Thomas L. Merrill

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Education:

Pennsylvania State University, University Park, PA 8/91 – 8/94
Ph.D. in Mechanical Engineering – Transport Phenomena

University of Michigan, Ann Arbor, MI 9/89 – 12/90
M.S. in Mechanical Engineering – Thermal Fluid Numerical Analysis

Bucknell University, Lewisburg, PA 9/83 – 5/87
B.S. in Mechanical Engineering

Experience:

Associate Professor, Mechanical Engineering, Rowan University, Glassboro, NJ 1/08 – present

Responsibilities are divided between teaching, scholarship, and service. My teaching role is focused on thermal fluids courses: thermodynamics, heat transfer, fluid mechanics, biofluids, and computational fluid dynamics. Junior / Senior clinic projects involve a variety of projects sponsored by FocalCool, LLC, the U.S. Navy, private industry, and local entrepreneurs. My research focus involves developing technology to reduce tissue damage from ischemia that may result during heart attacks and strokes. This work is supported by the National Heart, Lung, and Blood Institute. We have raised $1.7M in research funding over the last seven years. My service responsibilities involve being a University Senate representative and directing the Rowan Undergraduate Venture fund.

CEO, Director of Research and Development, FocalCool, LLC, Sewell, NJ 1/05 – present

Lead all facets of medical device start-up R&D: collaboration with Cleveland Clinic Foundation partners, management of contract manufacturers, animal testing services, legal services, patent work, business plan development and communication with NIH and private investors. Our objective: develop the world's first organ-specific cooling catheter to significantly reduce tissue damage arising from stroke, traumatic brain injury, and heart attacks.

Accomplishments:

- Designed, developed and tested a novel blood cooling catheter and console in 14 months. Used Comsol Multiphysics and EES to optimize catheter mechanical design, in terms of Teflon extrusion geometry, blood entry locations and coolant hydraulics. This system is a Class II pre-clinical device.
- Demonstrated rapid tissue cooling in the brain and heart with nine large pigs, 2 - 4ºC in 12 minutes – approximately 3X faster than competitive intravascular devices.
- Raised $2M in private and federal funding to create FocalCool, LLC.
- Inventions – three cooling catheter patents submitted; two granted and one under review.

Assoc. Director, Mechanical Engineering, MicroDose Technologies, Monmouth Jct., NJ 8/06–1/08

Primary responsibilities included: functional group management, program management, and program technical leadership. Supervised the mechanical engineering group consisting of three engineers, a designer, and a machinist. Lead a three million dollar DOD program developing a nerve agent antidote delivery system. This program involves 10 technical staff members, including chemist, biologists, and electrical engineers. In collaboration with Novartis, lead all aspects of mechanical engineering design and communication. Our objective: a highly efficient piezoelectric dry powder inhaler.

Accomplishments:

- Led the development of user-feedback test inhalers for a 55-person marketing study done in the U.S., Japan, and Sweden. These test inhalers incorporated five different user feedback options including sound, sight, and vibration.
- Led the development of the first stand-alone electrically integrated nerve agent antidote inhaler.
- Applied finite element analysis (FEA) to predict the mechanical stresses within our piezoelectric assembly and guide development to improve the design.
- Applied FEA to design and analyze the fluid dynamics of flow channels and the acoustics of blister synthetic jetting.

Principal Engineer, Wyeth Research, Dept. of Biomedical Engineering, Princeton, NJ 9/02 – 12/04

Supervised two engineers and three technicians on drug discovery projects. Our goal: help chemists and biologists discover three new development-track compounds each year by accelerating chemical synthesis, purification, and in-vivo testing at animal, tissue and cellular levels.
Accomplishments:

- Designed, assembled and tested Wyeth's first automated microdialysis system. This system provides real-time animal neurochemistry analysis, reducing data collection time by 25%.
- Helped design, assemble and test Wyeth's first automated cell patch clamping system. When compared to a previous manual system, this system provides a 5X increase in IC_{50} data throughput.
- Helped design, assemble and test Wyeth's first Morris water maze using an Atlantis water platform. This maze is used to investigate memory and learning for Alzheimer drugs.
- Helped design and test Wyeth's first automated hippocampal tissue stimulation system for studying long-term potentiation (LTP). The new system, using LabView, provides a 2X increase in data throughput, thus eliminating 75% of the tedious monitoring needed with a manual system.
- Co-Inventor for "Perfusion system and apparatus for automated multi-channel patch-clamp recordings utilizing inside-out whole-cell configuration", US Patent 7,465,558, Issued Nov. 17, 2005.

