, 1987 - June 30, 1989.
88. Principal Investigator, "Thermal property measurements of composite materials using a laser pulse method," ISU University Research Grant - $3,000, May 15, 1987 - June 30, 1988.
89. Principal Investigator, "A demonstration of energy conservation from integrating a hydronic radiant panel ceiling and a residential heat pump," Exxon Overcharge Restitutionary Fund - $55,000, October 25, 1986 - June 30, 1988.
90. Principal Investigator, "Heat pipe literature search and benchtop experiment," ISU Research Mini-grant - $600, March 8, 1987 - June 15, 1987.
91. Principal Investigator, "A study of thermal effects in a solid material irradiated by a laser beam," ISU University Research Grant - $3,500, May 15, 1986 - June 30, 1987.
92. Principal Investigator, "A thermal performance study of engine driven heat pump systems," ASHRAE Grant-in-Aid - $6,000, February 10, 1986.
93. Principal Investigator, "Effect of oil on heat transfer and pressure drop inside augmented tubes during condensation and evaporation of refrigerants," ASHRAE - $117,185, January 1, 1986 - April 31, 1988.
94. Principal Investigator, "Thermal property measurement sensor," ISU Research Mini--grant - $800, July 30, 1985 - May 31, 1986.
95. Principal Investigator, "Residential wind generator system evaluation," Iowa Electric Light and Power

Company - $32,380, April 1, 1985 - December 31, 1986.

96. Principal Investigator, "Heating system evaluation," Iowa Electric Light and Power Company -$52,410, May 1, 1984 - May 15, 1986.
97. Principal Investigator, "Real time determination of concentration of oil dissolved in refrigerant flow stream without sample removal," ASHRAE - $92,079, April 1, 1984 - April 30, 1987.
98. Principal Investigator, "Two-phase flow induced vibrations of a heat exchanger tube in cross flow," ISU University Research Grant - $3,100, May 15, 1984 - June 30, 1985.
99. Co-Principal Investigator, "Evaluation of enhanced heat transfer tubing for evaporation and condensation," ARCO Metals Company - $111,740, October 1, 1983 - March 31, 1986.

Articles Written and/or Under Review

1. Schaff, F., Tanskyi, O., Pate, M., Claridge, D., and Culp, C. A Prototype of a Novel Membrane Air-conditioning System based on the Claridge-Culp-Liu Dehumidification Process: Part 1. Proof-of-Concept Verification and Membrane-Module Evaluation
2. Schaff, F., Tanskyi, O., Pate, M., Claridge, D., and Culp, C. A Prototype of a Novel Membrane Air-conditioning System based on the Claridge-Culp-Liu Dehumidification Process: Part 2. Proof-of-Concept Verification and Membrane-Module Evaluation
3. Schaff, F., Tanskyi, O., Pate, M., Claridge, D., and Culp, C. A Prototype of a Novel Membrane Air-conditioning System based on the Claridge-Culp-Liu Dehumidification Process: Part 3. Proof-of-Concept Verification and Membrane-Module Evaluation
4. Karim*, M., Das*, D., Sadr, R. and Pate, M. “Optimal Hydrocarbon-CO2 zeotropic for a supercritical organic Rankine Cycle”, Energy Conversion and Management, 2022 (In Review)
5. Alvarez*, A., and Pate, M. , Khan*, S. “Solar Radiation Modeling and Design Optimization of Solar Collector Tilt Angle for Annual Maximum and Seasonally Balanced Energy Received”, Journal of Solar Energy Engineering, 2022 (In Review)

Published Journal Articles

1. Sadr, R., Das, D., Karim, M. and Pate, M. “Optimal Hydrocarbon Based Working Fluid Selection for a Simple Super Critical Organic Rankine Cycle”, Energy Conversion and Management, 2021, Vol. 243, pp. 114-124
2. Claridge, D., Culp, C., Liu, W., Pate, M., Haberl, J., Bynum, J., Tanskya, O., & Schaff, F., “A Performance Analysis of the Claridge-Culp-Liu Dehumidification Process; A Novel Approach for Drying Moist Air Based on Memberance Separation, Vacuum Compression and Subatmospheric Condensation”, International Journal of Refrigeration, 2021, Vol.122, pp. 192-200
3. Meleika, S. and Pate, M. “The Influence of Range Hood Exhaust Orientation on Capture Efficiency”, Science and Technology for the Built Environment, 2021, Vol. 26, Issue 6, pp. 843-867
4. Meleika, S., Hicks, T., Pate, M. and Sweeney J. “The Design, Construction and Evaluation of a Test Chamber for Measuring Rangehood Capture Efficiency”, Science and Technology for the Built Environment, 2020, Vol.26, Issue 6, pp. 856-872
5. Yang, P., Pate, M. and Strzelec, A.. “Gasoline Particulate Filter Substrate Heterogeneity Effects on Its Performance”, SAE International Journal of Engines, 2020, Volume 13, Issue 1, pp. 49-62
6. Meleika, S. and Pate, M. “The Effects of Cook-Top Temperature on Range Hood Capture Efficiency”, Science and Technology for the Built Environment, 2020, Vol. 27, Issue 3, pp. 283-302

