CONTENTS
2  Dean’s Letter
4  Design with Impact
24  Sponsors
25  About Design Day 2017
28  Student Design Projects
58  Advisers
Engineering design is inherently an immersive process. It involves an enormous amount of time and demands focused attention. As projects grow in complexity, the design experience becomes even more immersive. The goal, of course, is showing, rather than telling, how something works or how a specific solution solves the problem at hand.

The best attempts change beliefs and open the gate to new possibilities. Every year, thousands of engineering students in the U.S. and around the globe demonstrate their savvy by presenting senior design projects to their peers. While some have considered this a mere graduation requirement, we look at the deeper meaning of the experience. By throwing ourselves into an ill-constrained, multidisciplinary project, we at the School of Engineering learn how to defend decisions, work within constraints, and draw from the sum of our experiences.

This publication represents what is so fantastic about engineering design and problem solving as immersive experiences. The undergraduate and graduate students as well as the faculty members you will read about here immerse themselves in ideas, challenges, and projects that directly benefit people.

The benefits may be economic, social, medical, industrial, or personal. The ideas may be ready for implementation or the launch of further investigation and design en route to a finished product that changes or saves lives. With more and more interdisciplinary research at the School of Engineering, the scope of projects is remarkable.

This year, our featured projects range from a bridge to better the daily lives of residents to building cheaper batteries and from making a hospital stay more pleasant to more effectively diagnosing disease. I am so proud of the mix of work that unfolds here, and I hope you enjoy this glimpse into what we do as much as we enjoy doing it.

The diversity of ideas and solutions continues to advance our profession and improve the lives of many. I’m sure you join me in eagerly looking forward to the innovations from our students and faculty members next year.

Best regards,

Philippe M. Fauchet
Dean, School of Engineering
Dean’s Chair in Engineering
Professor of Electrical Engineering
Paloma Mendoza (BE’17), president of the Society of Hispanic Professional Engineers at Vanderbilt, and teammates Jake Van Geffen (BE’17) and Luke Van de Vate (BE’17), all civil engineers, designed a new pedestrian bridge for the village. Van Geffen and Van de Vate traveled to San Esteban in May 2016 to check out the site, take geotechnical samples and make initial calculations.

The 180-foot-long pedestrian bridge needed to be long-lasting as well as sustainable. The team decided a suspension bridge with wooden planks would be the most affordable while best addressing the site and the community’s needs. Unlike a steel bridge, materials for a pedestrian suspension crossing are readily available and don’t need to be imported. Additionally, should a board loosen or fall off, Esteban residents can make repairs without the need of a steel worker or expensive equipment.

“The trickiest part was finding how far back from the river we should build the towers,” Mendoza said. “You want to figure out what you can do to make it work but not overdo it where the cost-benefit analysis doesn’t make sense.”

Each week, the team members set deadlines for themselves to complete difficult calculations. They worked closely with professional engineers and other experts, including advisers Kevin Colvett of CH2M Hill and Mark Warriner of LDA Engineering, to refine the design and ensure it would work.

Construction is scheduled to begin in August and finish in 2018. The project partner is HOI — formerly Honduras Outreach Inc. — a nonprofit organization that sponsors more than 50 mission trips to Honduras and Nicaragua each year.

Mendoza, whose summer internship conflicted with the team’s trip to the Agalta Valley, hopes to see it someday. “People there really do risk their lives trying to cross the river,” she said. “Helping someone, even if I never meet them — that is what drew me to the project.”

Facing page: Jake Van Geffen (BE’17) stands in the Rio Grande near San Esteban, Honduras, taking measurements for his team’s pedestrian bridge.

Left: Paloma Mendoza (BE’17)

Below: A CAD model of the bridge that team members designed for workers to build later this year.

Bottom of page: Team members built one section of the bridge to show at the School of Engineering’s annual Design Day event on April 24.
Adaptive PCR uses left-handed DNA to monitor and control molecular reactions in the PCR process. Left-handed DNA, which mirrors the DNA found in all living things, has the same physical properties as regular, right-handed DNA, but it does not participate in most biological reactions. Adding a fluorescently tagged L-DNA to a PCR sample creates signals that monitor molecular reactions and can be used to control them.

The new method promises increased ease and reliability. It reduces PCR’s sensitivity to environmental conditions and shrinks the machines themselves from desktop to handheld size. As such, adaptive PCR could be used at the bedside to identify different diseases by their DNA signatures.

The prototype adaptive PCR machine has duplicated the results of conventional PCR machines in controlled conditions. It also amplified DNA under conditions where conventional PCR machines failed.

“Adaptive PCR is powerful but finicky, requiring extremely controlled conditions, weeks of equipment calibration and running samples in triplicate in case one of the machines fails.

Enter “adaptive PCR,” a new method for controlling DNA duplication that was devised by Frederick Haselton, professor of biomedical engineering, and Nicholas Adams, research assistant professor of biomedical engineering. Their breakthrough, for which Vanderbilt has submitted a patent application, makes copying DNA quicker, easier and more portable.

It could lead to a hand-held DNA photocopier that identifies the bacteria or virus causing an infection even before symptoms appear.

Adaptive PCR uses left-handed DNA to monitor and control molecular reactions in the PCR process. Left-handed DNA, which mirrors the DNA found in all living things, has the same physical properties as regular, right-handed DNA, but it does not participate in most biological reactions. Adding a fluorescently tagged L-DNA to a PCR sample creates signals that monitor molecular reactions and can be used to control them.

The new method promises increased ease and reliability. It reduces PCR’s sensitivity to environmental conditions and shrinks the machines themselves from desktop to handheld size. As such, adaptive PCR could be used at the bedside to identify different diseases by their DNA signatures.

The prototype adaptive PCR machine has duplicated the results of conventional PCR machines in controlled conditions. It also amplified DNA under conditions where conventional PCR machines failed.

“These advantages have the potential to make PCR-based diagnostics more accessible outside of well-controlled laboratories, such as point-of-care and field settings that lack the resources to accurately control the reaction temperature or perform high-quality sample preparation,” Adams said.

The development was supported in part by the Bill & Melinda Gates Foundation through its Grand Challenges in Global Health Initiative in Diagnostics program and the Vanderbilt-Zambia Network for Innovation in Global Health Technologies program funded by the National Institutes of Health.
Imagine that the tons of metal waste discarded every year could be used to provide energy storage for the renewable energy grid of the future instead of becoming a burden for waste processing plants and the environment,” said Cary Pint, assistant professor of mechanical engineering.

Pint and a team of undergraduate and graduate students created the world’s first steel-brass battery that stores energy at levels comparable to lead-acid batteries while charging and discharging at rates comparable to ultra-fast charging supercapacitors.

The key is anodization, a common chemical treatment that gives aluminum a durable and decorative finish. Anodizing scraps of steel and brass using nonflammable water electrolytes, which contain potassium hydroxide, commonly found in laundry detergent, and residential electrical current restructured the metal surfaces into nanometer-sized networks of metal oxide. The networks store and release energy when reacting with a water-based liquid electrolyte.

These nanometer domains explain the speedy charging, as well as the battery’s exceptional stability. After testing for 5,000 consecutive charging cycles, the equivalent of more than 13 years of daily charging and discharging, the steel-brass battery retained more than 90 percent of its capacity.

“When our aim was to produce the materials used in batteries from household supplies in a manner so cheaply that large-scale manufacturing facilities don’t make any sense, we had to approach this differently than we normally would in the research lab,” Pint said.

Research project co-authors include Andrew Westover (PhD’16) and Nitan Muralidharan, a graduate student in the interdisciplinary materials science program. The team also included undergraduate and graduate students in mechanical engineering.

The next step is to build a full-scale prototype battery suitable for use in energy-efficient smart homes.

“We’re forging new ground with this project, where a positive outcome is not commercialization but instead a clear set of instructions that can be addressed to the general public. It’s a completely new way of thinking about battery research,” Pint said.

The work was supported by grants from the National Aeronautics and Space Administration, the National Science Foundation, and a Vanderbilt Discovery Grant. PSC Metals in Nashville provided access to its scrap metal facility.
Innovation Garage teams work with the Wond’ry, Accenture pros to invent and disrupt

The two team names for Vanderbilt’s Innovation Garage arguably cover most of what innovation is: Team Invent and Team Disrupt.

