

Minimally Invasive Medical Technologies Center (MIMTeC)

A National Science Foundation (NSF)

Industry/University Cooperative Research Center (I/U
CRC)

2009 Annual Report

A Year in Review



Letter from Directors

The Minimally Invasive Medical Technologies Center (MIMTeC) was established as a National Science Foundation (NSF) Industry / University Cooperative Research Center (I/U CRC) in 2007. Each year we are delighted to provide an annual report that reflects the Center's activities and accomplishments during the period July 1, 2008 – June 30, 2009.

Innovation in medical devices is key to enabling better healthcare; and this is very important as our population ages. MIMTeC, through its partnerships with NSF and industry collaborators has accomplished a number of significant activities this past year. This annual summary is a compilation of those activities, including research, discovery, and the development of mutually beneficial collaboration.

This report highlights the Center's research themes. Members of MIMTeC maximize their awareness of a higher fidelity of detail as a major benefit of membership. A valuable outcome of Center partnerships is a growing relationship and access to talented young men and women in the engineering sciences who have achieved their academic credentials, preparing them for careers in the medical field.

The work of the Center could not be accomplished without our faculty, our graduates and undergraduates at the University of Minnesota and the University of Cincinnati, and most importantly, our industrial partners. These same partners constitute our Industry Advisory Board, which provides guidance and strategic direction. We are very appreciative to them for their efforts.

We look forward to expanding the Center with new industry partners and engaging in new research directions, which add value to the practice of medicine through efficient and effective design. The past year has been exciting, and we look to a bright future and productive year ahead.

We encourage feedback and look forward to the future.



Arthur Erdman, Ph.D.
Director, MIMTeC
Director, Medical Devices Center
Institute for Engineering in Medicine
University of Minnesota



Carlo Montemagno, Ph.D.
Co-Director, MIMTeC
University of Cincinnati



Kenneth Rosen, MBA
Administrative Director, MIMTeC
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Administrative Director, MIMTeC
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Overview

The National Science Foundation (NSF) established a program where academia and industry collaborate in a variety of disciplines. This program, which creates centers of excellence, is known as an Industry/University Cooperative Research Center (I/U CRC). The University of Minnesota and the University of Cincinnati have teamed with a group of medical device companies in the United States to create the Minimally Invasive Medical Technologies Center (MIMTeC).

Following NSF guidelines, MIMTeC established relationships with a number of companies with high levels of interest in medical technology. Each of these companies serves as a member for a minimum of three years, paying a membership fee of \$50,000 per year. Membership provides opportunity to help develop the Center's strategic direction and sharing in research results through access to discovery and intellectual property.

MIMTeC operates using a July – June fiscal year and since it is university-based, it must adhere to the policies and procedures of those institutions. Each fiscal year constitutes a class. Therefore, member companies belong to a yearly class. This annual report covers the period of July 1, 2008 – June 30, 2009 (Class #2).

MIMTeC's **vision statement** is *"To be a nationally-recognized leader in research that meets the needs of United States companies who design, manufacture and market devices for minimally invasive medical diagnosis and treatment."* This vision is further defined through MIMTeC's **mission statement**: (a) *To develop enabling technologies and methodologies for advanced minimally invasive medical devices for the benefit of center members and society and (b) To enlarge the cadre of scientists and engineers capable of advancing minimally invasive medical technologies.*

Organization

MIMTeC was created through a collaboration between two uniquely qualified universities: the University of Minnesota (UMN) and the University of Cincinnati (UC), each bringing strength in engineering and medicine.

Partners

During this past year, Cordis, Great Batch, and Medtronic withdrew their membership at the conclusion of the second year. The inset graphic illustrates MIMTeC's industrial partners Class 2. MIMTeC leadership continues to recruit new collaborators.



Research Themes

MIMTeC is focused on translational research that addresses critical scientific and educational challenges. This research is where academia and industry collaborate in a precompetitive environment, and in areas where the type of research being conducted by MIMTeC is best performed in academia – work that is not performed at member companies.