7. Meleika, S., Pate, M. and Jacquesson, A., "The Effects of Range Hood Mounting Height on Capture Efficiency", Science and Technology for the Built Environment, 2020, Vol. 27, Issue 3, pp. 303-315

8. Claridge, D., Culp, C., Liu, W., Pate, M., Haberl, J., Bynum, J., Tanskya, O., & Schaff, F., "A new approach for drying moist air: the ideal Claridge-Culp-Liu dehumidification process with membrane separation, vacuum compression and sub-atmospheric condensation", International Journal of Refrigeration, 2019, Vol. 105, pp. 211-217.

9. Nagy, P. and Pate, M.B., "Chronological variations in ASHRAE handbook refrigerant thermodynamic and transport properties from 1981 to 2017", ASHRAE Transactions, 2019, Volume 25, pp. 211-217

10. Yin, P., Pate, M.B., and Battaglia, F., "In-field performance evaluation and economic analysis of residential ground source heat pumps in heating operation." Journal of Building Energy, 2019, Volume 26, V100932

11. P. Yang, M.B. Pate and A. Strzelec, "Throat Unit Collector Modeling of Gasoline Particulate Filter Performance", SAE International Journal of Engines, 2019, Volume 12(4), pp. 417-426

12. Yin, P., and Pate, M.B., "An energy and life-cycle cost comparison of residential PSC and ECM blower systems operating at excess pressures due to restrictive ducts", Journal of Building Engineering, 2019, Volume 22, pp. 305-313.

13. Choi, W., Pate, M.B., Warren, R.D., & Nelson, R.M, "An economic analysis comparison of stationary and dual-axis tracking grid-connected photovoltaic systems in the US Upper Midwest", International Journal of Sustainable Energy, 2019. 37(5), pp. 455-478.

14. Ruud, W. D.E. Claridge, S. Noynaent, D. Burnett, D. Westphal, M.B. Pate, L. Zuo "Redeveloping depleted hydrocarbon wells in an enhanced thermal system (EGS) for a university campus: Progress Report of Real-Asset-Based Feasibility Study", Energy Strategy Studies, 2018. 21, pp. 191-203.

15. Choi, W, M.B. Pate, J.F. Sweeney, "Uncertainty and signal-to-noise ratio analysis for unsteady background noise", Noise Control Engineering Journal, 2018. 66(2), pp. 131-141

16. Choi, W. and M.B. Pate, "An evaluation and comparison of two psychoacoustic loudness models used in low-noise ventilation fan testing", Building and Environment, 2017. 120: p. 41-52.

17. Choi, W., M.B. Pate, and J.F. Sweeney, "An acoustic performance analysis of AC-motor bathroom ventilation fans for a decade-long period, 2005–2015", Science and Technology for the Built Environment, 2017. 23(7): p. 1167-1177.

18. Sweeney, J.F. and M.B. Pate, "Lifecycle analysis of a single-family residential rainwater harvesting system in a subtropical, Metropolitan Environment", Journal of Sustainable Water in the Built Environment, 2017. 3(4): p. 04017012.

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30. Rajendran, N. and M. B. Pate, "Transient temperature near a void in a material heated by a moving laser beam," Conference on Review of Progress in Quantitative Nondestructive Evaluation, La Jolla, California, pp. 641-648, July 31-August 4, 1988.

31. Reichert, B. A., R. M. Nelson and M. B. Pate, "The transient response of an air-to-water cross-flow heat exchanger," Proceedings of the 1988 National Heat Transfer Conference, July 24-27, Houston, Texas, Editor, H. R. Jacobs, Vol. 3, ASME, pp. 291-300, 1988.

32. Huang, K. and M. B. Pate, "A model for air-conditioning condensers and evaporators with emphasis on in-tube enhancement," IIR Conference on Refrigeration Machinery, Purdue University, pp. 266-276, July 18-21, 1988.

33. Rajendran, N. and M. B. Pate, "The effect of laser beam velocity on cut quality and surface temperature," 1988 ASME Winter Annual Meeting, November 28-December 2, Chicago, Illinois in Collected Papers in Heat Transfer, HTD-Vol. 104, Volume 1, ASME, pp. 121-127, 1988.

34. Khanpara, J. C., M. B. Pate and A. E. Bergles, "A comparison of local evaporation heat transfer enhancement for a micro-fin tube using refrigerants 22 and 113," 1987 ASME Winter Annual Meeting, Boston, Massachusetts, December 13-18, 1987, in Boiling and Condensation in Heat Transfer Equipment, HTD-Vol. 85, ASME, New York, pp. 31-39.