Innovation Garage is the result of a partnership between the Wond’ry, Vanderbilt’s epicenter for innovation and entrepreneurship, and Accenture PLC, a global consulting company that works with clients on strategy, technology and operations. The idea is to give cross-disciplinary teams of students a yearlong experience solving real problems with the aid of Vanderbilt professors and top Accenture executives.

The first team designed an app that matches qualified workers with oil industry tasks — basically, the TAKL of that industry. The second deconstructed a large manufacturer’s supply chain to figure out why certain parts didn’t show up on time and what could be done about it.

At one spring meeting, Team Invent came together — in person and on Skype — in a sunlit Wond’ry conference room to discuss progress on the app and the pitch video they wanted to make to promote it. The three-person team included engineering science major Luke Price and chemical engineering major Jessica Banasiak, both juniors who said they were there to learn from the pros, and a teammate who is pursuing his MBA.

“Most of my classes are with students who have the same major,” Banasiak said. “Innovation Garage is helping integrate the things I’m learning about the oil industry through the lens of chemical engineering with other facets of that business.”

She told her team, led by Doug Schmidt, Cornelius Vanderbilt Professor of Engineering and professor of computer science and computer engineering, about her idea to focus more attention on the toughest-to-fulfill tasks the app will address and integration of oil well location data.

At the same time, Team Disrupt was using multiple regression analysis, looking at more than a half-million purchases made across several years to produce an algorithm. Their instructor, Dave Berezov, associate professor of the practice of engineering management, said the Innovation Garage work mirrors assignments students are likely to receive in their first jobs.

“They’re also getting direct working experience with professionals up to the senior executive level of one of the largest consulting firms on Earth,” Berezov said. “I tell them that the first-year associates usually get a view of the parking lot, but they’re getting a look from the C-suite.”

His team developed the algorithm to enable their client to identify parts orders most likely to experience delivery delays and address those earlier, preventing interruptions in the manufacturing process.
IBD is a chronic inflammation of the gastrointestinal tract, and its two main subtypes, ulcerative colitis and Crohn’s disease, have different molecular signatures. The new sensor, which could be used during routine colonoscopies, not only can identify the subtype but also determine the inflammation level of the intestinal wall. With current technology, doctors can only identify the symptoms and then make their best guess at which underlying disease to treat.

IBD affects at least 1 million U.S. adults, including many whose symptoms are fairly advanced by the time of diagnosis.

“With current methods, ultimately the diagnosis is dependent on how the patient responds to therapy over time, and you often don’t know the diagnosis until it’s been a few years,” said Anita Mahadevan-Jansen, Orrin H. Ingram Professor of Biomedical Engineering and director of the Biophotonics Center at Vanderbilt University.

She invented the first-of-its-kind sensor. The customized endoscope uses Raman spectroscopy, the chemical-fingerprinting technique, to detect molecular markers of IBD in the colon. After further refining, the device should enable doctors to diagnose IBD more quickly and accurately. Doctors now use a combination of radiology and pathology to diagnose the subtype and guide treatment decisions.

Without an objective gold standard, up to 15 percent of patients are diagnosed with indeterminate colitis, meaning the subtype is unknown, and up to 14 percent have their IBD reclassified based on their response to treatment.

“Most people go through a baseline colonoscopy as part of routine care, and you could imagine using this to get a baseline Raman signal for each person,” said Mahadevan-Jansen. “If someone presents with IBD symptoms later on, our system then determines if it’s more likely to be UC or Crohn’s. Once treatment starts, you have an objective measure to track the response because you can then use the device to quantify mild, moderate or severe inflammation.”

The device also can detect early indicators of IBD before observable changes in the intestinal tissue. The team is refining algorithms to help doctors interpret test results, looking at how gender, diet, demographics and treatment regimen influence the Raman signature.

“It’s a unique way of thinking about personalized medicine that takes into account all sorts of information — beyond just the genome — including demographics and many other factors that make a person unique,” said Mahadevan-Jansen.

Anita Mahadevan-Jansen, photographed here in her laser laboratory, has developed a new optical sensor that can accurately detect different types of inflammatory bowel disease.
What elevates PredictGov above other tracking systems is that it accounts for hundreds of variables and updates the prognosis every 24 hours.

The company behind PredictGov, Skopos Labs Inc., was accepted into the inaugural class of the Law Tech Lab at Duke University and placed second in the accelerator’s pitch competition in April. It also has partnered with GovTrack.us, a popular resource for tracking federal legislation. GovTrack embeds the score on the page for each bill, exposing the ranking platform to an audience likely to top 10 million unique users this year alone.

Creator John Nay (PhD’17) said PredictGov takes into account factors within the political process, such as the bill’s sponsor, co-sponsor and amendments, as well as external factors, such as economic trends and financial indicators. Users easily can see how similar measures fared in the past and what main factors contribute to the current score.

“Beyond predicting the likely outcome, we provide understanding of the context of the bill,” said Nay, whose research focuses on machine learning, natural language processing and forecasting.

PredictGov will help lobbyists, advocates and citizens focus their efforts and fine-tune strategies as circumstances change. The platform is intentionally agnostic and not designed for any political party or group, Nay said.

The underlying technology has the potential for broader applications, including the assessment of online news for so-called fake stories and, in the financial world, tracking changes in a company’s value. Nay and two other co-founders — Professor J.B. Ruhl, who directs the Vanderbilt University Program on Law and Innovation, and Professor Oliver Goodenough, director of the Center for Legal Innovation at Vermont Law School — have incorporated as Skopos Labs with PredictGov as the first offering.

Even the most experienced congressional analyst couldn’t sift through the sheer numbers of data points that PredictGov does, Ruhl said, and that makes it a valuable tool. “It doesn’t replicate human judgment but provides insights that help people make judgments,” he said.

The team’s venture is aptly named. Derived from “teleskopos,” the Greek word for far-seeing, skopos also is used to describe one theory of translating text.

PredictGov uses machine learning, Big Data to forecast congressional action

A recent Vanderbilt computer science Ph.D. is making waves with a platform that scores bills’ chances of being enacted.
The American Society of Civil Engineers has estimated that more than $3.6 trillion is needed by 2020 to rehabilitate and modernize the nation’s failing infrastructure. An important element in any modernization effort will be the development of new and improved methods for detecting damage in these structures before it becomes critical. That is where “mood ring materials,” as the team that developed the technology dubbed them, come in.

A cross-disciplinary team of researchers is incorporating fluorescent nanoparticles into construction materials. Those particles react to stress by changing their appearance, creating a new kind of detection system that can monitor structures in an efficient and cost-effective fashion, said Cole Brubaker (MS’16), a doctoral student in civil engineering at Vanderbilt University’s Laboratory for Systems Integrity and Reliability.

The team’s initial studies showed adding a tiny concentration of special nanoparticles — called white light quantum dots — to an optically clear polymer matrix produces a distinctive light signature that changes as the material is subjected to a broad range of compressive and tensile loads.

The researchers theorize that the quantum dots emit light in a broad spectrum because more than 80 percent of the atoms lie on the surface. They also know that the bonds between the surface atoms and molecules surrounding them play a critical role.

The result: A permanent record of how much stress the underlying material has experienced. The researchers have verified that the material can act as a new kind of strain gauge that records the cumulative amount of stress applied to it.

The team has many challenges to overcome before the mood-ring materials are ready for commercialization. Among them are reading the particles when stresses on materials force them closer together and light bleaching out the quantum dots, making them impossible to read.

Professor of Chemical and Biomolecular Engineering Kane Jennings, another member of the team, said they’re still working on why the quantum dots respond as they do.

“Entrapping these quantum dots in ultrathin polymer films on metal surfaces can provide advance warning when the underlying metal is about to sustain physical or chemical damage,” he said.

‘Mood ring materials’ hold potential key to infrastructure’s future

Materials treated to show whether they’re structurally sound or failing could play an important role in minimizing and mitigating damage to the nation’s infrastructure.