Research and Development Engineer, Abiomed, Inc., Danvers, MA 9/00 – 9/02

Worked in a product development team designing, conducting and analyzing experiments needed to create a new product: The AB5000 Biventricular Support Console, a Class III device. Worked independently to critically evaluate outside cardiovascular support technology for potential acquisition.
Accomplishments:

- Helped develop an improved pneumatic control system using miniaturized electro-mechanical valves, mass flow meters, compressors, solenoids and embedded software. This electro-mechanical system provides substantial system flexibility, allowing the AB5000 to control both existing and envisioned disposable pumps, a significant benefit over the earlier console.
- Helped develop an improved pneumatic flow-sensing algorithm that more accurately measures blood flow. Console blood flow measurement error was reduced by 60%, from ±0.5 L/min to ±0.2 L/min.
- Completed numerous FDA required design verification tests and required documentation. Testing included: electrical safety (EN 60601-1), electromagnetic compatibility (EN 610004-2 thru -6), shock and vibration (RTCA/DO-160C) and biocompatibility testing with four ~75 kg pigs.
- FDA product approval March 2003 following our July 2002 submission. The AB5000 Biventricular Support Console now generates ~ $40 million in annual revenue for Abiomed, Inc.
- Fully characterized the hydraulic performance of two outside ventricular support devices: Berlin Heart and US Surgical.
- Completed an in-depth analysis of the AbioCor battery performance for a FDA investigational device exemption (IDE). The AbioCor is a pre-clinical heart replacement pump.

Staff Project Scientist, University of Pittsburgh, Department of Surgery 12/98 – 9/00

Led the laboratory testing program for artificial lung development, a pre-clinical Class III device that uses a pulsating balloon surrounded by hollow fiber membranes to exchange oxygen in the vena cava. Supervised two laboratory engineers and two manufacturing technicians. Designed, conducted, and analyzed in-vitro, ex-vivo, and in-vivo tests for device characterization. These tests examined pneumatics, mass transfer performance, hemodynamics and blood trauma.
Accomplishments:

- Optimized the catheter mechanical design using physics models and bench testing. Models solved the governing equations for structural mechanics and pneumatics as a function of catheter geometry. Results: 1) elimination of oxygen pressure drop creep – enabling chronic animal testing, 2) maximized oxygen partial pressure throughout hollow fiber bundle – maximizing mass transfer between device and blood, and 3) minimal helium pressure drop during balloon oscillation – again maximizing mass transfer.
- Designed, assembled, and tested a novel dynamic balloon-volume sensor. Coupled a thermal mass flow meter and a LabView program to measure delivered volume to the oscillating balloon. This sensor allowed real-time device trouble shooting during animal testing and device performance fine-tuning – both critical for upcoming clinical trials.
- Completed ten acute animal studies and nine chronic animal studies – demonstrating in-vivo capabilities.

Senior Engineer: Absorption Heat Transfer, United Technologies – Carrier, Syracuse, NY 8/94 – 12/98

Led the laboratory testing program for absorption cycle research. Supervised three skilled technicians and an engineer, including project planning, budgeting, reporting and performance reviews. Our goals: 1) improve existing lithium-bromide absorption products through modeling and experimentation and 2) develop a new ammonia-water absorption product in collaboration with the Department of Energy (DOE).
Accomplishments:

- Designed, built and managed the operation of three new absorption laboratories involving an array of testing parameters and complex control algorithms (value - $1M).
- Created component-specific analytical models, from first principles for transport process prediction and overall cycle models for system performance optimization and cost reduction. Physical process modeled: falling film two-phase heat and mass transfer taking place during absorption. Software used EES and VisSim. Outcome: 1) Lithium-bromide: a new heat exchange surface area distribution that reduced overall cost by ~10% and increased performance by ~5%, 2) Ammonia-water: an overall cycle feasibility study that guided heat/mass exchanger prototype designs.
- Successfully integrated the research activities of three external sources: private industry (Phillips Engineering, St. Joseph, MI), academia (Ohio State Univ., Columbus, OH) and government (Battelle Labs, Columbus, OH) to create enhanced heat and mass transfer devices for a novel heat pump.

Funded Research:

Attenuating reperfusion injury with combined hypothermia and gradual reperfusion, Merrill, T.L., National Institute of Health, National Heart, Lung and Blood Institute, $299,000, Sept. 1, 2013 – Sept. 1, 2014. Principal Investigator.

Bioengineering Team-Based Projects and Summer Immersion to Improve Design Expertise: Kadlowec, J., Merrill, T., National Institute of Health, $200,000, May 15, 2013 – March 15, 2018. Principal Investigator (multiple-PI).