35. Reid, R. S., M. B. Pate and A. E. Bergles, "Augmented in-tube evaporation of refrigerant 113," 1987 ASME Winter Annual Meeting, Boston, Massachusetts, December 13-18, 1987 in Boiling and Condensation in Heat Transfer Equipment, HTD - Vol. 85, ASME, New York, pp. 21 - 30.

36. Schlager, L. M., M. B. Pate and A. E. Bergles, "Evaporation and condensation heat transfer for micro-fin tubes using refrigerant 22," 1987 Meeting of the Dentsche Kuelte-und Klimatechnische Verein (DKV), West Germany, pp. 361-377, November 18 - 20, 1987.

37. Rajendran, N. and M. B. Pate, "The thermal response of a material during a laser cutting process," Proceedings of the 6th International Congress on applications of lasers and electro-optics, ICALEO '87, San Diego, California, November 8 - 12, 1987 in Focus on Laser Materials Processing, IFS Publications, Bedford, UK, pp. 129 - 134, 1988.

38. Khanpara, J. C., A. E. Bergles and M. B. Pate, "A comparison of in-tube evaporation of R-113 in electrically heated and fluid heated smooth and inner-fin tubes," 24th National Heat Transfer Conference, Pittsburgh, August 9-12, 1987, in Advances in Enhanced Heat Transfer - 1987, HTD-Vol. 68, ASME, New York, pp. 35-45.

39. Zhang, Z. and M. B. Pate, "A semi-analytical formulation of heat transfer from structures with embedded tubes," 24th National Heat Transfer Conference, Pittsburgh, August 9-12, 1987, in Heat Transfer in Buildings and Structures, HTD-Vol. 78, ASME, New York, pp. 17-23.

40. Reid, R., M. B. Pate and A. E. Bergles, "Evaporation of refrigerant 113 flowing inside smooth tube," ASME Paper No. 87-HT-51, 24th National Heat Transfer Conference, Pittsburgh, August 9 - 12, 1987.

41. Pate, M. B., "Design considerations for air-conditioning evaporator and condenser coils," 1987 NATO Advanced Study Institute on Thermo-hydraulic Fundamentals and Design of Two- Phase Flow Heat Exchangers, Povoa de Varzim, Portugal, July 6-17, 1987. Also published in Kluwer Academic Publishers, Dordrecht, the Netherlands, pp. 849 - 884, 1988.

42. Baustian, J. J., M. B. Pate and A. E. Bergles, "Properties of oil-refrigerant liquid mixtures with applications to oil concentration measurement," Proceedings of the XVIII International Symposium on Heat and Mass Transfer in Cryoengineering and Refrigeration, Dubrovnik, Yugoslavia, September 1 - 5, 1986, Hemisphere Publishing Corporation. Also published in Heat and Mass Transfer in Refrigeration and Cryogenics, Hemisphere Publishing Corporation, New York, pp. 404 - 428, 1987.

43. Zhang, Z. and M. B. Pate, "A numerical study of heat transfer in a hydronic radiant ceiling panel," 1986 ASME Winter Annual Meeting, Anaheim, California, December 7 - 12, in Numerical Methods in Heat Transfer, HTD-Vol. 62, ASME, New York, pp. 31 - 37, 1986.

44. Reichert, B. A., R. M. Nelson and M. B. Pate, "A computer simulation of a cross-flow heat exchanger

operating in a moist air environment," 1986 ASME Winter Annual Meeting, Anaheim, California, December 7 - 12, in Computer-Aided Engineering of Energy Systems, AES-Vol. 2 - 2, ASME, New York, pp. 89 - 96, 1986.

45. Khanpara, J. C., M. B. Pate and A. E. Bergles, "Augmentation of R-113 in-tube condensation with micro-fin tubes," 1986 ASME Winter Annual Meeting, Anaheim, California, December 7-12, in Heat Transfer in Air Conditioning and Refrigeration Equipment, HTD-Vol. 65, ASME, New York, pp. 21-32, 1986.

46. Pate, M. B. and D. R. Tree, "A study of the subcooled flow region of a capillary tube-suction line heat exchanger," Proceedings of the XVIII International Symposium on Heat and Mass Transfer in Cryoengineering Band Refrigeration, Dubrovnik, Yugoslavia, September 1 - 5, 1986, published Hemisphere Publishing Corporation. Also published in Heat and Mass Transfer in Refrigeration and Cryogenics, Hemisphere Publishing Corporation, New York, pp. 165 - 186, 1987.

47. Rajendran, N. and M. B. Pate, "A computer model of the startup transients in a vapor-compression refrigeration system," Proceedings of the IIR Conference on Progress in the Design and Construction of Refrigeration Systems, Purdue University, August 5-8, 1986. Also published in the Refrigeration Science and Technology Series, International Institute of Refrigeration, Paris, France, pp. 201-213, 1986.