Cole Brubaker, left, a doctoral student in civil engineering, and Ian Njoroge, a doctoral student in chemical engineering, manipulate quantum dots.

Far left: Fluorescent nanoparticles that can be incorporated into materials to indicate risk of structural failure.
The New Product Design and Development course, offered for 15 years by David Owens, professor for the practice of management and innovation and professor of the practice of engineering management, got a priceless boost this year. Owens delivered lectures on intellectual property and took students through exercises in the design process inside the Wond’ry, Vanderbilt’s new makerspace. They also used its work areas and equipment to build their prototypes.

In a screen-and-cubicle world, Owens said, opportunities to learn through tinkering are valuable but all too rare. It’s one thing to talk about a solution and another to hand one to the client.

“It’s not surprising that the maker explosion is happening as our world goes more virtual,” Owens said. “It’s energizing to put something you made in front of people, and we never had the space before to do that very well. We were scraping for shop space.”

Teams present their designs tradeshow style at the end of the course and are prepared to discuss their process, per-unit cost, manufacturing challenges and a variety of other considerations for consumers. In the most recent round of presentations, a fragrant booth offered a solution to workplace stress — a stick-on aromatherapy pad that allows users to breathe in lavender and eucalyptus, the designers said, plus shows colleagues that they may need extra understanding and support.

A few feet away, Adetayo Ajayi (BS’17) showed visitors a better way to ensure ventilation equipment is easy to access, sterilized and ready to use. All the tools fit precisely into a vacuum-formed plastic tray made in the Wond’ry, he said.

Another team, asked to come up with an entertaining, educational mobile for cribs that was easy to clean, easy to remove and gender-neutral, presented one that moves vertically like a Ferris wheel.

New Product Design and Development gets students thinking in a different way, said Kyle Eason, an MBA whose team designed an easy way to check if children’s IV lines are staying put. They installed a small, plastic window with an LED light inside the standard hand brace the hospital uses.

“You’re working with very talented engineers and very smart people from all different backgrounds,” he said. “The biggest thing I’m taking away is learning to adapt products to the needs of people. To know where products come from and what people do to get them to market is invaluable to my business education.”

The Wond’ry makerspace opens doors to Children’s Hospital solutions

Solutions to real-life problems at the Monroe Carell Jr. Children’s Hospital at Vanderbilt ranged from the delightfully whimsical to the disarmingly simple, designed by engineering undergraduates and MBA students teaming up in a state-of-the-art makerspace.
Treating the root cause of sepsis

Sinead Miller (MS’15, PhD’17) said IMPACT was the most useful course she took at Vanderbilt. That’s undoubtedly because she launched her company, PATH EX, in the middle of the semester.

PATH EX is testing a device that treats the root cause of sepsis by removing bacteria from the blood in a process similar to dialysis. With the oversight of Professor of Biomedical Engineering Todd Giorgio, she designed a device that captures and removes a multitude of blood-borne pathogens, including Acinetobacter baumannii, a leading cause of sepsis worldwide. Its associated mortality rate reaches upwards of 72 percent.

“At the beginning of the course, I did not know the first thing about starting a company, regulatory strategy or figuring out the customer’s actual needs vs. what I think those needs are,” Miller said. After learning those fundamentals, she set out to advance her company by raising capital and applying to a business accelerator.

By the start of fall semester, the associate professor of mechanical engineering was passing along the lessons he learned to eight young entrepreneurs in a new class for both graduate and undergraduate students. IMPACT (Initiating, Maximizing, Promoting, and Accelerating Commercialization and Translation) is a version of I-Corps that is adapted to medical devices and includes Webster’s own experience.

“Making it applicable to medical devices meant adding information on regulatory and intellectual property issues,” he said. “I-Corps also requires participants to speak to 100 potential customers, but I asked students to speak to 70 to accommodate their other classes and research.”

IMPACT is a cooperative effort between the Vanderbilt Institute in Surgery and Engineering and the Vanderbilt Center for Technology Transfer and Commercialization aimed at helping students launch their own companies. They also heard from lecturers from the School of Medicine and various engineering disciplines and worked in labs.

For the final, students pitched their companies to an audience of engineering and medical professors, fellow graduate students, physicians and nurses, and fielded tough questions about devices. For the inaugural IMPACT class, the teams were:

• **LumaSil**, biomedical engineering master’s student John Mendoza (BE’16) and mechanical engineering Ph.D. student Patrick Anderson. Their device uses blue and infrared light to treat chronic diabetic wounds.

• **SpineX**, mechanical engineering Ph.D. students Matthew Vandell and Erik Lamers. The team created a $200 fabric exoskeleton to help nurses lift patients safely.

• **KickIt Health**, Kevin Cyr (BE’17) and mechanical engineering Ph.D. student Patrick Wellborn. They redesigned the IV stand for more base stability and to encourage patients to walk.

• **PATH EX**, Sinead Miller (MS’15, PhD’17) and mechanical engineering Ph.D. student Frederico Campisano. Their device treats the root cause of sepsis by removing bacteria and endotoxins from the blood.

Other IMPACT instructors were Byron Smith (MS’12) and founder of EndoInSight Inc., and Chris Harris, Vanderbilt Center for Technology Transfer and Commercialization’s director of licensing.
Alexander Plevka, Aisyah Areena Zainal Abidin, Benjamin Streeter, Khairunnisa Aqilah Md Ridzuan and Emily Entrekin — all BE’17 mechanical engineering graduates — designed a locking mount so city workers easily can remove future decorative bike racks or similar public art pieces and take them into the shop for repair or repainting.

The idea didn’t come to them right away. With the city’s entire public art collection to consider, the team decided to put their focus on the maintenance challenges of the unusual bike racks, which include some shaped as sound waves, flowers and even a banjo.

When a bike rack needs attention, workers are forced to break up the concrete posts or try to repair and paint the rack at the site. Those approaches have been difficult, inefficient and costly.

Anne-Leslie Owens, a Nashville Public Art project coordinator who worked with the team, said their plan made sense since the racks are prone to damage and pranks. “They get a lot of wear and tear. Paint chips off and the metal starts to rust. One bike rack ended up in a tree,” she said.

“There are a lot of different maintenance issues, and we learned we needed a better system to install them.”

The Vanderbilt team’s creation went through four iterations of design, test and build. The final design features a sealed lockbox on a steel rod set in a concrete cylinder. The box fits into a compartment in the middle of the cylinder, which will be flush and not visible, allowing workers to remove and reinstall smaller bike racks and artwork as necessary. The device has the potential to cut the city’s costs on such projects by half.

“We ended up with a very simple design,” Plevka said. “For longevity, simple is better.”

The team also created a series of infographics to accompany the mounting system.

“We definitely saw a need for more communication between artists and engineers,” Streeter said.

All five team members said they are interested in art, and Md Ridzuan is an art minor. This is the second year the Metro Arts Commission, the project sponsor, has worked with Vanderbilt engineering students.

“It has been great for us,” Owens said. “I can see this design getting broader use as I look at other projects — in parks, on greenways, the MTA and even for traffic control.”
On behalf of the School of Engineering, welcome to Design Day 2017. This year you’ll see more than 70 engineering and computer science capstone projects completed in partnership with sponsors including Nissan North America, Siemens, Fiserv, Camgian Microsystems, Sterling Ranch Development Company, DENSO, NASA Marshall Space Flight Center, and more. Senior design courses provide students with experience working on real-world projects that involve design constraints, budgets, reviews and deadlines. Students learn about professionalism, licensing, ethics, teamwork, entrepreneurship, intellectual property and all the key skills of their disciplines. As their projects take form, student teams interact with their industry and faculty advisers, hold meetings, write formal documentation and present their work. By the end of the academic year, the teams produce prototypes, design processes or virtual demonstration. Design Day is the showcase for the lessons learned over four years of their engineering education.

We recognize the value of senior projects mentored and supported by external advisers — industry representatives, entrepreneurs, nonprofit members as well as research and clinical faculty. This experience allows you to work with Vanderbilt engineering seniors and discover what makes our students stand out among other applicants when it comes to employment and postgraduate study. If you or your colleagues are interested in sponsoring a project or to learn more, please contact me.