Organizing the Curriculum - Enhancing Student Understanding of Core Engineering Concepts through Biomedical Activities, Farrell, S., Staehle, M., Vernengo, J., Merrill, T.,L., Polikar, R., National Science Foundation Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES), $200,000, 2012 – 2014, Co-Principal Investigator (Co-PI).

Making The Connection - Using a Long-Term Sustainable Design Project to Integrate the Mechanical Engineering Curriculum, Eric W. Constans, Hong Zhang, Jennifer A. Kadlowec, Krishan Bhatia, Thomas L. Merrill, National Science Foundation Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES), $199,958, June 1 , 2011 - May 31, 2014. Co-Principal Investigator (Co-PI).

A Combination Endovascular Device: Thrombectomy With Localized Hypothermia, T.L. Merrill, National Institute of Health, National Institute for Neurological Diseases and Stroke, $207,000, March 15, 2011 – March 15, 2012. Principal Investigator (PI)

A Cooling Guide Catheter for Rapid Heart Cooling, Merrill, T.L., NIH, National Heart , Lung and Blood Institute, NIH NHLBI, $944,128, March 2008 – March 2011. Principal Investigator (PI).

Peer-Reviewed Publications:

Sikorski, R.A., Merrill, D.R. and Merrill, T.L., Predicting Regional Brain Cooling Following Intracranial Thrombectomy With Localized Therapeutic Hypothermia, J. Med. Devices 7(3), 030927 (2 pages) doi:10.1115/1.4024514, Jul 03, 2013

Dahm, K., Riddell, W., Merrill, T., Harvey, R., and Weiss, L., Implementing Entrepreneurial Assignments in a Multidisciplinary, Sophomore-Level Design Course, Advances in Engineering Education, Volume 3, Number 3, http://advances.asee.org/vol03/issue03/09.cfm, (36 pages), Winter 2013.

Merrill, T.L., Mingin, T., Merrill, D.R., Akers, J.E., Perfusion, "A Hemolysis Study of an Intravascular Blood Cooling System for Localized Organ Tissue Cooling" doi: 10.1177/0267659112462733. Epub 2012 Oct 9.

Merrill, T.L., Merrill, D.R., Akers, J.E., Improved ease of use designs for rapid heart cooling, J. Med. Devices, Volume 6, Issue 3, 035001, http://dx.doi.org/10.1115/1.4006853, (10 pages) September 2012.

Merrill, T. L., Merrill, D. R., Nilsen, T., Akers, J., Design of a Cooling Guide Catheter for Rapid Heart Cooling, J. Med. Devices, Volume 4, Issue 3, 035001(8 pages) doi:10.1115/1.4002063, September 2010.

Vasilyev, D.V, Merrill, T.L, Iwanow, A., Dunlop, J, Bowlby, M.R., A novel method for patch-clamp automation, European Journal of Physiology, ISSN: 0031-6768 (Paper) 1432-2013 (Online) DOI: 10.1007/s00424-005-0029-2, April 5, 2006.

Vasylyev, D.V., Merrill, T.L., Bowlby, M. R., Development of a Novel Automated Ion Channel Recording Method Using "Inside-Out" Whole-Cell Membranes, *Journal of Biomolecular Screening*, October 18, 2005 as doi:10.1177/1087057105279481.

Merrill, T.L., *Therapeutic Hypothermia*, Edited by S. Mayer and D. Sessler, Book Chapter 9: Thermodynamics and Heat Transfer and co-author of Chapter 10: Surface and Endovascular Cooling. Marcel Dekker, New York, NY, (2005).

Hattler, B.G., Lund L.W., Golob, J., Russian, H., Merrill, T.L., Frankowski, B., and Federspiel, W.J., A respiratory gas exchange catheter: In vitro and in vivo tests in large animals, *Journal of Thoracic and Cardiovascular Surgery*, 124, pp. 520-530, (2002).

Golob, J.F., Federspiel W.J., Merrill, T.L., Frankowski, B.J., Litwak K., Russian H., and Hattler B.G., Acute in-vivo testing of an intravascular respiratory support catheter, *Journal of the American Society for Artificial Internal Organs,* 47(5), pp. 432-437, Sep-Oct (2001).

Merrill, T.L., Thermally controlled bubble collapse in binary solutions, *International Journal of Heat and Mass Transfer,* Vol. 43, pp. 3287-3298, (2000).

Conference Proceedings:

Sikorski, R., Merrill, D.R., and Merrill, T.L., Computational Modeling of the Canine Middle Cerebral Artery During Localized Hypothermia Stroke Treatment, SBC2013-14596, American Society of Mechanical Engineering (ASME) 2013 Summer Biomedical Engineering Conference, Sunriver, OR, June 20-23, 2013.

