Senior Design Projects

2025

JOINT DEPARTMENT OF
BIOMEDICAL ENGINEERING

MARQUETTE UNIVERSITY

MEDICAL COLLEGE OF WISCONSIN

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Novel adaptive self-standing robot that engages children with disabilities through multisensory and cause-and-effect interactions.

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Senior Design Projects

2025

To our Industry Partners

We are pleased to present the Biomedical Engineering Senior Design Projects completed during the 2024-2025 academic year with the joint department between Marquette University and the Medical College of Wisconsin.

The Joint Department of Biomedical Engineering at Marquette University and the Medical College of Wisconsin is dedicated to preparing students for their professional and personal lives after graduation. Undergraduate students can specialize in biomechanical, bioelectrical, or biocomputer engineering. In addition to courses in engineering, mathematics, and the life sciences, students are required to complete several design challenges in the freshman year and a year-long project-based capstone design course in the senior year. Students develop their teamwork skills, learn about the product development process used in industry, and are made aware of the unique requirements and constraints of medical device design. They consider legal and regulatory issues, use standards where applicable, conduct economic analyses, and learn about packaging, sterilization, and testing of medical devices. Several project deliverables, similar to those used in industry, are required. This capstone design experience provides students with the knowledge base and skill sets needed to be effective contributing members of a medical device company, clinical engineering department, or academic research laboratory, and create value for their customers.

This was the ninth year of our new Joint Department of Biomedical Engineering between Marquette University (MU) and the Medical College of Wisconsin (MCW). Department faculty from MU and MCW served as advisors to project teams. This year we continued our 20-year collaboration with the Milwaukee Institute of Art and Design (MIAD). Four of our project teams collaborated with industrial design students from MIAD during the spring semester.

In our Biomedical Engineering Department, students may enhance their design experience and preparation for careers in the engineering profession through work experience. At the Les Aspin Center for Government Studies, students can work as interns for the US Food and Drug Administration and learn first-hand how the FDA functions and what is required to market a regulated medical device. Students participating in our highly popular and nationally recognized Cooperative Education Program gain work experience at medical device companies prior to graduation.

As you read through this report and learn of the benefits of industry sponsorship of senior design projects, please consider becoming a sponsor. We recognize the value to our students and program of strong ties to industry, and we are interested in working with additional companies to help us prepare our students for careers in biomedical engineering.

Respectfully,

Jay R. Goldberg, Ph.D., P.E.
Professor of Practice in Biomedical Engineering
Senior Design Course Instructor

Frank Pintar, Ph.D.
Professor and Chair
Joint Department of Biomedical Engineering

Requirements for Industry Sponsorship of Senior Design Projects

Senior Design Course Sequence

At Marquette University, all senior biomedical engineering students are required to successfully complete a set of project-based capstone design courses (BIEN 4920 Principles of Design, and BIEN 4998 Senior Design).

At the end of these courses, students will demonstrate

- the ability to connect and apply the knowledge and skills developed in previous engineering (and other) courses towards a design solution (to a specific problem) that creates value for a customer,
- the ability to plan and produce a product or service that will meet customer needs,
- the ability to work effectively in teams, and
- written technical and oral communication skills.

Senior Design Project

The major component of the course is a design project that is managed by a multidisciplinary team of three to five students for an entire academic year. During the year, project teams identify customer needs, develop potential designs, construct and test prototypes, and deliver a design and/or working prototype to their industry sponsors. Project teams develop project schedules, maintain project notebooks, conduct economic and risk analyses of their design solutions, and develop and present written and oral project proposals and final reports.

Many of the projects are industry sponsored and provide students with an opportunity to learn about the needs of the medical device market and the operations of a company. Experience gained from industry sponsored projects helps prepare students for careers in the medical device industry. Teams are advised by a biomedical engineering faculty member and a representative from the sponsoring company.

Benefits of Sponsorship of Senior Design Projects

Benefits to companies

- Additional resources at little cost to company. Three to five senior engineering students will be dedicated to each project for two semesters. The sponsoring company can specify the composition of the project team (biomedical, electrical, computer, and mechanical engineering students). This can be very beneficial to companies with limited engineering resources and can allow companies to focus efforts on higher priority projects.
- Involvement and participation in the training of new engineers and potential employees.
- On-campus advertisement of the sponsoring company.

Involvement in the senior design project will provide the company access to and a higher profile among graduating engineers.

Benefits to students

- Opportunity to work on real-world problems important to industry.
- Exposure to the medical device industry and market.
- Experience with project management and product development.
- Familiarity with requirements and constraints of medical device design.

Requirements for Industry Sponsorship

Personnel

Sponsoring companies must identify at least one company representative to act as an industry advisor to the project team. The industry advisor would be the company contact for the project team, advise students on customer needs, provide technical expertise and advice, and approve design concepts and prototypes.

Faculty advisors will be responsible for administrative issues (grading, monitoring progress of teams, dealing with team personnel issues, etc.) and providing guidance to the team.

Time

At a minimum, industry advisors must be available to discuss project requirements, customer needs, and potential designs. Communications can be virtual, in-person, or by phone or e-mail. The industry advisor determines the frequency of communications.

Travel

The industry advisor determines the need for travel.

Funding

Depending upon the needs and expectations of the sponsor, a fund of $1000–$1500 may be necessary to pay for prototypes and testing.