Sincerely,

Thomas Withrow
Assistant Dean for Design
Associate Professor of the Practice of Mechanical Engineering
514 Olin Hall
615-322-3594
thomas.j.withrow@vanderbilt.edu

Mailing address:
PMB 351592
2301 Vanderbilt Place
Nashville, TN 37235-1592
DEPARTMENT OF BIOMEDICAL ENGINEERING

FACULTY ADVISER
Matthew Walker III, Associate Professor of the Practice of Biomedical Engineering

FACULTY ADVISERS

26
FACULTY ADVISER

Minimizing Waste Using Mass Exchange Networks (MENs)
AISC–ASCE Student Steel Bridge Competition

28
FACULTY ADVISER

Fast and Furious Power Wheels for Mobility-Impaired Children

28
FACULTY ADVISER

Validation Model for Catheter-Based Delivery Systems
Reproducible Stereotaxic Injection System for Neonatal Mice
Multiplexed Small-Volume Stored Bioreactor for Brain Tumor Organoid Development
Development of a Smart Hydrocephalic Shunt
Frequency-Selective Silencing Device to Enhance ICU Patient Recovery
A Novel Cerebral Flow-Diversion Stent for the Treatment of Bifurcation Aneurysm
Ocular Tracking to Aid Radiotherapy Guidance for Eye Tumors (O-TARGET)
Temporarily Modulated Cell Culture System
Development of a Smart Ballistics Vest for Police Officers
OptiVent: Personalized Intervention for Acute Respiratory Distress Syndrome
Addressable LED Bank for Studying Sensory Integration in Primates
Improving Football Helmet Design to Limit Mild Traumatic Brain Injuries
Biosensing Ballistic Vest
SYTE: The Infant Monitor

34

34

31

33

32

33

33

31

31

32

33

32

34

34

37

36

36

37

38

38

39

39

40

40

41

41

42

42

42

43

43

44

SYTE: The Infant Monitor

DEPARTMENT OF CIVIL ENGINEERING

FACULTY ADVISER
Lori Troxel, Associate Professor of the Practice of Civil and Environmental Engineering

FACULTY ADVISORS

36

36

37

38

39

39

40

40

41

41

42

42

42

43

43

44


ASCE–ASCE Student Steel Bridge Competition
Sterling Ranch Home for Race to Zero Competition
Honda Pedestrian Bridge
Sterling Ranch Multimodal Transit System

DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING

FACULTY ADVISERS
Russell Dunn, Professor of the Practice of Chemical and Biomedical Engineering
Scott Guelcher, Professor of Chemical and Biomedical Engineering

FACULTY ADVISORS

38

38

39

39

40

40

41

41

42

42

42

43

43

44

Minimizing Waste Using Mass Exchange Networks (MENs)
Developing Software for Volatile Organic Compound Recovery in Air Pollution Control
Software for Economic Comparison of Volatile Organic Compound Recovery Technologies
PhoGene-Free Route to Poly carbonate Production
Designing an Ideal Heat Exchanger and Wastewater Recovery Network for a PVC Complex Chemical Site
Design of a Heat Exchanger Network and a Mass Exchange Network (HEN-MEN) to Reduce Utilities for a PVC Site
Designing a Multi-Product Microbrewery
Nitrogen Trichloride Prevention and Control within the Chlor-Alkali Industry
Designing a Facility to Produce Phthalic Anhydride from O-Xylene Using a Novel Catalyst
Design of a Grassroots Plant to Produce 100,000 Metric Tons per Year of Cumene
Design and Optimization of a Chlor-Alkali Brine Concentration Process for Improved Recycling of Spent Electrolysis Brine
Using a New Catalyst to Enhance the Selectivity of Linear Alpha Olefin Production
Creating Useful Chemicals from Natural Gas

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

FACULTY ADVISERS
Ralph Bruce, Professor of the Practice of Electrical Engineering
Jules White, Assistant Professor of Computer Science and Computer Engineering

FACULTY ADVISORS

45

46

46

47

48

48

49

49

Sterling Ranch Low-Energy Home Design
Building a Correlation Engine into Camgian Eghurt
Amazon Echo Display
Vandy Van Bus Shelter
FPGA Version of a CubeSat Experiment
Solar Powered Capacitive Deionization
Smart Home Analytics at Sterling Ranch
3D MRI: Providing Insight into Neuroanatomy
iOS App integrated with Hexoskin Smart Shirt Technology
A Novel Cerebral Flow-Diversion Stent for the Treatment of Bifurcation Aneurysm

DEPARTMENT OF MECHANICAL ENGINEERING

FACULTY ADVISER
Thomas J. Withrow, Associate Professor of the Practice of Mechanical Engineering

FACULTY ADVISORS

50

51

51

52

52

53

53

54

54

55

55

56

56

57

57


Robert Webster III, Associate Professor of Mechanical Engineering

Aerial Dance Apparatus
Next-Generation Ankle Exoskeleton
DENSO Automated Manufacturing and Assembly Cell
Design of an Algorithm for Efficient Cooling Tower Control
Fiserv’s Magnetic Stripe Quality Project
In-Space Manufacturing
Two-Wheel Dynamic Center of Gravity Wheelchair
Metro Arts Public Art Collection: Conserving Public Artwork
Nissan Over-Under Material Handling System
Development of a Low-Cost Soft Robotic Deep Sea Sample Collection Tool
Junctural Hemorrhaging Control Device
Laparoscopic Tool Development
Installation Angle Analysis of Wing Fasteners on Gulfstream G-650
Post-Boost Roll Control Using Cold Gas Thrusters
Suborbital Launch Vehicle Roll Control System and Avionics
The Needlescopic Operation for Sinus Endoscopy (The Nose)

DESIGN AND PROJECT FACULTY

Brochure data were collected and managed using REDCap electronic data capture tools hosted at Vanderbilt University’s REDCap (Research Electronic Data Capture) as a secure, Web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) Automated export procedures for seamless data downloads to common statistical packages, and 4) procedures for importing data from external sources. REDCap is supported by a Vanderbilt Institute for Clinical Trials and Translational Research grant [UL1TR000445 from NCATS/NIH].

Fast and Furious Power Wheels for Mobility-Impaired Children

Children with mobility impairments lack a sense of independence, depth perception, cause and effect, and social acceptance. These children do not have access to power mobility because insurance doesn’t cover power wheelchairs for this age group. The goal of our project is to give mobility-impaired children the independence and social interaction they crave by creating a highly-modified power toy car. Our team targets common limitations in children ages 2 to 5, and modifies one base car to fit the needs of many children, giving them development opportunities, independence, and the social interaction they crave, with a fun twist.

The organization GOBabyGo addresses the same need, but customizes a single car for a single child. Our design aims to be used by many children with varying limitations and diagnoses. The car features an adjustable seat, steering wheel, arm rests, and many possible inputs for motor activation.

Validation Model for Catheter-Based Delivery Systems

Stem cells are poised to revolutionize modern medicine. Transplants today have vastly improved the outcomes of thousands of patients battling leukemia and severe hepatic veno-occlusive disease. Researchers now are actively developing many therapies. While in vitro and in vivo experiments generally verify the efficacy and safety of potential therapies, regulators must also consider the effect of specific parameters such as transport on the outcome. Current testing methods do not look into important stem cell outcomes such as differentiation, nor are they cost-effective. Catheter-based delivery systems are the current stem cell-transport method of choice yet they remain largely misunderstood and not well-characterized. Many untested stem cell therapies are currently in market and need to be validated by the FDA as safe and effective. To further characterize catheter delivery parameters, a mathematical model was developed. Our mathematical model, alongside current in vitro validation methods, will serve as a preliminary screening tool for future potential catheter designs.

Reproducible Stereotaxic Injection System for Neonatal Mice

Stereotaxic injection rigs are primarily used to perform minimally invasive procedures on small animals for the purpose of research. The rig employs the use of a 3D coordinate system to accurately target small areas in the body. However, these rigs are designed for adult animals. Our objective is to design a supplemental platform adapted for neonatal animals, particularly mice, which fits into the existing rig. In addition to the platform, we have 3D modeled head molds based on microCT scans of neonatal mice at various weights, orientations, and stages of growth. This was achieved through the development of a pipeline that intakes 3D image files and produces a 3D printable mold based on an inversion of the file. The purpose of these molds is to stabilize the animals during injection, reducing movement and improving injection precision by combating the malleability of the neonatal skull.