48. Pate, M. B. and D. R. Tree, "Two-phase flow in a diabatic capillary tube," Proceedings of the IIR Conference on Progress in the Design and Construction of Refrigeration Systems, Purdue University, August 5-8, 1986. Also published in the Refrigeration Science and Technology Series, International Institute of Refrigeration, Paris, France, pp. 89-101, 1986.

49. Maxwell, G., R. Nelson, M. Pate and H. Shapiro, Proceedings of the Air Movement Distribution Conference, Purdue University, West Lafayette, Indiana, pp. 246-252, May 27-29, 1986.

50. Zhang, Z., M. B. Pate and R. M. Nelson, "A performance evaluation of a residential solar hydronic radiant heating system," Proceedings of the 1986 ASME Solar Energy Conference, Anaheim, California, April 14-17.

51. Pate, M. B. and D. A. Zoz, "Transient response of a two-region decaying temperature surface probe," ASME Paper No. 85-WA/HT-52, 1985 ASME Winter Annual Meeting, Miami Beach, Florida, November 17-21.

52. Zhang, Z., T. Liu, M. B. Pate and R. M. Nelson, "An experimental study of a residential solar system coupled to a radiant panel ceiling," 1985 ASME Winter Annual Meeting, Miami Beach, Florida, November 17-21, in Heat Transfer and Fluid Flow in Solar Thermal Systems, ASME, New York, pp. 45-52, 1985.

53. Pate, M. B. and D. A. Zoz, "A method of measuring thermal conductivity using a decaying temperature surface probe," Proceedings of the 19th International Thermal Conductivity Conference, Cookeville, Tennessee, October 20-23, 1985, Plenum Press, New York, pp. 249-260, 1988.

54. Pate, M. B. and D. A. Zoz, "Nondimensional study of heat transfer from a two-region surface probe," Proceedings of the 4th International Conference on Numerical Methods in Thermal Problems, Swansea, U.K., July 15-18, 1985.

55. Pate, M. B., A. Myklebust and J. H. Cole, "A computer simulation of the turbine flow meter rotor as a drag body," Proceedings of the 1984 ASME International Computers in Engineering Conference, Las Vegas, Nevada, August 12 - 16, 1984, Vol. 2, Bk. No. G240, ASME, New York, 1984.

56. Pate, M. B. and D. R. Tree, "A two-phase flow model for a capillary tube with friction and heat exchange," 21st National Heat Transfer Conference, Seattle, July 1983, in Heat Exchangers for Two-

Phase Flow Applications, ASME, New York, pp. 75 - 80, 1983.

57. Pate, M. B. and D. R. Tree, "An experimental analysis of capillary tube-suction line heat exchangers," Proceedings of the XVth International Congress of Refrigeration, Paris, August 31-September 7, 1983, B2-109, pp. 162-167.

Books or Chapters of Books

1. Pate, M. B., Evaporators and Condensers for Refrigeration and Air Conditioning Systems, Chapter 12 in Boilers, Evaporators, and Condensers, Ed. S. Kakaf, pp. 635-715, John Wiley: New York, NY 1991.

GRADUATE STUDENTS

Doctoral Students Advised

1. Basheer Mugdadi (Ph.D., Present), Major Professor
2. Syed Hameed (Ph.D., Present), Co-major Professor
3. Edgar Yokubaitis (Ph.D., Present), Major Professor
4. Tristan Smith (Ph.D., Present), Major Professor
5. Simon Padron (Ph.D., Present), Major Professor
6. Uzair Ahmed (D. Eng, present), Major Professor
7. Paul Nagy (Ph.D., 2020) Major Professor
8. Sam Meleika (Ph.D., 2020), Major Professor
9. Vahideh Kamranzadek (D. Eng., 2020), Major Professor
10. Juan Cornejo (PhD, 2020), Major Professor
11. Pengze Yang (Ph.D., 2019) Co-Major Professor
12. Guan Huang (Ph.D., 2018) Co-Major Professor
13. Yasuko Sakurai (D.Eng., 2016) Major Professor
14. Wongyu Choi (Ph.D., 2016) Major Professor
15. Adnan Ayub (D.Eng., 2016) Major Professor
16. James Sweeney (Ph.D., 2015) Co-Major Professor
17. Peng Yin (Ph.D., 2015) Major Professor
18. Oleksander Tanskyi (Ph.D., 2015) Co-Major Professor
19. Kris Lineberry (Ph.D. 2011) Major Professor
20. Xiahui Zhou (Ph.D. 2010) Co-Major Professor
21. Ryan Warren (Ph.D. 2008) Co-Major Professor
22. Shailesh Joshi (Ph.D. 2005), Co-major professor
23. Predrag Popovic (Ph.D.1999), Major professor
24. Shin-Miin Tzuoo (Ph.D. 1998), Major professor
25. Lance Rewerts (Ph.D. 1994), Major professor
26. Jian-Yuan Lin (Ph.D. 1994), Major professor
27. Shane Moeykens (Ph.D. 1994), Major professor
28. Steve Zoz (Ph.D. 1994), Major professor
29. Robert Bittle (Ph.D. 1994), Major professor
30. Joe Huber (Ph.D. 1994), Major professor
31. Donald Gauger (Ph.D. 1993), Co-major professor