Other

Students have access to Marquette University's computer network, libraries, Discovery Learning Laboratory (machine shop, collaboration space, 3D printers, prototyping resources), faculty expertise, and engineering laboratories. Sponsors may want to provide additional resources (prototyping facilities and/or personnel, laboratories, etc.) to their project teams if desired.

Types of Projects Appropriate for a Senior Design Project

- Lower priority projects for which the company lacks resources.
- Projects that can be completed in nine months or less.
- New products (hardware or software).
- Product improvements (new features, packaging, materials, etc.).
- Process improvements.
- Development of test procedures and/or test equipment.

Protection of Proprietary Information

Sponsors can request that members of their project teams sign non-disclosure agreements to protect confidential and proprietary information.

To Sponsor a Biomedical Engineering Senior Design Project

If you have any questions about our senior design program or if you are interested in sponsoring a senior design project please contact **Dr. Jay Goldberg at jay.goldberg@marquette.edu.**

We look forward to working with you.

Industry Sponsors

2024-2025
GE Healthcare, Waukesha, WI
Boston Scientific, Minneapolis, MN

2023-2024
Visionary League, Milwaukee, WI
Tecomet, Inc., Kenosha, WI

2022-2023
eClusion, Milwaukee, WI
GE Healthcare, Waukesha, WI
Medtronic USA, Minneapolis, MN
Fresenius Kabi, Lake Zurich, IL

2021-2022
GE Healthcare, Waukesha, WI
eClusion, Milwaukee, WI
Spectroscopy and Data Consultants, Pty. Ltd., Brisbane, Australia

2020–2021
SeaSpine, Carlsbad, CA
Spectroscopy and Data Consultants, Pty. Ltd., Brisbane, Australia

2019–2020
SeaSpine, Carlsbad, CA
Medtronic USA Inc., Minneapolis, MN
GE Healthcare, Waukesha, WI
Spectroscopy and Data Consultants, Pty. Ltd., Brisbane, Australia
FreedomTrax, Waukegan, IL

2018–2019
GE Healthcare, Waukesha, WI
Spectroscopy and Data Consultants, Pty. Ltd., Brisbane, Australia
Resolution Medical, LLC, Minneapolis, Minnesota

2017–2018
Mortara Instruments, Milwaukee, WI
3M, Minneapolis, MN
GE Healthcare, Waukesha, WI

2016–2017
Siemens Medical Solutions USA Inc., Hoffman Estates, IL
Safe Place Bedding, LLC, Conesville, OH
9 Degrees of Human, Milwaukee, WI

2015–2016
Medtronic USA Inc., Minneapolis, MN
Trek Bicycle Corporation, Waterloo, WI
Cardiac Profiles Inc., Franklin, TN
Zimmer Biomet, Warsaw, IN

2014–2015
GE Healthcare, Waukesha, WI
Medtronic USA Inc., Minneapolis, MN
Rowheels, Fitchburg, WI

2013–2014
Cytophil, Inc., East Troy, WI
DesignWise Medical, Loretto, MN
GE Healthcare, Waukesha, WI
Siemens Healthcare, Hoffman Estates, IL
Medtronic USA Inc., Minneapolis, MN

2012–2103
NeoCoil, LLC, Pewaukee, WI
Gauthier Biomedical, Grafton, WI
3M, Minneapolis, MN

2011–2012
GE Healthcare, Waukesha, WI
Medtronic USA Inc., Minneapolis, MN
Innovator of Disability Equipment and Adaptations, LLC, Pewaukee, WI

Device to Measure Volume of Oxygen Delivered via AMBU Bag

Project Team
Max Marquez
Ryan Steffens
Anthony Limon
Logan McCullough
Francis Nuguid

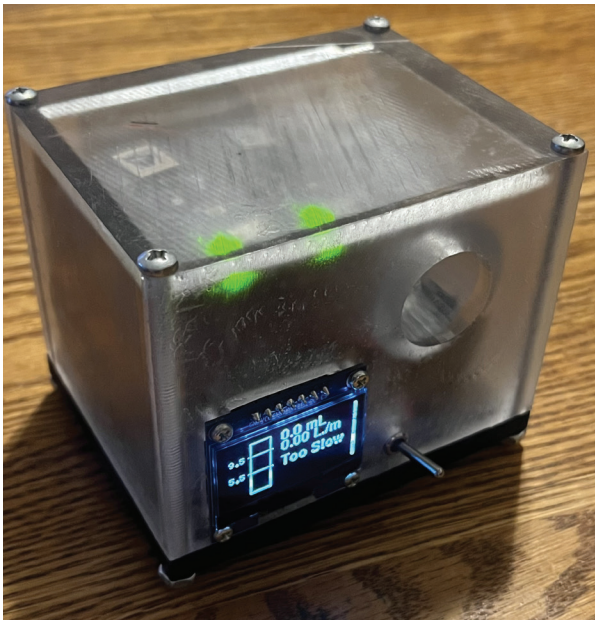
Faculty Advisor
Dr. Guilherme Garcia

Sponsor
Dr. Jay Tumulak
Marquette University
School of Nursing

Bag Valve Mask (BVM) systems, also known by their brand name Ambu bag, are devices used to manually ventilate patients in intensive care settings. Medical staff manually pump air by rhythmically squeezing the bag. Today, BVM devices pose a risk of patient hyperventilation or hypoventilation because they do not include a flowmeter to measure the volume of oxygen delivered to the patient.