Most research institutions induce hypothermia as the primary form of anesthesia. We are currently integrating a cooling system into the platform to safely prolong hypothermia, increasing potential procedure time. Additionally, our pipeline could be applied to CT or microCT scans of any animal model to produce a standard mold for other rigs or forms of research.

Multiplexed Small-Volume Stirred Bioreactor for Brain Tumor Organoid Development

Three-dimensional cell culture via rotating bioreactors is becoming a more appealing option for research as it distributes nutrients evenly throughout the cells under low shear stress conditions. However, current commercial technologies use inordinately large volumes and can only culture single cell types, making them ill-suited for high-throughput screening (HTS). The SpinΩ, a rotating bioreactor from Johns Hopkins University, paved the way for HTS bioreactors by incorporating gear-driven spinning impellers into a 12-well culture plate.

The STAM-24 spinning bioreactor for brain organoids expands on the SpinΩ by utilizing linked chain-and-sprocket systems to turn 3D-printed impellers. This system is integrated with 24-well culture plates to enable higher-throughput screening while fitting into a hypoxic chamber to better mimic the low-oxygen environment of brain tumors. With this bioreactor, further efforts can be made in screening drugs for patient-specific chemotherapy and understanding neural development.
DEVELOPMENT OF A SMART HYDROCEPHALIC SHUNT

Our project is centered on ventriculoperitoneal shunt technology for pediatric patients afflicted with hydrocephalus. Hydrocephalus is a condition characterized by the excessive collection of cerebrospinal fluid (CSF) in the brain and affects 1 in 1000 live births, making its treatment the most frequent procedure in pediatric neurosurgery. The current shunt technology has seen no major improvement in the past 50 years, and has a 50 percent failure rate within two years of insertion. There is no proper way to detect this failure, which leads to severe neurological symptoms due to brain compression and swelling before the shunt is removed or replaced.

To address this issue, we are developing a “smart shunt” that will be able to detect failure before it is clinically apparent. This will be achieved through semi-continuous, remote monitoring of shunt function, represented by the Intracranial Pressure (ICP) of the ventricles in the brain. Not only will the shunt monitor its own function, it also will be able to detect failure and inform the patient and physician of this failure. This will allow for timely care and reduction in the prevalence of adverse, preventable symptoms.

A NOVEL CEREBRAL FLOW-DIVERSION STENT FOR THE TREATMENT OF BIFURCATION ANEURYSMS

It is estimated that 1 in 50 people in the United States has an unruptured intracranial aneurysm. Aneurysms can form anywhere in the brain but commonly occur in bifurcated areas such as the verteobasilar junction (VBJ). Constant pressure and blood flow at this junction increase the likelihood of rupture, a life-threatening event because the VBJ supplies blood to key brain structures. Current treatments of bifurcated aneurysms are either invasive or complex, making it difficult for both the patient and provider to ensure safety and efficacy. Our aim is to make treatments simpler and safer through the use of a single flow-diverting stent. The stent features layers of densely meshed leaves that expand within the aneurysm to reduce residual blood flow. These leaves are held up by a stent body in the luminal space featuring an open coil configuration to minimize the bodily exposure to metal. Our stent is recapturable and allows users to accurately position the device in various neck morphologies. We are testing the efficacy of our stent by running computational fluid dynamic models using parameters determined by Ouread et al. Our goal is to achieve a two-thirds reduction in blood flow velocity to successfully treat the aneurysm.

OCULAR TRACKING TO AID RADIOTHERAPY GUIDANCE FOR EYE TUMORS (Co-Target)

Choroidal melanoma treatment requires the immobilization of the eye during both pre-treatment imaging and radiotherapy procedures in order to locate and target the tumor. Current clinical methods for immobilizing the eye are either invasive, highly inaccurate, or both. At Vanderbilt, the standard of care is to direct the patient to look at the end of a pencil. Thus, a need exists for a device that can non-invasively limit eye movement during these procedures. Our solution is an optical system mounted to the patient’s therapy mask that will provide a focus point for the patient, track eye motion, and prompt the patient to rectify deviations. Our system will provide improved accuracy in locating the tumor during the two pre-treatment imaging procedures and lead to a more specific treatment region for radiotherapy. This solution will improve the clinician’s view of the tumor during therapy planning and correct error introduced by patient movement, preventing vision loss and tumor recurrence. We intend to produce a CT and radiotherapy compatible version of our design that will successfully track and guide patient gaze during imaging and treatment.
TEMPORALLY MODULATED IN VIVO CELL CULTURE SYSTEM

Cell culture systems allow simulation of in vivo conditions without the necessity of using live model organisms. These systems allow science to study biological interactions on a fundamental level. However, there are still model discrepancies such as the lack of temporal modulation — varying the environment with time — which are needed for truly accurate physiological representation. Our goal is to create a more robust experimental apparatus that allows for temporal modulation and increases fidelity to in vivo conditions. This has been accomplished through the creation of a new cell culture plate lid that is compatible with commonly available commercial well plates and allows generation of temporal profiles for any delivered solution. With built-in channels for flow and lidded for varying numbers of wells, our epoxy molded lid is an accurate, precise and easily reproducible device. Our lid additionally improves sterility by eliminating the need to expose cells to culture conditions outside the well plate, thereby greatly reducing exposure to contaminants. Since it is completed, this new design will decrease the preparation time per trial, allowing for greater concurrency among projects, while also minimizing external confounding variables through material standardization and improving the power of each experiment.

DEVELOPMENT OF A SMART BALLISTICS VEST FOR POLICE OFFICERS

Nearly 50,000 police officers were physically assaulted in 2015. Of these officers, nearly 60 percent were alone and 30 percent were seriously injured. The inability of an incapacitated officer to automatically communicate with dispatch exacerbates the dangers faced by officers. Providing an integrated system capable of biometric and force sensors to monitor and assess officer condition as well as rapid threat assessment and communication will greatly reduce exposure to contaminants. The Vanderbilt Department of Hearing and Speech in concert with one another.

OPTIVENT: PERSONALIZED INTERVENTION FOR ACUTE RESPIRATORY DISTRESS SYNDROME

Acute Respiratory Distress Syndrome (ARDS) is characterized by fluid buildup in the lungs, which results in a significant loss of usable lung volume and susceptibility to ventilator-induced lung injury (VILI). ARDS is found in 10 percent of ICU patients and has an average in-hospital mortality rate of 40 percent. The current standard of care is one-size-fits-all, with recommended ventilator settings based on patient height alone. To minimize the risk of VILI, tidal volume (TV) and positive end-expiratory pressure (PEEP) settings should be chosen based on patient-specific respiratory mechanics and updated regularly to reflect changes in the patient’s condition. Stress index is a measure of stress placed on the lungs. Prior research has shown that patient outcomes improve when TV and PEEP are chosen such that stress index is optimized. We are developing OptVent, a software that recommends optimal ventilator settings based on stress index, ideal body weight, and other patient-specific data. OptVent collects data from a ventilator, then isolates relevant portions of each breath to calculate stress index and elastance. After stepping through different combinations of ventilator settings, the program recommends the TV and PEEP settings that minimize the risk of lung injury.

ADDRESsABLE LED BANK FOR STUDYING SENSORY INTEGRATION IN PRIMATES

Currently, there is not an effective way to study how the brain processes individual stimuli in a stimulus-rich environment. A device that meets these needs will provide valuable insight into multisensory integration and lay the foundation for further clinical research of neurological disorders like autism and schizophrenia. We aim to build a concave display of LED lights to interface with a pre-existing speaker scaffold that will project specific stimuli in a controlled space. A Rhinoceros Macaque monkey will experience the complicated stimuli. The Vanderbilt Department of Hearing and Speech will analyze its response with infrared eye tracking and electrodes to gather data from the superior colliculus, a midbrain structure where auditory and visual stimuli are processed.