The principle areas of research themes or focus are those in the disciplines of medical devices or system components that can provide minimally invasive approaches to health management. This philosophy is aligned with industry growth and expectations as well as an awareness of the technical prowess of the United States. The areas must show promise for industrial partnership and must be relevant and transferable to commercial product in a short period of time. Proposed research is driven by both academia and industry.

Member Benefits

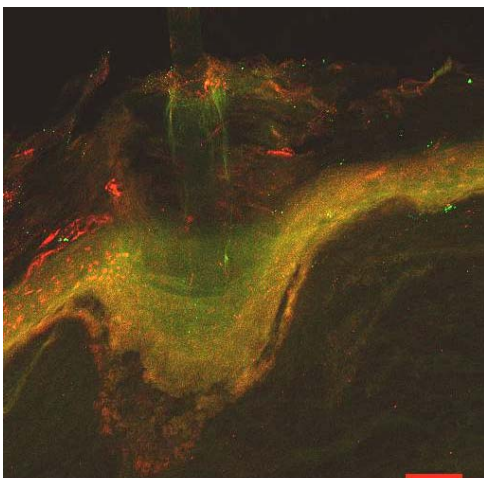
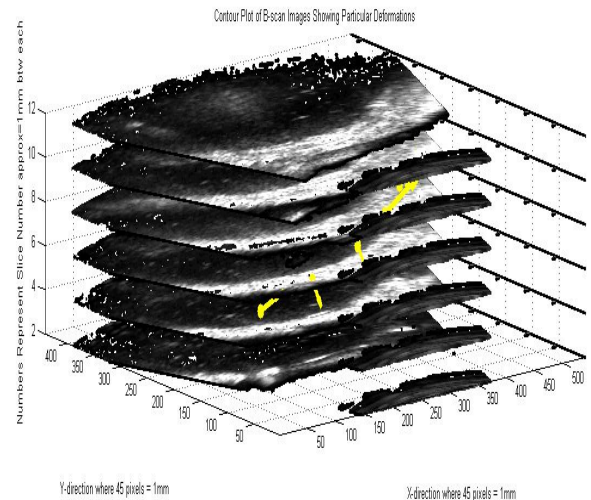
- ✓ Bridge gap between federal research funding and company product development investment
- ✓ Amplify industry funds return on investment – leverage
- ✓ Access to leading edge research expertise, facilities and future workforce

The areas of concentration for the previous year (Class 2) have been focused on looking at MEMS sensors, ultrasound mapping, image-guided interventions, battery-less wireless sensing, and new approaches to tissue cutting. The following are the titles of the research projects.

University of Cincinnati

- ◆ Ultrasound Temperature Mapping for Design Verification of Thermal Devices*
- ◆ Image-Based Deformation Analysis of Soft Tissues – Internal Organs
- ◆ In Vitro Photoelastic Model of Arterial Aneurysms with Wall Stress Sensing Capability*
- ◆ Rationale Design of the Human Device Interface and Catheter-Based Interventions

**Completed*



University of Minnesota

- ◆ Neurophysiology of the Lower Urinary Tract
- ◆ Design of MRI Compatible Instrumentation for Image-Guided Interventions*
- ◆ Battery-Less Wireless Sensing for MIS and other Biomedical Applications*
- ◆ New Tactile MEMS Sensors for Endoscopic End-Effectors

**Completed*

As the center moves forward, its research is driven more by the needs of member companies so that it creates more value for them and for potential new members. Member companies will collaborate to design this research so that it is pre-competitive enough for competing companies to comfortably share both their input and the knowledge, data and intellectual property that is generated by it.

The research will likely be in areas of common interest to all members, so that it can be pooled together to fully-leverage industry membership funds and generate the value of several times the amount of funding from each member company.

This collaborative effort began at the Fall 2009 meeting, with the objective of designing the next year of research projects to be finalized and approved by the Spring 2010 meeting.