The goal of this project was to create a flowmeter to measure the volume of air delivered by BVM devices and provide feedback to medical staff on the correct pumping rate to maintain normal ventilation. The flowmeter was fabricated using two pressure transducers to record the pressure difference across a venturi tube. The pressure difference was converted into the air flowrate via an experimentally determined discharge coefficient, thus allowing quantification of the volume of air delivered each time the pump was squeezed.

Testing of the device showed an accuracy of 3.7 + 2.7% for estimating the volume of air delivered per pump squeeze, which was well within the customer needs of ±10% error. The prototype flowmeter included a screen to graphically depict the pumping rate and alert medical staff if the pumping rate was too fast or too slow. Clinical studies have not yet been conducted with the new device but will be required for commercialization.



2024-2025

Projects

2024-2025

Wireless Measurement of Central Venous Blood Pressure

Project Team
Patrick Bohnart
Abbi Gunter
Kayla Imanzi
Jack Kelly

MIAD Partners
Carmen Briones
Anna Keebler
Lizzie Mathew

Faculty Advisor
Dr. Said Audi

Sponsor
Dr. Jayshil Patel
Medical College of Wisconsin

In a typical ICU, multiple vital signals are continuously measured to keep track of a patient's health during their stay. With the number of signals being measured, the area around the patient is cluttered with wires, tubes, and other equipment. The density of this equipment can have a negative effect on the patient and visitors' mental health, as well as pose challenges for assistive staff who are trying to navigate this environment.

The goal of this project was to alleviate these mental and physical strains on patients by decluttering their immediate environment, specifically by replacing the wired connection between an arterial blood pressure transducer and the monitor with a wireless alternative. This required developing a device capable of wirelessly transmitting arterial blood pressure data from the transducer and displaying it on the existing monitoring system. To achieve this, we developed a system consisting of a paired transmitter and receiver, both equipped with Bluetooth-enabled Arduinos, to wirelessly relay the measured blood pressure data to the monitor.

Verification testing showed that the device was able to transmit the pressure wirelessly with error that is consistent with other measurement methods used in the ICU. The casing for the components was designed in a way to provide comfort and an aesthetically pleasing appearance to the patient. Clinical testing would have to be conducted before commercialization of the device.

Novel Adaptive Toy for Children with Disabilities

Project Team
Benjamin Bolz
Madelyn Filer
Paige Harrill
Salvatore Peragine
Sean Riter

MIAD Partners
Logan Moris
Nick Chang
Christina Thomas

Faculty Advisor
Molly Erickson

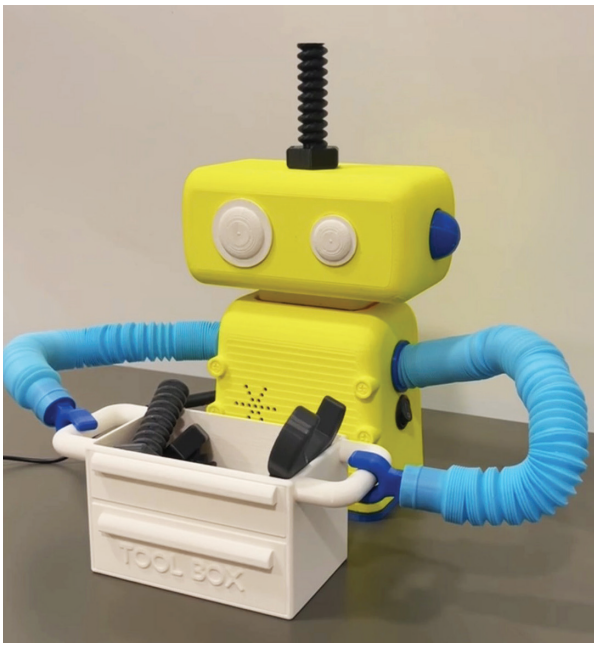
Sponsor
Marquette University Orthopaedic and Rehabilitation Engineering Center (OREC)

Children with sensory motor challenges frequently face barriers when using off-the-shelf toys due to inaccessible features that limit their opportunities for developmental play. This often leads to limitations where children watch others play instead of engaging in play themselves. Switch adapted toys provide more inclusive and engaging options, allowing the toys to be activated by a variety of therapy switches that can be swapped in. However, many of these toys can be cost-prohibitive for families and cost up to 3 times more than non-adapted, off-the-shelf versions.

The purpose of this project was to design and develop a custom switch adapted toy to support early developmental play for children with sensory motor challenges aged birth to three years. This work was designed to meet the specifications of an experienced speech-language pathologist who worked with these children.

The final device is a self-standing robot that engages children through multi-sensory and cause-and-effect interaction. An auxiliary port allows therapists to connect external therapy switches, enhancing usability for children with motor impairments. The toy simulates sneezing with randomized "ah" sounds followed by an "achoo" that is accompanied by synchronized head rotation that drops a tool. The toy is controlled by an Arduino microcontroller, a motor controller, and a UART voice module. The estimated production cost is $38.33, significantly reducing the price barrier compared to existing adaptive toys.