32. Majid Ghassemi (Ph.D.,1993),Co-major professor
33. Steve Eckels (Ph.D. 1993), Major professor
34. Steve Crown (Ph.D. 1993), Co-major professor
35. Ian Hsiao (Ph.D. 1992), Major professor
36. Nolan Van Gaalan (Ph.D. 1991), Major professor
37. Natarajan Rajendran (Ph.D. 1990), Major professor
38. Lynn Schlager (Ph.D. 1988), Major professor
39. James Baustian (Ph.D. 1988), Major professor
40. Zuanglin Zhang (Ph.D. 1987), Major professor
41. Jatin Khanpara (Ph.D. 1986), Co-major professor

Masters Students Advised

1. Jimmie Smith (MS, present), Major Professor
2. Shaun Garcia (MS, present), Major Professor
3. Ahmad Jawad (MS, 2022), Major Professor
4. Jay Verlekar (M.S., present), Major Professor
5. Pranav Gadekar (M.S., present), Major Professor
6. Edgar Yokubaitis (M.S., 2021), Major Professor
7. Sam Nguyen (M.S., 2021), Major Professor
8. Debranjan Das (M.S., 2021), Co-Major Professor
9. Mohammed Kazim (M.S., 2021), Co-Major Professor
10. Axel Jacquesson (M.S., 2020), Major Professor
11. Troy Anora (M.S., 2020), Major Professor
12. Mario Heredia (M.S., 2020) Major Professor
13. Adrian Alvarez (M.S., 2020), Major Professor
14. Adithya Athreya (M.S., 2020), Major Professor
15. Sarojeet Deb (M.S., 2019) Co-Major Professor
16. Yousef Almarzzoq (M.S., 2019) Major Professor
17. Vincent Lau (M.S., 2019) Co-Major Professor
18. Yongki Hendranata (M.S., 2018) Major Professor
19. Michelle Petersen (M.S., 2018) Major Professor
20. Trey Hicks (M.S., 2018) Major Professor
21. Cesar Pelli (M.S., 2018) Major Professor
22. Jake Hodges (M.S., 2018) Major Professor
23. Syed Mohammad (M.S., 2018) Major Professor
24. Sulaiman Alsaleem (M.S., 2017) Major Professor
25. Eric Coronado (M.S., 2017) Major Professor
26. Jose Mejia (M.S., 2017) Major Professor
27. Ryan Collins (M.S., 2016) Major Professor
28. Hamad Khaled (M.E., 2016) Major Professor
29. Kiran Prasad (M.S., 2016) Major Professor
30. James Young (M.S., 2016) Major Professor
31. Felipe Assuncao (M.S., 2016) Major Professor
32. Pedro Antonio Gomez (M.S., 2015) Major Professor
33. Meinan Chen (M.S., 2015) Major Professor
34. Tiffany Hargett (M.S., 2015) Major Professor
35. Feinan Zhao (M.E. 2015) Major Professor
36. Ce Ding (M.E. 2015) Major Professor
37. Yupeng Zhang (M.S. 2014) Major Professor

38. Yuliang Ji (M.E. 2014) Major Professor
39. Paul Nagy (M.S. 2014) Major Professor
40. Jieyun Zhang (M.E. 2014) Major Professor
41. Huan Zhang (M.E. 2014) Major Professor
42. Matt Daugherty (M.S. 2014) Major Professor
43. Francesco Schaff (M.S. 2014) Co-Major Professor
44. Jennifer Reese (M.S. 2013) Major Professor
45. Grant Wheeler (M.S.2013) Major Professor
46. Sean Elliston (M.S. 2012) Major Professor
47. Claire Mero (M.S. 2012) Major Professor
48. Vahideh Kamranzadek (M.S. 2011) Major Professor
49. Wei Wang (M.S. 2011) Major Professor
50. Daniel Escatel (M.S. 2011) Major Professor
51. Joe Craig (M.S. 2011) Major Professor
52. Chao-Chen Wei (M.S. 2010) Major Professor
53. Blake C. Dill (M.S. 2010) Major Professor
54. Vincent E. Cline (M.S. 2010) Major Professor
55. Sankaranarayanan Ravi (M.S. 2010) Major Professor
56. Peng Yin (M.S. 2010) Major Professor
57. James Hardy (M.S. 2010) Major Professor
58. Oleksdr Tanskyi (M.S. 2010) Co-Major Professor
59. Kavita Gangisetta (M.S. 2010) Co-Major Professor
60. Joel Logan (M.S. 2008) Co-major Professor
61. Chris Hoeck (M.S. 2008) Major Professor
62. Matt Swenka (M.S. 2007) Co-Major Professor
63. Jeff Bartels (M.S. 2008) Major Professor
64. Kevin Braun (M.S. 2007) Major Professor
65. Eric Henderson (M.S. 2007) Major Professor
66. Peter Swanson (M.S. 2007) Major Professor
67. Jon Giles (M.S. 2007) Major Professor
68. Emar Makishev (M.S. 2007) Major Professor
69. David Hamilton (M.S 2006.) Major Professor
70. Joshua Kading (M.S. 2006) Co-Major Professor
71. Asif Khah (M.S. 2006), Major professor
72. Daryn Moorman (M.S. 2005) Major Professor
73. James Swales (M.S. 2005) Major Professor
74. Ryan Warren (M.S. 2005) Co-major Professor
75. Matthew Fitzgerald (M.S. 2005) Co-major Professor
76. Steve Feltes (M.S. 2005) Major Professor
77. Jeremy Cloutier (M.S. 2004), Co-major professor
78. Miroslaw Trifunovic (M.S. 2000), Major professor
79. Wen-Ya Ho (M.S. 1999), Major professor
80. Duane Wolf (M.S. 1995), Major professor
81. John Kelly (M.S. 1995), Major professor
82. Daniel Ray (M.S. 1995), Major professor
83. Wade Huebsch (M.S., 1994), Major professor