MIMTeC Team

The organization of MIMTeC is supported by a solid management team, a robust cadre of faculty scientists and researchers, and an outstanding group of students at all levels of their educational experience. This is accomplished across two different campuses and different department, Mechanical Engineering at Minnesota and Biomedical Engineering at aCincinnati.

During this past year, the co-Director, Dr. Bala Haridas left the University of Cincinnati for industry. Carlo Montemagno, PhD, Dean of the UC College of Engineering and Applied Sciences and Charles R Doarn, MBA provided leadership during this absence. The coming year will bring a new co-Director at the University of Cincinnati.

Leadership

The Center is under the leadership of Arthur Erdman, PhD who serves as director. Dr. Erdman is a well known leader and mechanical engineer in medical device design at the University of Minnesota. He also heads up the University of Minnesota's Medical Design Center. He was joined by Bala Haridas, PhD, who served as co-director until his departure. Dr. Montemagno and Mr. Doarn provided a seamless transition.

The daily management functions of MIMTeC are handled by Kenneth Rosen, MBA at the Minnesota and Mr. Doarn at Cincinnati. They keep abreast of the center operations and maintain the business functions of the Center to maximize research return.

IAB

Membership in MIMTeC provides each member company a seat on the Industry Advisory Board (IAB). The chair of this board rotated from Medtronic's Dr. Cushing Hamlen to Procter and Gamble's Gary Gross in May 2009. The IAB provides guidance and selects research for the coming year. It also shares in the outcomes of the Center.

Students

All research conducted within MIMTeC is accomplished by an outstanding cadre of graduate and undergraduate students. A number of them have graduated this year. The following list of students is provided to illustrate the depth of discipline expertise.

Name	Discipline	School	Degree
Amel Alqadah	BME	UC	BS
Nilesh Billade	ME	UC	PhD (2009)
Mark Burgess	BME	UC	BS
Jason Kleinhenz	BME	UC	BS
Ashok Nageswaran	ME	UC	MS
Anna Nagle	BME	UC	PhD
Sweta Patel	BME	UC	BS
Eileen Slavin	Biology	UC	BS
Kyle Rich	BME	UC	PhD
Gaurav Srivastava	BME	UC	MS*
Swetha Subramanian	BME	UC	PhD
Christopher Weidner	BME	UC	MS
Deepa Deepa	ME	UMN	PhD
Mithun Gundi	Urology	UMN	MS*
Nathan Knudson	ME	UMN	PhD*
Blake Larson	ME	UMN	PhD
Peng Peng	ME	UMN	PhD

(*denotes graduation)

Education and Outreach

The output of the Center can be measured in a number of ways including intellectual property, the number of peer-reviewed papers published, the number of degrees granted, and the number of companies that have joined the Center.

Although MIMTeC is in its early stages, it has provided a platform of innovation and discovery. MIMTeC students have received invaluable experience working with faculty and industry leaders; and several have achieved their academic goal of graduating. The following lists highlights the Center's academic accomplishments.

Intellectual Property

Micro Sensors for In-Vivo Measurement of Tissue Stiffness – Minnesota - Rajamani

Ph.D. Thesis

Niles Billade, PhD (UC '09)

Ph.D., Mechanical Engineering

Novel Carbon Nano Fiber Composite Biomaterials for Functional Tissue Engineering

Deepa Deepa, PhD (UMN '09)

PhD, Mechanical Engineering

Laser-Assisted Breast Tumor Excision under MRI Guidance: A Multivariate Study

Master Thesis

University of Cincinnati

- Gaurav K. Srivastava, MS (UC '08)

MS, Biomedical Engineering

State of Stress in Idealized Fusiform Abdominal Aortic Aneurysm Phantoms: A Photoelastic Study

- Ashok R. Nageswaran, MS (UC '09)
MS, Mechanical Engineering
Deformation Analysis of Soft Tissues by Digital Image Correlation