We are developing OptVent, a software that recommends optimal ventilator settings based on stress index, ideal body weight, and other patient-specific data. OptVent collects data from a ventilator, then isolates relevant portions of each breath to calculate stress index and elastance. After stepping through different combinations of ventilator settings, the program recommends the TV and PEEP settings that minimize the risk of lung injury.

3D rendering of the HERMES system, retrofitting bulletproof vests with an integrated series of biometric and force sensors to monitor and assess officer condition. Sensory data acquired is transmitted via Bluetooth before threat assessment based on an established algorithm.
Babies are social beings. The Bucharest Project in Romania found that infant orphans were stunted in their development due to the lack of personal care in understaffed orphanages. However, if the orphans were placed in a foster family by age 2, they were indistinguishable from a community control by age 8.

The SYTE system is a monitor built to detect the human interactions encountered by babies in the NICU to assure that they are receiving the interactions they fundamentally require. An Xbox Kinect is used both visually and phonically within NICU rooms to track visits as well as word counts. Previous attempts to monitor infant interactions have focused purely on the auditory realm. Research using these methods have raised questions about whether a parent or a nurse talking to an infant are equivalent in regard to future development. Use of the SYTE monitor will provide observations about the type and amount of interactions, and whether parental interactions are especially potent.

Improving Football Helmet Design to Limit Mild Traumatic Brain Injuries

Mild traumatic brain injuries alter the lives of American football players of all ages. Football related concussions affect more than 400 professional and Division I athletes each year and result in long-term medical costs that can exceed $700 million, as in the case of the most recent National Football League settlement. Despite the high incidence rate, most football helmets do little to prevent concussions but focus instead on preventing skull fractures.

The goal of this project is to limit concussion incidence by designing a helmet to reduce both the linear and rotational acceleration experienced by football players during impact. The design incorporates external dynamic shock absorbing packets containing a non-Newtonian material. This helmet dissipates energy through the translocation and transformation of the shock absorbing material upon impact. The air-tight, water-tight packaging of the shock absorbing material allows the helmet to be used in intense weather conditions while the snap on attachment allows the packets to be easily replaced on the sideline in case of damage.

Biosensing Ballistic Vest

Currently, the only methods of communication for police officers are the radio and the panic button, which is found either on the radio or the officer’s belt. The manual process of having to reach for the radio or panic button to communicate can contribute to officer danger and sometimes death. The Biosensing Ballistic Vest aims to improve officer safety through physiological monitoring and enhanced, automated communication. The vest will read an officer’s vital signs and discriminate between his/her resting and alarm states depending on deviations from his/her personalized baseline readouts. These monitoring capabilities, coupled with the ability to recognize blunt force impact, allow the vest to determine if the officer is in danger. If in danger, the vest will automatically communicate to other officers and/or the police department through a mobile phone app, which allows for seamless integration into the existing communication system. The vest will also house a Bluetooth beacon to provide closer-range location tracking ability so that backup can easily identify the location of the officer in danger. While existing vest designs offer passive protection, the Biosensing Ballistic Vest improves upon this protection by actively helping officers when they are unable to help themselves.
ASC-ASCE Student Steel Bridge Competition

The overarching objective of the 2017 ASC-ASCE Student Steel Bridge Competition was to simulate a real structural engineering project from conception to completion in the form of a small-scale bridge competition. For the competition, the four members of the Vanderbilt Steel Bridge Team (Mr. Steel Yo Girl) developed a cantilever design capable of being constructed in under 30 minutes and to withstand a combined load of 2,500 pounds with minimal deflection. The three-dimensional bridge truss provided excellent stiffness to resist both lateral and vertical load of 2,500 pounds with minimal deflection. The three-dimensional conception to completion was entered into the U.S. Department of Energy’s “Race to Zero” competition.

Civil Engineering

Honduras Pedestrian Bridge

During the rainy season in Honduras’ Agatha Valley, the Rio Grande reaches high water levels. San Esteban residents must travel four hours to the nearest bridge, limiting access to schools and clinics. We partnered with Honduras Outreach, Inc., a nonprofit organization serving communities in Central America, to design a safe, constructible, and cost-efficient pedestrian bridge for the 700 residents affected.

In May 2016, two members of the design team traveled to Honduras to conduct a site survey and collected geotechnical samples. The team evaluated the geotechnical and hydraulic conditions in order to select the type of bridge and foundations. The team chose a 165-foot-long cable-suspended bridge in order to span the river without a pier and to simplify construction. The bridge deck, steel cables, and concrete foundations were designed after careful consideration of pedestrian usage, wind, and hydraulic loads. Construction of the bridge is scheduled to begin in August 2017.

Civil Engineering

Sterling Ranch Home for Race to Zero Competition

Sterling Ranch is a master-planned “smart city” currently under development 20 miles southwest of Denver, Colorado. Sterling Ranch’s developers recognize that the energy usage in both residential and commercial buildings accounts for 40 percent of the United States’ total annual energy consumption, and they intend to design and build sustainably. Our team’s mission is to help Sterling Ranch and their predominant homebuilder, Lennar, modify their existing Colorado ranch home plan so that it achieves net-zero energy. We plan to design a home that is cost-effective, comfortable for its users, and easily reproducible nationwide. Additionally, our sustainable home design was entered into the U.S. Department of Energy’s “Race to Zero” competition.

To achieve net-zero energy we used B3Opt, a building science energy and cost optimization program, to simulate various home design alternatives. We looked at innovative insulation methods, HVAC systems, household appliances, window types, and lighting systems, and we ultimately selected the alternatives that were both energy efficient and economical. Our design also includes solar panels on the roof that enable the home to achieve net-zero energy. It is our hope that this home inspires similar sustainable home design by proving that net-zero energy homes can be both architecturally stunning and affordable.

Civil Engineering

Sterling Ranch Multimodal Transit System

Sterling Ranch, a sustainable community located southwest of Denver, Colorado, lacked a comprehensive and innovative transit plan that would connect residents between major hubs inside and outside the 5-square-mile community. The goal of this project was to develop a multimodal, accessible and extensive transit plan that would allow residents to travel conveniently through the community and surrounding areas. The team developed transit user profiles, performed a benefit analysis for transit modes, and analyzed traffic impact studies for Sterling Ranch. Additionally, the team determined how the transit system would alleviate traffic congestion and create a comfortable environment for the community members. The deliverables for this project included identifying the best alternate modes, locating major transit hubs, and devising the most efficient transit routes. The final transit system includes multiple low-cost, convenient, and sustainable modes that efficiently transport residents between schools, recreational locations, and commercial centers.

This transit system provides safe and accessible transportation options for all members of the community. It improves the quality of life for Sterling Ranch residents while delivering the sustainable and eco-friendly practices promised. Perhaps most importantly, this innovative transit system enhances Sterling Ranch’s already strong image as the city of the future.

Civil Engineering
High demand for environmental regulations has forced chemical production companies to spend money on waste treatment. Production cost can be reduced substantially by integrating waste streams and recycling valuable materials in the system. A software interface is one of the holistic ways to implement Mass Exchange Networks (MENs), because it can reduce the pollutants released to the environment.

Our software, an Excel user interface, is capable of identifying an optimal MENs while being cost-effective and energy-efficient. It provides graphical representations of the optimal MENs and data for all streams (up to 10 rich streams and 10 lean streams). The software considers various user inputs, design parameters, mass separating agents and environmental constraints. This user-friendly software contains features that allow users to adjust the minimum composition driving force for each MEN. The program is also equipped with a cost estimator that predicts the return on investment for the design. This prediction allows the engineers to create the most economical chemical plant.

Our software, an Excel user interface, is capable of identifying an optimal MENs while being cost-effective and energy-efficient. It provides graphical representations of the optimal MENs and data for all streams (up to 10 rich streams and 10 lean streams). The software considers various user inputs, design parameters, mass separating agents and environmental constraints. This user-friendly software contains features that allow users to adjust the minimum composition driving force for each MEN. The program is also equipped with a cost estimator that predicts the return on investment for the design. This prediction allows the engineers to create the most economical chemical plant.