This adapted "Sneezy" toy provides an affordable and accessible option to encourage sensory learning, motor engagement, and play opportunities for children with sensory motor challenges.



2024-2025

Projects

2024-2025

D.F.D. (Discrete Fluid Delivery) Cup

Project Team
Sam Cascella
Maisey Kenny
Lucas Montanari
Naomi Voglewede
Isaak Zabel

MIAD Partners
Audrey Nadrasik
Will Gates

Faculty Advisor
Dr. Jay Goldberg

Clinical Advisors
Dr. Jessica Schnell
Amy Morgan
Children's Wisconsin

Difficulty in swallowing (dysphagia) affects patients of different ages. This project was carried out in collaboration with the Complex Care Program at Children's Wisconsin, specifically with a patient who suffers from a variety of medical complexities including dysphagia. In the case of this patient and the many others who suffer from dysphagia, drinking liquids can lead to the liquid entering the lungs and the patient choking (aspiration). Thus, there is a need for a device that allows dysphagia patients to safely swallow independently. This can be achieved by delivering small amounts of liquid to the patient's mouth.

The purpose of this project was to create a cup that allows for only a small, discrete amount of liquid to be delivered to the user while drinking. This was accomplished by creating a cup that consisted of an outer plastic body, silicone insert, straw, reservoir, and lid. By squeezing the silicone insert, liquid is displaced into the reservoir which is designed to hold a safe amount of liquid for the patient to drink (~5cc). From the reservoir, the lid has a mouthpiece from which the patient can bring the liquid from the reservoir to their mouth via a normal straw mechanism. The cup assembly can be produced at a low cost, contains food-safe silicone, is easy to clean, and can be used by patients of all ages.

Project Team
Niko Rios
Jorge Torres
Josh Nordan
Dylan Mingo

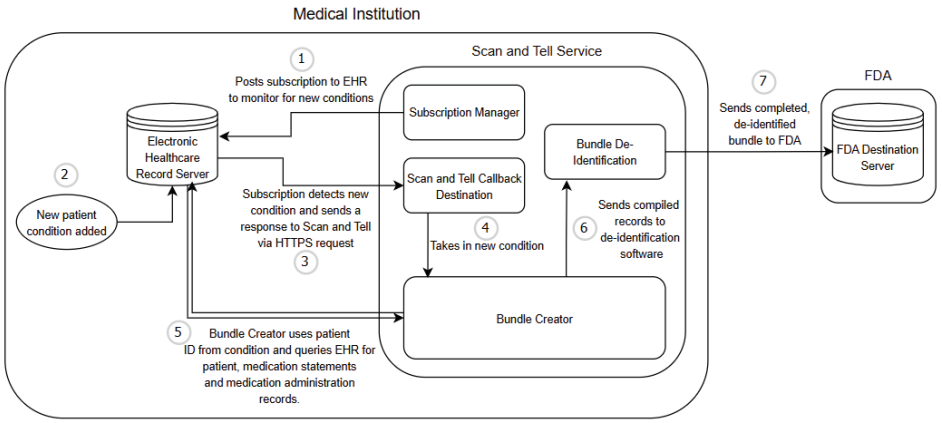
Advisors
Dr. Teri Sippel Schmidt
Alex Barrington

System to Alert Health Care Providers and FDA of Imaging Findings (Scan and Tell)

Currently in healthcare, there is a lack of real time, automatic drug side effect tracking, leading to missed opportunities to identify and track trends among drug side effects. As a result, new, unintended side effects of medications may go undocumented. Current solutions rely on reports from healthcare professionals, consumers, and manufacturers that require the reporter to manually gather and send the data, and it is completely voluntary. This results in drug side effects and trends, especially minor ones, that are unlikely to be reported, potentially going unnoticed and costing hospitals and patients alike more money and time to treat.

The purpose of this project was to provide an automatic alert system for the FDA, notifying them of conditions and medications, allowing them to enhance their database to search for any trends among the reports. Our product, Scan and Tell, automatically reads through a patient's file once a new condition is logged, grabbing key information, such as patient conditions and medications, and sending the de-identified data to the FDA via a standardized JSON object.

Testing to verify the design indicated that Scan and Tell automatically detected when a new condition was discovered in our demo server. Furthermore, it was able to fetch the patient's full condition and medication information as well as fully de-identify the data and send it to our second demo server which acted as a placeholder for the FDA.



2024-2025

Projects

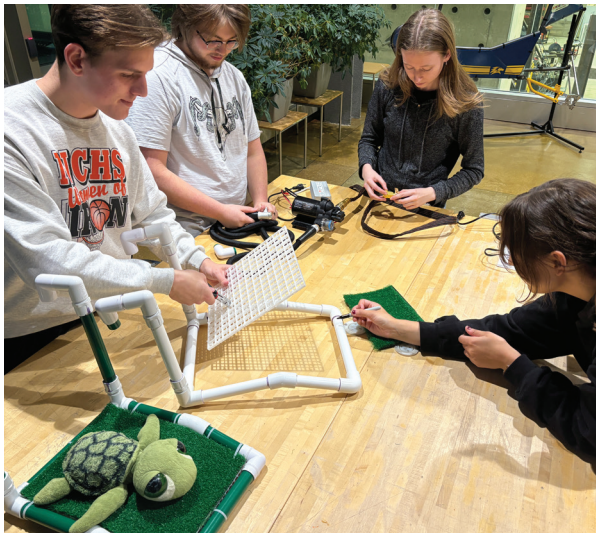
Design of Aquatic Landscape for Turtle Rehabilitation