University of Minnesota

- Nathan J. Knutson, MS (UMN '09)
Master of Science, Mechanical Engineering
Magnetic Resonance Imaging: Material and Device Compatibility
- Scott McDonald, MS (UMN '09)
Master of Science, Mechanical Engineering
Metallic Artifact Suppression through Material Combinations in Magnetic Resonance Imaging

Peer-reviewed Manuscripts

- Mast TD, Pucke DP, Subramanian SE, Bowlus WJ, Ruddich SM, Buell JF. Ultrasonic Monitoring of In-vitro radiofrequency Ablation by Echo decorrelation Imaging. *J Ultrasound Med*, 2008; 27:1685-97.
- Zhang, Y., Kim, S., Erdman, A.G., Roberts, K.P., and Timm, G.W. Feasibility of Using a Computer Modeling Approach to Study SUI Induced by Landing a Jump. *Annals of Biomedical Engineering*. 2009; 37(7): 1425-33.
- Zhang, Y., Sweet, R.M., Metzger, G.J., Burke, D.M., Erdman, A.G., and Timm, G.W. Advanced Finite Element Mesh Model of Female SUI Research During Physical and Daily Activities. *Studies in Health Technology and Informatics*. 2009; 142: 447-52.

Conference Publications

- ♦ Zhang, Y., Timm, G.W., Sweet, R.M., Metzger, G.J., Burke, D.M, and Erdman, A.G. Computer model based dynamic urethrovaginal support assessment for female SUI. International Continence Society (ICS) Conference. San Francisco, CA. USA. 2009.
- ♦ Zhang, Y., Sweet, R.M., Metzger, G.J., Burke, D.M, Erdman, A.G., and Timm, G.W. Feasibility Study of Subject-specific Computer Model Approach in Female Stress Urinary Incontinence Research. *Annual Meeting of the American Urological Association*. Chicago, IL, 2009. *J Urol* 181(4) suppl: 572.
- ♦ Zhang, Y., Forrest, A.J., and Timm, G.W. Periarethral Neuromusculature Stimulation in Reducing Voiding Frequency: A Rat Study. *24th Annual Meeting of Engineering & Urology Society*. Chicago, IL, USA. 2009.
- ♦ Zhang, Y., Timm, G.W., Erdman, A.G., and Sweet, R.M. Finite Element Analysis of the Female Pelvis. *23rd Annual Meeting of Engineering & Urology Society*. Orlando, FL, USA. 2008.
- ♦ Zhang, Y., Timm, G.W., Erdman, A.G., and Sweet, R.M. Computer Simulation of Female Urinary Incontinence. *7th Design of Medical Device Conference*. Minneapolis, MN, USA. 2008. (*Published in the ASME Journal of Medical Devices*. 2008).

