Thomas L. Merrill

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Education:

Pennsylvania State University, University Park, PA 8/91 – 12/94
Doctor of Philosophy in Mechanical Engineering
Dissertation: *Bubble Heat and Mass Transfer Dynamics in Binary Solutions* (Advisor: Dr. H. Perez-Blanco)
University of Michigan, Ann Arbor, MI 9/89 – 12/90
Master of Science in Mechanical Engineering (Advisor: Dr. W. Schultz)
- Graduate Study Focus**:** thermodynamics, transport phenomena, and computational techniques applied to thermal fluid sciences.

Bucknell University, Lewisburg, PA 9/83 – 5/87
Bachelor of Science in Mechanical Engineering

Computer Skills: Comsol Multiphysics (Finite Element Modeling), Engineering Equation Solver (non-linear systems solver), Visual Basic, FORTRAN, LabView, and Solidworks.

Research Experience:

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

- Supervise the mechanical engineering group consisting of three engineers, a designer, and a machinist. Our technology: pulmonary drug delivery systems.
- 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.
- 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 design improvements.
- Applied FEA to design and analyze the fluid dynamics of inhaler flow channels and the resonant acoustics of blister synthetic jetting.

Director of Research and Development, FocalCool, LLC, E. Windsor, NJ 1/05 – present

- NIH Grant Principal Investigator, Title: Active mixing catheter for selective organ cooling, Awarding Institute: National Institute of Neurological Diseases and Stroke, Amount: $170,000. Goal: Apply active mixing heat transfer enhancement to create a medical device that rapidly cools blood inside arteries for neuroprotection from stroke.
- Manage all facets of company R&D: contract manufacturers, contract animal testing services, legal services, patent work, business plan development, and communication to NIH and collaborators at the Cleveland Clinic Foundation.
- Design, develop, fabricate, and test blood cooling systems in both invitro and invivo settings. Hardware systems are designed using differential (FEA) and control volume analysis. FEA analysis applies the governing equations for heat transfer and structural mechanics to define optimal catheter geometry. Control volume analysis solves a system of non-linear equations to define optimal blood entry points.
- Demonstrated rapid tissue cooling in the brain and heart with nine large (~70 kg) pigs, 2 - 4ºC in 12 minutes – approximately 3X faster than competitive intravascular devices.

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

- 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.

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

- Designed and conducted experiments for improving cardiovascular support products. These experiments measured device performance in terms of dynamic pressure/flow characteristics for air and blood. Ex vivo and in vivo testing included evaluation of blood trauma and thrombus formation.
- Developed improved fluid control systems using miniaturized electro-mechanical valves, mass flow meters, compressors, solenoids, and embedded software that requires control algorithm development.
- Developed improved fluid flow sensing algorithms more accurately measure blood flow over a broad range of operating conditions.
- Ensured that design verification testing met product specifications and FDA medical device acceptance standards, as well as QSR. This includes budgeting, scheduling and completing off-site standards testing. FDA Product Approval achieved 3/03 – AB5000 Biventricular support device, based on a FDA submission 7/02.
- Tested and analyzed outside intellectual property for potential blending with existing ABIOMED, Inc. technology.

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. Supervised two laboratory engineers and two manufacturing technicians.
- Designed in-vitro, ex-vivo, and in-vivo tests and protocols for device characterization. These tests investigated gas exchange performance, hemodynamic impact, and blood trauma.
- Optimized catheter design: Designed a dual lumen catheter using compressible flow analysis and elastomer property theory. Design models used a combination of Newton's method with sparse matrix techniques to solve systems of non-linear algebraic equations. This design ensured constant oxygen flow to the artificial lung during lengthy chronic animal testing.
- Oscillating flow meter design: Coupled a thermal mass flow meter with a Labview program to measure delivered volume to an oscillating balloon. This meter allowed real-time device trouble shooting during chronic animal testing and enabled device performance fine-tuning, critical for future clinical trials.
- Two invention disclosures: A dynamic balloon volume sensor and an intravascular blood conditioner for supporting patients with partial or complete oxygen deprivation.

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

- Designed, built, and managed the operation of three absorption laboratories involving a wide array of testing parameters and complex control algorithms (value - $1M).
- Supervised three skilled technicians and an engineer in the construction, use, and maintenance of these testing labs, including project planning, budgeting, reporting, and performance reviews.
- Created component-specific analytical models, from first principles, for transport process prediction, and generated overall cycle models for system performance optimization and cost reduction. The conjugate gradient method was used to solve this non-linear optimization problem. Physical process modeled: falling film two-phase heat and mass transfer occurring with absorption.
- Project management: 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.

Research Assistant: The Pennsylvania State University. University Park, PA 8/91 - 8/94

- Designed and tested a bubble absorber that met the original design goals in terms of ease of manufacturing, heat transfer performance, compactness, and cost effectiveness.
- Created a unique transient 2D finite difference model for predicting bubble collapse inside a subcooled binary liquid. A Lagrangian approach was used with an adaptive grid to handle the moving gas-liquid interface. This model revealed the complex behavior of two species during bubble collapse; these findings were published in two articles in the International Journal of Heat and Mass Transfer.
- Industrial consulting: Trane Co., La Crosse, WI, Lithium-bromide absorption chiller modeling and analysis.
- Awarded a Japanese Patent for a novel bubble absorber design.

Mentoring and Teaching Experience:

Mentor – Abiomed Inc. (2000-2002)

- Supervised 5-month internships by Cornell University sophomores and juniors. Guided interns along two paths: 1) carrying out individual research studies related to previously uninvestigated aspects of blood pumping and 2) conducting product development tests such as artificial heart battery life tests.