Project Team
Alyssa Fons
Isabella Koeppen
Claudia Seyfarth
Jarrett Albert
Ryan Iskra

Faculty Advisor
Dr. Scott Beardsley

Sponsor
Dr. Donald Neumann
Lynn Rice
Wildlife in Need Center (WINC)

2024-2025



The Wildlife in Need Center (WINC), located in Oconomowoc, WI is a volunteer supported nonprofit organization with a total of over 18,000 volunteer hours during the 2024 fiscal year. The WINC facility has limited space available to store, rearrange, and clean their turtle habitats which are used to heal injured turtles. The existing turtle habitats are too taxing on the volunteers to move, drain, and clean and require constant moving of heavy tubs – posing risk of injury to the volunteers. The habitats themselves are obtained through donations making them very different from one another and difficult to arrange and clean the components necessary for the turtles to heal.

The purpose of this project was to create more modular aquatic elements that are compatible with a variety of habitat shapes and sizes as well as improve staff ergonomics by reducing the weight of the tank during movement. The final solution was made to be reproducible as the habitats at WINC are rotated in and out of use and the design can be easily shared with other wildlife centers.

The first component of the final design is an off-the-shelf electronic pump which is quiet, compact, and able to be operated hands-free once in use. The chosen pump was modified with the hoses attached by team members, which save space by being expandable and come with a shut-off valve to allow for quick enclosure changes without the pump aspirating. The second component of the final design is a PVC haulout that the injured turtles use as a basking platform. The PVC haulout contains threaded joints to ensure fitting with a variety of habitats and allows easy reproduction with readily available materials. Along with the haulout design itself, a construction guide was made and shared with WINC and requires minimal tools and background knowledge of the construction. The haulout itself consists of PVC pipe, fittings, zip ties, a plastic grate, and aquarium turf. With these components, the haulout meets all established specifications and allows for turtle rehabilitation. The final design was tested and confirmed to be more modular and less taxing on the volunteers when compared to the prior solutions used by WINC volunteers and staff.

Remote Electrical Safety Test Device for Mobile Imaging Devices

Project Team
Mackenna Clayton
Max Gamble
Zainab Khan
Amelia Linder

Faculty Advisor
Dr. Lei Fan

Sponsor
DJ Quam
GE HealthCare

Several hospitals and clinics use ultrasound imaging devices daily to diagnose and treat patients. To ensure the safety of these devices regular electrical safety testing is needed. These can include tests required by specific standards such as ground resistance and current leakage tests. Currently these tests require service technicians to physically access the ultrasound units which adds time, labor, and transportation costs.

The goal of this project was to design a prototype for a remote electrical safety testing device that can be used with GE Healthcare's ultrasound systems. The device was intended to automatically perform ground resistance and current leakage tests, store the data, and allow for remote access to the data which would minimize the need for onsite technician visits.

To achieve this, the team developed an Arduino based system which can perform accurate electrical measurements while complying with industry standards. The device also includes sensor circuits, a button, and an SD card, to perform and save the tests. The device was designed to prevent extraneous noise and other interference from being added to the system.

Testing verified that the device met most of the customers' needs and target specifications. The final design was able to measure ground resistance, store data locally with a SD card, and ensure user safety. While the system was not fully remote in the initial prototype, it laid the groundwork for future upgrades. The prototype was built for under the $2,000 target, which also allows for scalability. Risk analysis indicated reasonable risk values with appropriate mitigation strategies to deal with them. Overall, the project achieved its primary goal and provided a foundation for future enhancements.

Projects

2024-2025

Autonomous Bladder Emptying Device for Rat Spinal Cord Injury (SCI) Research

Project Team
MacKenna Bochnak
Dayane Garcia-Avila
Grace Peterson
Brenda Vizcaino Guzman

Faculty Advisor and Sponsor
Dr. James Hokanson

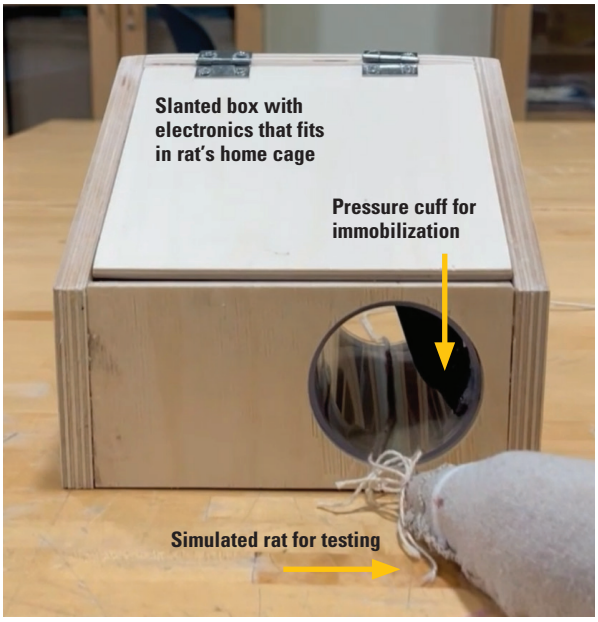
Spinal cord injuries (SCI) can result from traumatic events such as motor vehicle accidents, falls, and acts of violence, as well as from non-traumatic causes like diseases or medical complications. SCI often leads to motor dysfunction, respiratory difficulties, impaired circulation, bladder dysfunction, and sexual dysfunction. Current therapies are limited and primarily focus on managing pain, alleviating symptoms, and preventing further injury.