84. Hyeun-Mee Kang (M.S., 1994), Major professor
85. Martin Collins (M.S., 1994), Co-Major professor
86. Shin-Miin Tzuoo (M.S. 1994), Major professor
87. Lyle Berkenbosch (M.S. 1993), Major professor
88. Naci Zafer (M.S. 1993), Major professor
89. Steve Eckels (M.S. 1990), Major professor
90. Steve Zoz (M.S. 1990), Major professor
91. Halim Wijaya (M.S. 1990), Major professor
92. Craig Byall (M.S. 1990), Co-major professor
93. Donald Gauger (M.S. 1990), Co-major professor
94. Shannon Breon (M.S. 1990), Major professor
95. Mohammad Hasan (M.S. 1989), Co-major professor
96. Steve Crown (M.S. 1989), Co-major professor
97. Christopher Gersey (M.S. 1989), Co-major professor
98. Kuo-Hsiu Huang (M.S. 1987), Major professor
99. Andrew Nippert (M.S. 1987), Co-major professor
100. Bruce Reichert (M.S. 1987), Co-major professor
101. Robert Reid (M.S. 1986), Co-major professor
102. Richard Trewin (M.S. 1986), Major professor
103. Natarajan Rajendran (M.S. 1985), Major Professor
104. David Zoz (M.S. 1984), Major professor

PROFESSIONAL ACTIVITIES

ASME (American Society of Mechanical Engineers)

During 34 year period (1982 to present) have regularly attended and participated in Annual IMECE Conferences/Meetings and Summer Heat Transfer Conferences.

Chair of ASME K-19 Committee, Environmental Heat Transfer, Heat Transfer Division (2007-2010 and 2016-present, member since 2004).

Secretary for ASME K-21 Heat Transfer Education, Heat Transfer Division (2017-present)

Responsible for organizing multiple ASME symposium sessions at Annual Summer Heat Transfer Conferences and IMECEs from 1985 to present (in excess of 30 symposium sessions).

Paper reviewer for ASME Heat Transfer Division and Annual ASME Summer Heat Transfer Conferences and annual IMECE Conferences.

Past member and active participate of ASME Committee K-10, Heat Transfer Equipment (1984 to 1996).

ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers)

Secretary and Program Chair of Technical Committee TC 8.9 Residential Refrigerators and Household Freezers (Past Chair, Vice-Chair, for committee). Responsible for organizing symposium sessions, reviewing proposals, developing RFP's, and updating handbooks.

Co-Chair and co-organizer for more than 18 different symposia sessions at ASHRAE Annual Meetings since 1986.

Served on Program Committee 1998 to 2000 and 1989-1992. Responsible for organizing the program at the National ASHRAE meetings twice a year).

Past member of Technical Committee TC 1.3, Heat Transfer and Fluid Flow.

Past member of Technical Committee TC 8.4, Air-to-Refrigerant Heat

Exchangers. Past member of several ASHRAE Standards Committee.

Co-founder of ISU's Student Chapter of ASHRAE, June 1985.

Past Member, IIR (International Institute of Refrigeration)

Past American Editor of the International Journal of Refrigeration, 1988-1991
Past Member of Commission B1

Other Professional Activities

From 2016 to 2022, participated in 1 to 3 invited peer/project/proposal review panels each year: sponsored by DOE (General Office, EERE) and BTO (Building Technology Office). These panels are

Annual BTO Peer Review Panel (2016, 2017, 2018, 2019),

DOE Project Proposal Review Panel (2016,2017),

DOE Technology Commercialization Fund (TCF) (2018,2019,2020),

DOE/BTO SBIR Proposal Review Panel (2019,2020,2021)

U.S. State Department's Global Innovation through Science and Technology (GIST) Tech-I Competition, coordinated by AAAS, evaluated 20 international project proposals over a two week period (2016).