Volatile organic compounds (VOCs) are among the most important classes of chemicals used in the process industry and are a class of pollutant present in many gaseous and aqueous emission streams. In response to environmental regulations aimed at reducing air pollution, corporations are required to design innovative, cost-effective methods of eliminating VOCs from emission streams. The recovery and recycle of VOCs within a chemical process has the potential to control air pollution, increase process efficiency, reduce chemical waste and improve process profitability. Despite this, the widespread implementation of VOC recovery methods remains incomplete.

To address this, our team has designed a software package capable of analyzing a variety of recycling technologies and determining the most cost-effective method for recovering one or more pollutants from one or several emission streams. The software package is built within Microsoft Excel and performs calculations related to the design and cost of equipment and materials required to construct and operate adsorption, absorption, biotreatment, condensation, membrane separation, and flaring processes. By constructing our software within Microsoft Excel, we hope to make our work accessible to a wide audience and encourage the widespread adoption of improved process methodologies.
Designing a Heat Exchanger and Wastewater Recovery Network for a PVC Complex Chemical Site

Tackling energy and wastewater problems is essential to reduce their impact on the environment. According to the Energy Information Administration (EIA), chemical industries consumed about 5 quadrillion BTU of primary energy in 2010, and the number has only increased since then. Most plants lack optimum energy and wastewater recovery networks, which lead to energy waste, environmental pollution, and unnecessary expenditures. Energy recovery networks allow the plant to use high-temperature streams to heat low-temperature streams, and vice versa, reducing the need for hot and cold utilities. Wastewater recovery networks allow the plant to reuse streams with low contaminants to dilute more concentrated streams for use in chemical processes or for disposal.

In this project, our main approach includes analysis using the Heat Exchange Network Optimization Software (HENOS) and the Water Treatment Recycle (WTR) software, which were developed at Vanderbilt University to design the optimum energy and wastewater recovery networks. We provide several design proposals that meet the client’s requirement and consider safety analysis and the current plant design to determine the feasibility of each proposed network. Ultimately, our recommendation to the client is based on the design that has the best trade-off between energy and freshwater savings and cost.

Designing a Multi-Product Microbrewery

Beer is one of the most widely consumed beverages, predating the construction of the Great Pyramids in Egypt. In the U.S., more than 19 billion barrels are produced annually, and in the 2015 fiscal year, total revenues exceeded $105.9 billion. As compared to large-scale breweries, microbreweries focus more on quality, flavor, and brewing technique in their varieties over mass production. In recent years, sustainability efforts have become mainstream with manufacturers, placing a greater emphasis on reducing waste and energy consumption.

Our team designed a microbrewery for the production of six year-round, four limited-edition, and four seasonal brews. We present two operations: constructing a new facility and contracting to an existing one. Our overall approach is to design the two operations from the ground up and then perform an economic analysis to determine the viability of both. We aim to reduce operating cost and negative effects to the environment, focusing on producing quality beer that exceeds expectations. Our proposed solution produces 100,000 barrels per year, with production facilities in the Midwest and negligible emissions to the environment.

Nitrogen Trichloride Prevention and Control within the Chlor-Alkali Industry

The synthesis of chlorine via membrane electrolysis of brine solutions has the potential to produce nitrogen trichloride as a contaminant. Chlorine ions react with ammonia derivatives in the feedstock, which are frequently present due to animal waste and fertilizers in the water used to create the brine stream. Nitrogen trichloride is a dangerous compound capable of auto-detonation. The project analyzes various points of intervention to eliminate synthesis routes and degrade or remove generated nitrogen trichloride. In addition, the team attempts to develop methods for nitrogen trichloride detection using continuous process methods. Product is stored in on-sitepressurized vessels, creating potential for concentration of nitrogen trichloride contaminants. Existing methods rely on the removal of nitrogen trichloride through controlled purge streams, creating dangerous conditions for chemical operators and wasting product. The proposed solution reduces the need for operator intervention and provides secondary safety controls to prevent failure. Costing, safety, and efficacy analyses were conducted to explore the inclusion of this process in existing chlor-alkali facilities.
Phthalic anhydride and maleic anhydride are two common intermediates in the production of plastics. These two anhydrides can be formed by the oxidation of o-xylene or naphthalene. The primary product, phthalic anhydride, is a toxic chemical compound with several applications, including phthaleins, dyes, resins, plasticizers and insecticides. Phthalic anhydride is a key component in the plasticizers used to produce PVC, which is currently manufactured at 3 million tons per year.

A new catalytic system for the oxidation of o-xylene to phthalic anhydride recently has been developed with the capability to minimize most of the side products associated with the reaction. The objective of our project was to design a new, grassroots facility to accommodate this promising new catalytic process to produce 100,000 metric tons per year of phthalic anhydride. The production facility will be designed with consideration of potential reactor schemes, separation methods, heat exchange networks and waste management solutions that satisfy the product quantity and purity requirements. Energy consumption, production of waste, safety and economic feasibility will be key criteria in the design process. Potential designs will be modeled and analyzed using simulation software such as Aspen, Matlab and ChemCad. The novel catalyst used in the process can produce a high yield of product while significantly decreasing the amount of by-products incurred.

**Designing a Facility to Produce Phthalic Anhydride from O-Xylene Using a Novel Catalyst**

**Phthalic anhydride and maleic anhydride** are two common intermediates in the production of plastics. These two anhydrides can be formed by the oxidation of o-xylene or naphthalene. The primary product, phthalic anhydride, is a toxic chemical compound with several applications, including phthaleins, dyes, resins, plasticizers and insecticides. Phthalic anhydride is a key component in the plasticizers used to produce PVC, which is currently manufactured at 3 million tons per year.

A new catalytic system for the oxidation of o-xylene to phthalic anhydride recently has been developed with the capability to minimize most of the side products associated with the reaction. The objective of our project was to design a new, grassroots facility to accommodate this promising new catalytic process to produce 100,000 metric tons per year of phthalic anhydride. The production facility will be designed with consideration of potential reactor schemes, separation methods, heat exchange networks and waste management solutions that satisfy the product quantity and purity requirements. Energy consumption, production of waste, safety and economic feasibility will be key criteria in the design process. Potential designs will be modeled and analyzed using simulation software such as Aspen, Matlab and ChemCad. The novel catalyst used in the process can produce a high yield of product while significantly decreasing the amount of by-products incurred.

**Design and Optimization of a Chlor-Alkali Brine Concentration Process for Improved Recycling of Spent Electrolysis Brine**

Chlor-alkali plants generate three of the most vital commodity chemicals through manufacturing processes: sodium hydroxide, chlorine and hydrogen. The sodium chloride electrolysis reaction to produce these three commodity chemicals requires a feed of concentrated brine. However, as the reaction takes place, the concentration of the brine decreases at the outlet of electrolysis. For recycling purposes, it is necessary to increase the concentration of the spent brine solution to produce sodium hydroxide, chlorine and hydrogen in an economical, efficient and viable way. In this project, the chlor-alkali process was analyzed, optimized and designed to utilize the spent brine. The approach developed to solve this important process design issue included research and examination of the performance, viability, economics and other merits of the various brine concentration techniques. The analysis will provide the advantages and disadvantages of several brine concentration techniques and determine the cheapest option to meet the design specifications with best efficiency. Different concentration techniques considered include crystallization, evaporation, addition of salt and reverse osmosis. The recommended design is the most cost effective and operationally effective process for concentrating the spent brine to a specification that can then be recycled back into the chlor-alkali process.

**Using a New Catalyst to Enhance the Selectivity of Linear Alpha Olefin Production**

Linear alpha olefins (LAO) are straight chain alkenes — unsaturated hydrocarbons containing double bonds — where the double bond is in a terminal position. They are used as co-monomers in the production of polyolefins such as polyethylene plastics, detergents, surfactants, synthetic lubricants and plasticizers. LAO are synthesized from the oligomerization of ethylene. However, this route produces a wide variety of olefins, resulting in a significant yield loss of 1-hexene (C6H12) and 1-octene (C8H16). The LAO of greatest commercial interest.