Active research using animal models aims to enhance the understanding of SCI and to improve and expand available therapies. However, SCI research in animal models requires considerable effort in animal care. For instance, due to their inability to void urine independently, the bladders of injured animals must be emptied at least twice daily, including weekends. Failure to do so results in urine backing up into the kidneys, leading to death. Bladder emptying is typically performed manually by squeezing and pressing on the abdominal area.

The goal of this project was to develop a device capable of autonomously expressing a rat's bladder at scheduled times and verifying urine expulsion. The device was required to operate independently, relieving lab personnel from the daily task of manual bladder expression, and potentially increasing the feasibility and appeal of SCI research.

The project's scope was narrowed midway through the semester due to complexity and time constraints. The final prototype focused on autonomously identifying and immobilizing the rat in the correct position. A bladder-expressing component can be integrated into the existing prototype in a future senior design project.

Final device testing demonstrated that the sensors accurately detected an artificial rat placed in the device and that the immobilization mechanism activated correctly and applied sufficient force to restrain the rat. Testing with live rats was not performed due to a lack of required clearances, but it is recommended as a necessary step before the device can be commercialized.

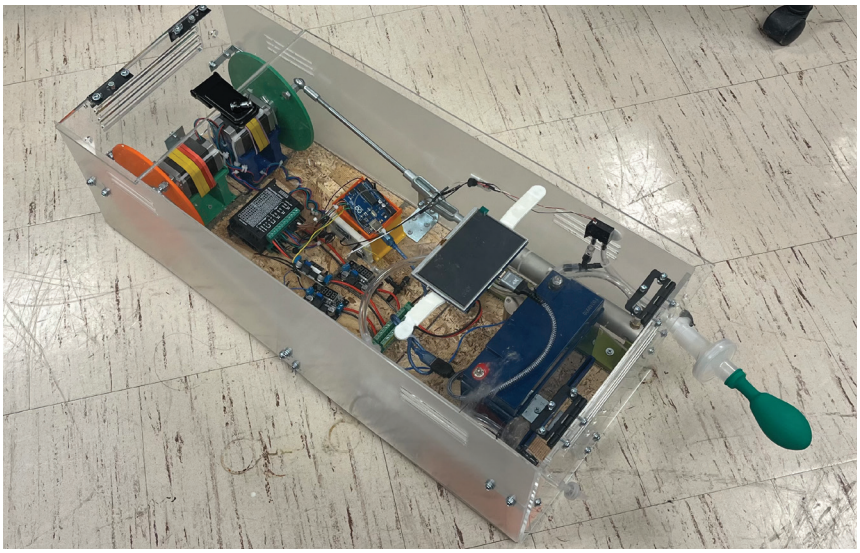


Project Team
Michael Kim
Tommy Butler
Austin Healey
Katie Rule
Drew Fore

MIAD Partners
Julianna Clayton
Hope Houts
Judah Hansen

Faculty Advisor and Sponsor
Dr. Lars Olson

Battery Powered Neonatal Ventilators



Pneumonia is an illness that negatively impacts child development in countries around the globe. It leads to fevers, disabilities later in life, and even death. Between 152,000 and 490,000 infants die annually because of pneumonia alone. Pneumonia affects the lungs of patients suffering from it, and malaria can impact a patient's ability to breathe. Once in the lungs, treatments for these illnesses include medication and ventilation; however, in many low-income countries around the world, ventilators are unaffordable and the network necessary to power them is not reliable or secure.

The purpose of this project was to develop a low cost, battery powered ventilation system for children under the age of one. The device was required to run for a minimum of one hour, maintain positive end expiratory pressure (PEEP), and have a swappable and rechargeable battery power system. The Neonatal Battery Powered Ventilator contains three major assemblies: the mechanical, the electrical, and the computational. The mechanical assembly provides air output to the patient and maintains PEEP through assistance from the computational and electrical assemblies. The computational assembly controls the rate of airflow, provides pressure readings, and opens and closes the electric check valve. The electrical assembly provides power to the entire system, allowing for rechargeability and swappable battery capabilities.

Testing involved verifying that PEEP was maintained and airflow was measured to the appropriate output, depending on the individual's weight. The current housing is merely a mockup for presentation purposes, but students from the Milwaukee Institute of Art and Design (MIAD) worked thoroughly with the design team to design a housing that would benefit both the patient, their families, and medical professionals who would all see and use the device. Patient studies were not conducted with the device but would be necessary for the further development of this product.