Additional MIMTeC-Funded Research

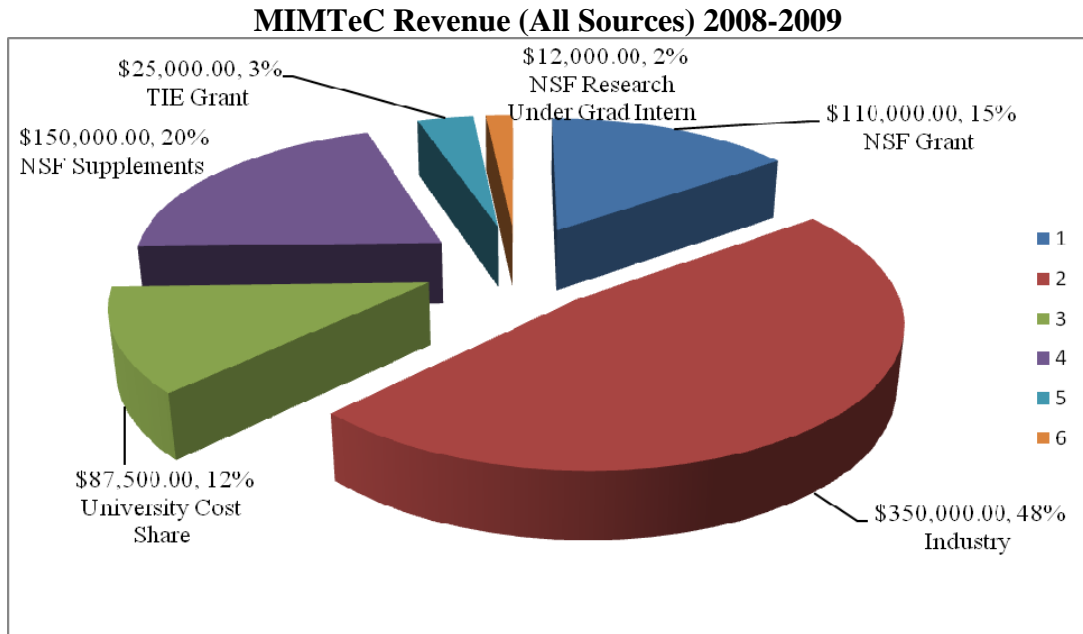
- (1) A TIE grant with Arizona State University –‘High Efficiency Power Delivery and Front-End, Module Design for Implantable Bio Sensors’
- (2) A fundamental research grant ‘Generalized Cutting Work and Fracture Energy Characterization for Soft Tissue Resection in Minimally Invasive Surgery
- (3) A CISE grant –‘Merging 3-D Anatomical and Surgical Tool Virtual Representations’.

Financial Summary

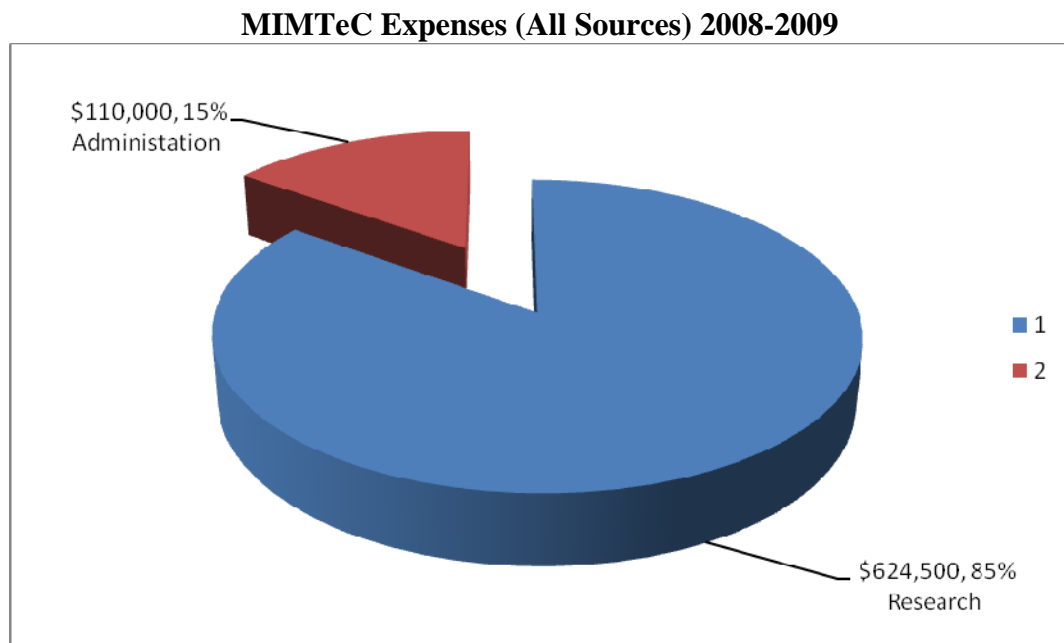
MIMTeC funding comes from various sources, including industry membership fees, university cost share, NSF grants and NSF supplements. The majority of the expenses support research activities.

The following pie charts illustrate the basic revenue and expenses at the top level.

Revenue



Expenses



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On the Web

MIMTeC - www.mimtec.org

NSF - www.nsf.gov/eng/iip/iucrc