Editorial Advisory Board, Journal of Thermal Science and Engineering Progress, publisher: Elsevier (2015 to present).

DOE Building Technology Office Review Panel, evaluated 15 ongoing research projects funded by DOE Building Technology Office (BTO) over a 3 day period in Washington DC (2014).

U.S. State Department's Global Innovation through Science and Technology (GIST) Tech-I Competition, coordinated by AAAS, evaluated 15 international project proposals over a two week period (2014).

Reviewed internal proposals (8 total) for the University of Nebraska on two separate occasions (2014).

Keynote Speaker on "Net Zero Energy Buildings " for 2013 ASME Summer Heat Transfer Conference, Minneapolis, MN (2013).

Maine Technology Institute's Development Loan Competition AAAS Research

Competitiveness Program – reviewed and scored 10 proposals (2013).

Saudi Arabia's King Abdulaziz City for Science and Technology (KACST) – Environmental Efficiency and Green Construction Program – conducted by AAAS, reviewed and scored 8 proposals (2013).

DOE ARPA-E: Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) Program, participated in 2 day panel meeting in Arlington, VA, reviewed six proposals in advance (2012).

DOE ARPA-E Rare Earth Alternatives in Critical Technologies (REACT) Program, member of two-day proposal panel in Washington DC—reviewed 10 proposals prior to panel meeting (2011).

DOE ARPA-E Gridscale Rampable Intermittent Dispatchable Storage (GRID) Program, participated in two-day proposal panel in Washington DC, reviewed 12 proposals prior to panel meeting (2010).

Taught two tutorials titled "Alternative Energy 1" and "Alternative Energy 2" at 2007 ASME/JSME Summer Heat Transfer Conference, July 2007,

Reviewed Heat Transfer textbook for Thomson Engineering "Principle of Heat Transfer 6th Edition by Frank Kreith and Mark Bohn (Summer 2007)-completed 12 hour review of textbook and recommended changes to authors and publisher

Participated in NSF Review Panel "National Science Foundation Wind and Solar Energy (PO71814)" August 24, 2007-reviewed proposals and attended meeting in Washington DC to rank and evaluate15 proposals

Keynote Speaker (one of 3), 2nd International Conference on Condensers and Condensation, March 1990

Invited Chapter Writer, Handbook on Boilers, Evaporators and Condensers, 1989

Review panelist (one of 6), Midwest Universities Energy consortium and Argonne National Laboratory

Review panelist (one of 3) to evaluate in-house activities at the Environment Protection Agency, Research Triangle Park, North Carolina

<u>Workshops and Short Courses Attended (1982 to 2006 at ISU)</u>

7th Annual Wakonse Conference on College Teaching, invited to be ISU Wakonse Fellow, May 2006.

Participated in the one-week NSF sponsored workshop "Conducting Rigorous Research in Engineering Education" conducted at the Colorado School of Mines in 2004. Assessment

Workshop at Alverno College, 3 days, June 2005.

Participated in a workshop, "Introduction to Learning-Centered College Classrooms" sponsored by project LEA/RN for a week in May 2005.

"Compressed Air Fundamentals", Compressed Air Challenge, 2 day workshop at ISU, October 2003.

“Compressed Air Advanced”, Compressed Air Challenge, 3 day workshop at ISU, October 2003.

"Cryogenics Engineering," Short Course at UCLA, May 16-20, 1988

"Thermal-Hydraulic Fundamentals and Design of Two-Phase Flow Heat Exchangers," NATO, Advanced Study Institute, Povoa de Varzim, Portugal, July 6-17, 1987

"Compact Heat Exchanger," ASME Short Course at Eighth International Heat Transfer Conference, San Francisco, CA, August 16-17, 1986

"Finite Element Analysis in Fluid Mechanics and Heat Transfer," Short Course at the University of Texas at Austin, July 14-18, 1986

"Two-Phase Flow and Heat Transfer in the Power and Process Industries," Short Course at NBS, Gaithersburg, Maryland, October 29-November 2, 1984.

"Multiphase Thermal Hydraulics," Workshop at Argonne National Laboratory, March 19-20, 1984

"HVAC Controls, Modeling and Simulation," Workshop at Georgia Institute of Technology, February 2-3, 1984

"Flow Induced Vibration in Power and Process Industries," Short Course at Argonne National Laboratory, May 24-26, 1983

"Two-Phase Fluid Mechanics Computation," Workshop at Argonne National Laboratory, September 21-22, 1982

UNIVERSITY ACTIVITIES

University Committees

Texas A&M University
Veterans Support Group (2014-2017)

Iowa State University
Member, University Graduate Curriculum Committee, August 2006-August 2007
Member, Graduate Council, August 2004-August 2007
Member, Ad Hoc Committee on Faculty Morale, October 1989-August 1991