Confidential Project

Project 1

Project Team
Elise Raschke
Joana Flores
Megan Schlaefer
Hayley Jamiola

Faculty Advisor
Dr. Bing Yu

Sponsor
Boston Scientific

Faculty

Pintar, Frank, Ph.D., Professor and Chair
Biomechanics of brain and spinal cord injury, mechanics of spine surgical techniques, motor vehicle crash trauma

Audi, Said H., Ph.D.
Acute lung injury, acute respiratory distress syndrome (ARDS), lung transplantation, pulmonary hemodynamics

Beardsley, Scott, Ph.D.
Neural coding/decoding, neuroplasticity and learning, human visuo-motor processing, functional neuroimaging

Cooper, Robert F., Ph.D.
Photoreceptor mosaic structure and function, image processing, automated analysis tools, clinical imaging

Dash, Ranjan, Ph.D.
Computational systems biology & bioengineering, computational biology and bioinformatics

Fan, Lei, Ph.D.
Computational biomechanics: cardio-cerebrovascular mechanics, cardiac-electro mechanics

Garcia, Guilherme, Ph.D.
Respiratory physiology, fluid mechanics of respiratory airflow, virtual surgery planning

Goldberg, Jay R., Ph.D., P.E.
Medical device design and innovation, biomaterials

Greenberg, Adam S., Ph.D.
Cognitive neuroscience of attention, human psychophysics and computational modeling of perceptual phenomena

Guillory II, Roger, Ph.D.
Cellular and molecular interactions of bioactive materials, bioabsorbable metals, vascular medical devices

Hokanson, Jim A., Ph.D.
Urologic function/dysfunction, electrical stimulation/ neuromodulation therapies, neural engineering

Joshi, Amit, Ph.D.
Molecular image-guided and remote-triggered therapies, breast cancer imaging and therapy, optical imaging

Kruger, Karen, Ph.D.
Orthopedic biomechanics, pediatric gait kinetics and kinematics using motion analysis techniques

Olson, Lars E., Ph.D.
Mathematical modeling, biomedical instrumentation and optics, cell engineering/cardiopulmonary physiology

Ropella, Kristina M., Ph.D., Professor and OPUS Dean
Signal processing, cardiac and neuro-electrophysiology, functional magnetic resonance imaging

Scheidt, Robert A., Ph.D.
Human motor control, rehabilitation engineering, human psychophysics of sensorimotor adaptation and learning

Schmit, Brian D., Ph.D.
Spinal cord injury, neurorehabilitation, human neurophysiology, biomechanics

Somasundaram, Karthik, Ph.D.
Motor vehicle crash trauma, pedestrian safety, computational modeling of dynamic events.

Stemper, Brian, Ph.D.
Biomechanics of traumatic brain and spine injury, biomechanics of the cervical and lumbar spine, automotive safety

Tefft, Brandon J., Ph.D.
Cardiovascular regenerative engineering and device design, tissue engineered vascular grafts and heart valves

Wang, Bo, Ph.D.
Stem cell engineering, hard tissue engineering and 3D bioprinting, cardiovascular tissue engineering, imaging

Williams, Jordan J., M.D., Ph.D.
Peripheral optogenetics for motor stimulation, brain-machine interfaces and neural prosthetics, motor learning

Yu, Bing, Ph.D.
Optical imaging and spectroscopy, optical endoscopy, cancer detection and therapeutic monitoring, global health

Marquette University and Medical College of Wisconsin Joint Department of Biomedical Engineering

Undergraduate Program

The Marquette University and Medical College of Wisconsin Joint Biomedical Engineering program is founded on one of the longest accredited biomedical engineering programs in the nation and was developed in collaboration with active industry professionals. We offer three selective undergraduate majors to better prepare students for competitive, career-building roles within the biomedical engineering profession. These include biocomputing, bioelectronics, and biomechanics.

Our undergraduate program offers students all the educational opportunities and campus community experiences of Marquette University along with access to the libraries, laboratories, lectures, faculty and clinical settings of the Medical College of Wisconsin and its clinical partners.

Accelerated Degree Program (ADP)

Our Accelerated Degree Program allows qualified students to receive a bachelor's and a master's in biomedical engineering in five years. Students with qualifying grade point averages enroll in the program during their junior year and begin thesis research the summer between their junior and senior years. Research laboratory experiences will continue during the summer before their senior year through their fifth year, culminating in a written thesis and defense.

Graduate Programs

For those considering advancing their career in biomedical engineering by pursuing a master's or doctoral degree, our graduate programs provide engaging clinical and research experiences designed to shape students into leaders in their chosen field.

Graduate School Programs

- Doctoral Program
- Master of Science in Biomedical Engineering
- Master of Engineering in Biomedical Engineering
- Certificate in Clinical Immersion in Medical Device Design

Featuring more than 30 dedicated labs designed to facilitate the transfer of new knowledge into innovations directly impacting patient care, our joint program supports student education with a rigorous research practice that offers a dynamic range of novel opportunities for the world's next generation of biomedical engineers. With a focus on collaboration, our research brings together world-class engineers and faculty physicians within state-of-the-art facilities to create solutions for the greater good.

Research Themes

Research themes are provided to help students drive their academic experience, ensuring they are well prepared to pursue their interests upon graduation.

- Biomechanics and Rehabilitation Engineering
- Biomedical Imaging
- Computational Systems Biology and Medicine
- Medical Devices and Bioinstrumentation
- Molecular, Cellular and Tissue Engineering
- Neural Engineering and Neural Rehabilitation

Clinical Partners

The Marquette University and Medical College of Wisconsin Joint Biomedical Engineering programs deliver far more than the reputation of two world-renowned institutions. We also offer valuable opportunities for students, faculty, and staff to conduct research with four equally reputable clinical partners, all located within minutes of campus:

- Children's Wisconsin
- Clement Zablocki VA Medical Center
- Froedtert Hospital
- Versiti Blood Center of Wisconsin

Sponsored Research

Both Marquette and the Medical College of Wisconsin have longstanding histories of successfully partnering on sponsored research supported by federal agencies, for-profit and non-profit entities.