Mentor – University of Pittsburgh (1999-2000)

- Supervised the research of two summer interns in the Artificial Lung Laboratory. The first intern studied the influence of vessel compliance on mass transfer. The second studied new ways to accurately measure the dynamics of balloon inflation and deflation.

Mentor – Penn State University (1991-1994)

- Taught two incoming research assistants how to safely operate a $75,000 absorption test rig built by my advisor and myself and funded by Osaka Gas, Osaka Japan. Helped guide their experimental work towards their M.S. degrees.

Teaching Assistant – University of Texas at Austin (1991)

- Taught the undergraduate fluid mechanics laboratory including lecture and laboratory work. Administered weekly quizzes and held office hours.

Refereed Journal Publications:

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.

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 invivo 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).

Federspiel, W.J., Golob, J., and Merrill, T.L., Ex-vivo testing of the intravenous membrane oxygenator, *Journal of the American Society for Artificial Internal Organs*, 46(3), pp. 261-267, (2000).

Merrill, T.L., Setoguchi, T., and Perez-Blanco H., Compact bubble absorber design, *Journal of Enhanced Heat Transfer,* Vol. 5, No. 4, pp. 249-256, (1998).

Merrill, T.L., and Perez-Blanco H., Combined heat and mass transfer during bubble absorption in binary solutions, *International Journal of Heat and Mass Transfer*, Vol. 40, No.3, pp. 589-603, (1997).

Merrill, T.L., Setoguchi, T., and Perez-Blanco H., Passive heat transfer enhancement techniques applied to compact bubble absorber design, *Journal of Enhanced Heat Transfer*, Vol. 2, No.3, pp. 199-208, (1995).

Refereed Conference Presentations:

Merrill, T.L., Yadav, J. Catheter optimization using Comsol Multiphysics, *2006 Comsol User Conference*, Cambridge, MA, October 23, 2006.

Merrill, T.L, Enhancing endovascular heat and mass transfer, *Neurocritical Care Symposium, Fourth International Clinical Neuromonitoring Meeting, Cleveland, OH,* Sept. 28th and 29th, (2001).

Merrill, T.L., Hattler, B.G., and Federspiel, W.F. Gas-side oxygen measurement for intravascular artificial lungs, *American Society for Artificial Internal Organs Annual Meeting*, New York, NY (2000).

Golob, J., Merrill, T.L., and Federspiel W.J., Acute testing of an intravascular artificial lung, *American*

Society for Artificial Internal Organs Annual Meeting, New York, NY (2000).

Golob, J. and Merrill T.L., Analysis of in-vivo flow effects on the in-vitro testing of intravascular oxygenators, *American Society for Artificial Internal Organs Annual Meeting*, San Diego, CA (1999).

Merrill, T.L., Setoguchi, T., and Perez-Blanco H., Compact bubble absorber design and analysis, *ASME International Absorption Heat Pump Conference,* AES-Vol. 31, pp. 217-223, (1994).

Book Chapters:

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

Technical Reports and Presentations:

Merrill, T.L. Enhancing endovascular heat and mass transfer: From artificial lungs to cooling catheters, Cleveland Clinic Foundation, Dept. of Neurology, Grand Rounds Aug. 29th, (2001).

Merrill, T.L., Golob, J.F., Russian, H., Frankowski, B., Lund, L., Litwak, K., Federspiel, W.J., Hattler, B. G., Continued Development of the Intravenous Membrane Oxygenator, *Grant DAMD17-98-1-8638, U.S. Army Medical Research and Materiel Command*, Fort Detrick, MD., 64 pp., (August 2000).

Merrill, T.L., Golob, J.F., Russian, H., Frankowski, B., Lund, L., Litwak, K., Federspiel, W.J., Hattler, B. G., Continued Development of the Intravenous Membrane Oxygenator, *Grant DAMD17-98-1-8638, U.S. Army Medical Research and Materiel Command*, Fort Detrick, MD., 97 pp., (August 1999).

Merrill, T.L., Heat and mass transfer in advanced aqua-ammonia cycles, *United Technologies Engineering Conference 97'*, Hartford, CT (March 1997).

Grants:

Awarded

- Principal Investigator, NIH – National Institute of Neurological Diseases and Stroke, *An active mixing catheter for selective organ cooling*, Amount $170,000, 7/05-7/06.
- Principal Investigator, Private Investor, *A cooling guide catheter for rapid organ cooling*, Amount $150,000, 1/05 to 7/05.
- Principal Investigator, Cleveland Clinic Foundation Research Grant, Dept. of Neurology, *Novel Cooling Devices for Ischemic Tissue Preservation*, Amount, $15,000, 11/02 – 11/03.

Submitted

- Principal Investigator, NIH – National Heart, Lung, and Blood Institute, *A cooling guide catheter for rapid myocardium cooling*, 8/1/07, Priority Score 190, Amount $1 MM 5/08-5/10.

Patents:

- Perfusion system and apparatus for automated multi-channel patch-clamp recordings utilizing inside-out whole-cell configuration, US Patent Applic. # 20050255446, together with D. Vasylyev and M. Bowlby, received 11/05,
- Active Mixing exchange catheter and method, Application #10,620,212, received 5/07
- Cooling catheter and method with adjunctive therapy capability, Application #10/305,374

Awards and Activities:

- 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)
- Pennsylvania State University Teaching Fellowship Award (7/94)
- Natural Sciences and Engineering Research Council of Canada Visiting Fellowship Award (7/94)
- Member of the American Society of Mechanical Engineering