College Committees

Texas A&M University
Chair, Doctoral of Engineering Admission Committee, August 2010-2018
Member, Subsea Engineering Program Committee, August 2014-2017
Affiliated Faculty member in the MTDE Depatment, 2021-2022

Iowa State University
Member, Engineering College Curriculum Committee, August 2004-2008
Member, College Mid-Course Adjustment Task Force, October 1991-1994
Chair, University Research Grant Committee, August 1990-1993
Member, Dean's Advisory Committee, August 1990-1993
Member, University Research Grant Committee, May 1988-May 1990
Member, Scholarship Committee, September 1982-May 1984

Department Committees

Texas A&M University

Member, ME Dept. Target of Opportunity (TOP) Faculty Hire Search Committee, 2017-2018.
Member, ME Dept. Faculty Advisory Committee, August 2016-August 2019.
Member, ME Dept.Graduate Program Qualifying Exam Committee (GPQC), 2017-present.
Member, ME Dept. Climate Committee, August 2017- 2020
Member, ME Dept. Faculty Mentoring and Success Committee. 2021-2022

Iowa State University
Chair, ME Academic Standards and Assessment Committee, August 2006-2008
Chair, ME Department Laboratory Committee, 2005-2006
Chair, Promotion and Tenure Committee for Michael Olsen, October 2005-December 2005
Member, ME Faculty Search Committee, August 2005-2008
Member, ME Program Improvement Coordinating Committee, August 2005-
2008. Chair, Promotion Committee for Srinivas Garimella, December 2003
Member, Promotion and Tenure Committee, 2003-Present
Chair, Promotion and Tenure Committee, 1997 – 1998
Chair, Bergles Professorship Search Committee, 1998 – 1999
Member, Promotion and Tenure Committee, August 1992-1996
Member, Honors and Awards Committee, August 1991-August 1992, August 1991-1995
Chair, Promotion and Tenure Committee, August 1990-August 1991
Chair, Promotion and Tenure Committee for Gregory Maxwell, October 1990 - January 1991
Chair, Promotion and Tenure Committee for Daniel Bullen, October 1995 - January 1996
Member, Engel Laboratory Committee, August 1987-August 1991
Chair, Laboratory Committee, August 1987-May 1989
Member, DEO Evaluation Committee, May 1987, April 2000
Member, Graduate Committee, August 1984-May 1985
Member, Chair's Advisory Committee, August 1983-August 1984

TEACHING AND EDUCATIONAL ACTIVITIES (2002-2)

- Book reading/discussion groups, Teach and Learning Circles, sponsored by CELT (2004, 2005).
- LEA/RN discussion group, Facilitator Jan Wiersema, biweekly Fall 2005.
- Participant in PEER Review of Teaching, organized by Dr. Thomas Brauman and Dr. Barbara Licklider, Miller Grant, biweekly, Spring 2006.
- Organizer and founder of "Teaching for Quality," ME Department, biweekly seminars, Spring 2006.
- Supervise 4 to 8 undergraduate students each semester enrolled in ME 490, Independent Study. (2001 to Present)
- Mentored a McNair Research Scholar. (2004-2006)
- Judged the past four years at the Iowa Lego League Competition (2002-2006) and past year at the Iowa Science Fair Competition (2005).
- Received two grants to write and publish a university-level textbook titled “Introduction to Compressed Air systems.” (Funded by DOE and IEC)
- Member of NSF review panel evaluating educational proposals. (2005)
- An active member of educational societies including the American Society of Engineering Education (ASEE).
- Participant in the Frontiers in Education (FIE) Annual Conference (2005, 2006)

- Graduate students (about 6) have won teaching Excellence Awards while working as teaching assistants at ISU. The most recent awardee was Michael Groen in 2005.
- Co-organizer of a series "HVAC in Education" symposium sessions for the American Society of refrigeration and Air Conditioning Engineering (ASHRAE).
- Freshman Honors Program Faculty Mentor. Nominated student for a $1,000 Alfred Mueller Research Grant. (2004-2005).
- Writing a book titled "An Introduction to Alternative Energy Conversion." (2005-2006)
- Participated in the one-week NSF sponsored workshop "Conducting Rigorous Research in Engineering Education" conducted at the Colorado School of Mines.
- Joined as a co-principal investigator with several other faculty members in the ME department to write and submit an NSF proposal to reorganize the department's design sequence to include all four years at ISU. (2005)
- Participated in a workshop, "Introduction to Learning-Centered College Classrooms" sponsored by project LEA/RN for a week in May 2005.

FORMER STUDENTS IN EDUCATION

Former graduate students who have gone on to become leaders in education as tenured Professors at other universities are:

Professor Steve Eckels - Kansas State University

Professor Lyn Schlager - University of Wisconsin, Platteville

Professor Steve Crown- University of Texas, Pan American

Professor Nolan Van Gaalen- Dordt College

Professor Robert Bittle -Texas Christian University

Professor Wade Huebsch- University of West Virginia

Professor Peng Yin – University of Louisiana