Industry Relations

As one of the first of its kind in the country, Marquette has sustained a proud tradition of connecting students with opportunities for transformative, real-world work experience since our co-op engineering program was founded in 1919. Today, Marquette works with more than 200 leading engineering and technology companies to help students build skills, gain invaluable professional experience, and make key connections that will help them thrive in their careers.

Partnering with Industry

To benefit patients and the future of health care, our joint department fosters collaboration with industry leaders, including such innovators as GE Healthcare, Medtronic, Baxter, and many others.

Collaborations include
- hiring undergraduate students for paid internships and co-op employment opportunities,
- working with senior design and freshman groups on innovative medical device projects,
- joining forces on translational research, and
- developing curricula that respond to industry needs.

Our industry partners value working with us to advance research for their health care products and services while seeking biomedical engineering students and graduates to join their workforces as valued members of their organizations. Our Industry Advisory Board is comprised of active and engaged alumni who are focused on helping to ensure our students are learning industry-leading skills to better prepare them for today's workforce.

The Marquette University and Medical College of Wisconsin Joint Department of Biomedical Engineering stands apart in that it is a true partnership between two institutions with a longstanding history of collaboration and innovation reaching back nearly a century. With unmatched cutting-edge clinical research and benefits and funding that allow students more opportunities for advancement, our joint department is dedicated to delivering an extraordinary educational experience designed to empower the next generation of biomedical engineers, scientists, and physicians.

Undergraduate Design Curriculum

Biomedical engineering students in the Joint Department of Biomedical Engineering learn about design throughout the four-year curriculum.

Freshman Year

Students first gain experience with the design process in the first year during BIEN 1100 and 1110 *(Introduction to Biomedical Engineering Methods I and II).* In these courses, they participate in several team design challenges. These experiences help develop teamwork skills, and teach students about the engineering design process, including technical, legal/ethical, regulatory, and economic design constraints. Students learn to identify customer needs, develop a list of performance requirements and specifications, convert requirements into design concepts, and build and test prototypes. They also learn about basic business concepts and entrepreneurship.

Sophmore and Junior Years

During the sophomore and junior years of the biomedical engineering curriculum, students take courses that include individual and team-based design projects which allow them to apply what they are learning in the course to the solution of a related problem. This helps them relate theory to practice.

In the junior year, students take *BIEN 3400 Clinical and Regulatory Issues in Biomedical Engineering Design*, in which they observe procedures in the clinical environment and learn to identify unmet clinical needs and opportunities for new product development. They hear various stakeholder perspectives on the design and use of medical devices and learn about the regulatory requirements of medical device design, including those of the FDA and ISO standards.

Senior Year

During the senior year, students are required to take BIEN 4920 *Principles of Design* and BIEN 4998 *Senior Design*. These courses require students to apply what they have learned during their previous years of the undergraduate curriculum in a multidisciplinary team-based project experience. They further develop their design, analytical, project management, communication, time management, and teamwork skills. They learn about the product development process, the medical device industry, testing for safety and efficacy, design validation, standards and regulations, risk management, project scheduling, patent issues, and a variety of design issues. Students complete a design project from problem definition to design verification (per ISO 9001 and 13485) and gain experience in generating the same project deliverables as required in industry.

Joint Department of Biomedical Engineering
Marquette University
1515 W. Wisconsin Ave.
Milwaukee, WI 53233

For more information about the Marquette University and Medical College of Wisconsin Joint Department of Biomedical Engineering, scan the QR code or visit **mcw.marquette.edu/biomedical-engineering**

Opus College of Engineering

JOINT DEPARTMENT OF BIOMEDICAL ENGINEERING
MARQUETTE UNIVERSITY
MEDICAL COLLEGE OF WISCONSIN

mcw.marquette.edu/biomedical-engineering

Since 1908, the Marquette University Opus College of Engineering has been uniquely blending professional engineering preparation with a liberal arts education to provide the world with well-balanced leaders in their profession.

Our mission
The mission of the College is to excel in four critical areas:

- To prepare all students for successful careers based on a strong moral and ethical foundation
- To advance the state-of-the-art in engineering
- To serve our professional and technical communities
- To contribute to our global society

The Opus College of Engineering offers six undergraduate degrees in eleven programs/majors through four departments: Biomedical Engineering; Civil & Environmental Engineering; Electrical and Computer Engineering; and Mechanical Engineering. Marquette also offers a wide range of graduate and doctoral programs.

Accreditation
All undergraduate programs offered by the Marquette University Opus College of Engineering are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, 410-347-7700.

The University
Founded in 1881 in Milwaukee, Wisconsin, Marquette University has been educating people of faith to be leaders in their professional lives, their communities and in society. Since the first graduating class of five men were awarded bachelor of arts degrees in the 1880s, Marquette has grown into a modern coed campus of more than 11,000 students who learn and grow through nationally admired undergraduate, graduate and professional programs.