Sikorski, R., Merrill, D.R., and Merrill, T.L., Predicting Regional Brain Cooling Following Intracranial Thrombectomy, ASME Design of Medical Devices Conference, Minneapolis, MN, April, 2013.

Sikorski, R., Chapman, B.E., and Merrill, T.L., Two dimensional blood shear modeling in a blood cooling catheter, Comsol 2012 Conference Proceedings, Boston, MA, October 2012.

Sikorski, R., and Merrill, T.L., Three dimensional blood cooling model inside a carotid bifurcation, Comsol 2012 Conference Proceedings, Boston, MA, October 2012.

Mingin, T., Akers, J., Merrill, D.R., Chapman, B.E., Jones, B., Merrill, T.L., Ex Vivo Blood Damage Measurement for an Intravascular Blood Cooling and Delivery System, SBC2012-80546, American Society of Mechanical Engineering (ASME) 2012 Summer Biomedical Engineering Conference, Fajardo, Puerto Rico, June 20-23, 2012.

Merrill, T.L., Akers, J., Merrill, D.R., Localized Brain Tissue Cooling For Use During Intracranial Thrombectomy, SBC2012-80833, American Society of Mechanical Engineering (ASME) 2012 Summer Biomedical Engineering Conference, Fajardo, Puerto Rico, June 20-23, 2012.

Akers, J.E., Merrill, D.R., Gorman, R. L, Merrill, T.L. Localized Cooling Device for Myocardial Tissue Salvage, SBC2011-53155, American Society of Mechanical Engineering (ASME) 2011 Summer Biomedical Engineering Conference, Farmington, PA, June 22-25, 2011.

LaBarck, A, J., Akers, J.E., Merrill, T. L., Tissue Oxygen Transport during Reperfusion and Post-conditioning, SBC2011-53064 , American Society of Mechanical Engineering (ASME) 2011 Summer Biomedical Engineering Conference, Farmington, PA, June 22-25, 2011.

Constans, E., Kadlowec, J., Bhatia, K.K., Zhang, H., Merrill, H., and Angelone, B. Integrating the Mechanical Engineering Curriculum Using a Long-term Green Design Project Part 1: The Hybrid Powertrain, American Society of Engineering Educators (ASEE) 2012 ASEE Annual Conference and Exposition, San Antonio, TX, June 10-13, 2011.

La Barck, A.J., Akers. J.E., and Merrill, T.L., Fluid Dynamics of Blood Flow during Reperfusion and Post-conditioning, Comsol 2010 Conference Proceedings, Boston, MA, October 2010.

La Barck, A., Akers. J.E., and Merrill, T., Fluid Dynamics of Blood Flow during Reperfusion and Post-conditioning, Comsol 2009 Conference Proceedings, Boston, MA, October 2009.

Montgomery, P., Pavelchak, M., and Merrill, T, Structural Mechanics of Cooling Catheters, Comsol 2008 Conference Proceedings, Boston, MA, October 2008.

Fluid Dynamics of Blood Flow during Reperfusion and Post-conditioning, La Barck, A., Docimo, J, and Merrill, T., Comsol 2008 Conference Proceedings, Boston, MA, October 2008

Patents:

Merrill. T.L., Cooling Guide Catheter and Associated Method of Use, US 8,353,942, Issued January 15, 2013.

Merrill, T.L., Active surface exchange catheter and method, US 7,211,066, Issued May 1, 2007.

Vasylyev, D. V., Merrill, T.L, Bowby, M.R., Federkiewicz, A., Perfusion system and apparatus for automated multichannel patch□clamp recording utilizing inside-out whole cell configuration, US 7,465,558 B2, Issued November 17, 2005.

Awards and Activities:

- 2012 Faculty Center Wall of Fame Awards for "Excellence in Advising"
- 2011 Faculty Center Wall of Fame Awards for "Excellence in Advising"
- 2004 Above and Beyond, Wyeth Research, Morris Maze Project, with Len Brigman machinist.
- 2003 Biomedical Engineering Outstanding Presentation, Automating Microdialysis, 7/03, Wyeth Research, Biomedical Engineering Annual Meeting.
- Two special awards for "Outstanding Contribution to Team Effectiveness" at Carrier Corp.:
    - Heat exchanger development leadership as part of a team developing an advanced, first of its kind, ammonia-water heat pump. (11/95)
    - Project leadership in the development of a 50-ton Lithium Bromide chiller to be used as a new development platform for absorption technologies. (9/97)
- Member of the American Society of Mechanical Engineering (ASME)
- Member of the American Society of Engineering Educators (ASEE)
- Reviewer
    - Journal of Applied Physiology
    - Perfusion
    - Journal of Medical Engineering and Physics
    - Journal of Artificial Internal Organs