Our team has developed an economically feasible plant design that reacts an inexpensive ethylene feedstock with a new catalyst that greatly enhances the selectivity for 1-hexene and 1-octene. This plant produces 100 MM lb/yr of LAO and includes an option to adjust the mass split of the desired products based on fluctuating market demand. Additionally, it operates within federal and state safety and environmental regulations. This plant has the potential to yield greater profits than existing competitors because of its higher yield of commercially useful LAO.
Creating useful Chemicals from natural gas

Mixtures of the aromatic chemicals benzene, toluene and xylene have conventionally been produced from crude oil byproducts. However, the expansion of American natural gas exploration has uncovered extensive methane reserves that could provide an economic and sustainable substitute for petroleum feed stocks in the production of aromatic hydrocarbons. Our goal is to design a process to increase selectivity of para-xylene, be operable under EPA guidelines, and adhere to appropriate safety precautions.

The initial stage of the process uses a dehydrocyclization catalyst to convert methane into an aromatic mixture. This process is highly endothermic, necessitating constant heating of the reactants to maintain a high product yield. The following stage is alkylation and subsequent methylation to produce para-xylene. Procedure options include using olefins, zeolite catalysts, methanol streams or syngas streams to alkylate the various aromatic streams. These alternative reactions are compared for economic efficiency. The process concludes with a separation scheme to purify para-xylene.

The utility of para-xylene as an intermediate in the petrochemical and polymer industries drives the economic success of this plant. Optimizing selectivity for para-xylene will result in the most profitable plant design.
Meetings are an integral part of any business, and a good deal of time is spent organizing the event and operating the display devices in a meeting room. Traditional interfaces, such as Google Calendar and remote controls, are not always intuitive and users need to have prior knowledge in order to operate them effectively. Productive meeting time is reduced as a result of this management overhead. Our system will improve meeting management by allowing users to manage meetings and control display devices using simple, intuitive voice commands.

The system uses an Amazon Echo to receive and respond to verbal user requests. The requests are then sent to an Intel Compute Stick, which is attached to the meeting’s display device via HDMI. The Compute Stick translates the requests using a USB-CEC Adapter into commands that control the display. This allows users to conduct meetings easily using only their voices. This is more intuitive than existing interfaces, and can be used by people with physical disabilities who cannot operate a standard computer or remote. Our system will simplify meeting management, improve productivity, and save businesses time and money.

**Amazon Echo Display**

**FPGA Version of a Cubesat Experiment**

Approximately one year ago, the Institute for Space and Defense Electronics (ISDE) at Vanderbilt designed and launched a Cubesat experiment to monitor data errors in commercial memories on-orbit. This design used a microcontroller to operate the experiment. In future experiments, ISDE is looking to expand the capabilities of the design implementation to include control of the guidance and navigation of the spacecraft bus as well as replace multiple ICs with a single chip. The objective of this project is to enable this goal by designing a board that uses a Field Programmable Gate Array (FPGA) in place of a microcontroller to operate an experiment.

The team has designed a board that meets the power and form requirements of a Cubesat experiment board. In operation, the FPGA writes and reads from an on-board memory every five minutes. When errors are detected between what was written to the memory and what was read, those errors will be corrected by the FPGA. The team can also communicate externally with the FPGA and receive the number of errors that have taken place.

**Vandy Van Bus Shelter**

Vanderbilt University currently provides an immensely valuable service to students through the Vandy Van System. This system is used by hundreds of students each day to move across campus quickly and safely. However, the program currently lacks designated shelters to make stops easily identifiable and protect students from inclement weather. Working with many campus stakeholders, our team designed a Vandy Van bus shelter that not only shields students from the weather but also keeps them safe and up-to-date on the status of the Vandy Van. The design is highly modular to be more sustainable and practical as the campus continues to grow and develop. It incorporates safety elements such as a security camera and blue light system, and the shelter includes a screen to provide riders live route information and arrival times. The shelter will serve as a useful contribution to student life and will further roll out as the Vandy Van program continues to develop and evolve.

**Solar Powered Capacitive Deionization**

Access to safe drinking water is a significant challenge in many communities, especially those in typically remote areas without access to large-scale infrastructure of power and water supply. Furthermore, some of these communities’ only water source is brackish groundwater. Existing water treatment technologies all have significant limitation when applied in small-scale and off-grid brackish groundwater desalination. For example, reverse osmosis is more suitable for continuous operation, which poses a challenge using periodic solar energy, whereas distillation processes are energy inefficient. In order to address the issues presented by the lack of potable water and the problems in existing water treatment, we will use an emerging technique known as Capacitive Deionization (CDI). CDI can provide drinkable water to these regions in an energy efficient, sustainable manner by means of solar energy. CDI works by removing ions from water flowing through charged supercapacitors. These supercapacitors have a positively and negatively charged plate which attracts ions of opposite charge, pulling the ions from the brackish water. Additionally, unlike previous CDI systems, our system will feature real-time feedback to control the destination of the output flow, be entirely solar powered, and significantly reduce the concentration of ions in brackish water.
Though sustainability continues to be a hot topic in modern architectural development, much of the research in this area focuses on developing resource-efficient appliances and buildings. Sterling Ranch, a housing development in southwest Denver, Colorado, is working to couple its focus on sustainable facilities with the addition of software that can help residents develop sustainable habits. Each home at Sterling Ranch is equipped with sensors that monitor water, electricity, and energy use as well as photovoltaic energy production.

Our system uses information from these in-home water sensors to help Sterling Ranch residents understand their water consumption patterns. The software analyzes collected sensor data to produce a time-segmented water consumption summary and tips about how residents can reduce their overall use. The graphical results of this analysis are displayed in real time on an in-home tablet application, making these insights easy to access and understand. It is our hope that access to this analysis will motivate residents to develop more sustainable habits and fully understand the environmental and financial benefits of reducing their water consumption.

### 3D MRI Providing Insight into Neuroanatomy

Our project’s overarching goal is to harness the transformative power of virtual and augmented reality to reduce the ambiguity of radiological data for medical students and clinicians. We provide a clear visualization of radiological medical data with a multi-platform, easy-to-use application. Clinicians and medical students often have difficulty analyzing traditional radiological data because it is presented in only two dimensions. Even when these images are combined and 3D printed anatomical regions of the brain are created, they are often difficult to analyze due to the medium’s rigidity and opacity. Our application, coded in the game engine Unity3D, displays a three-dimensional model of the brain taken directly from a set of magnetic resonance images. With our application’s intuitive user interface, users can manipulate, rotate, expand, and visualize the model clearly. Further applications of the project include assisting with neurosurgery, diagnoses of pathologies of the brain, and inviting other anatomical regions to be segmented and modeled.
Aerial dance is a subgenre of modern dance that incorporates a structure suspended in the air to allow for full three-dimensional creative movement. Lizard Walker and Thérèse Keegan are local Nashville aerial dancers who have asked us to create a custom apparatus for their performances. The apparatus must remain safe and portable while designed to be different than other, existing aerial dance apparatuses to ensure that it provides the opportunity for a unique performance. Additionally, each individual part of the apparatus needs to be replicable at a high volume level and designed so that a customer or performer can easily piece the entire configuration together with simple instructions. This will allow for other artists in the field to experiment with the apparatus as well. Our solution is a two-piece pyramidal steel structure suspended with structurally graded spansets. The custom joints provide the opportunity for complete disassembly of the apparatus. The upper tier fits within the lower for ease of transportation, and the painted steel bars provide comfortable gripping for the performers.

AERIAL DANCE APPARATUS

Karl Morcott
Maymur Baig
Rachel Armstrong, ME/CS
Harry McGraw
Maymur Baig
Harry McGraw

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

NEXT-GENERATION ANKLE EXOSKELETON

Karl Morcott
Maymur Baig
Harry McGraw
Rachel Armstrong, ME/CS

For centuries, people have strived to enhance human performance, and our aim is no different. We are trying to enhance human walking by reducing the metabolic energy consumption by 10 percent. In order to do this, we are designing an ankle exoskeleton that stores energy and transfers it back to the user. Our ankle exoskeleton contains an energy storage device (i.e., spring or resistance band) that is placed parallel to the user’s Achilles tendon. When the user takes a step, some of the energy produced is stored in the device (i.e., the spring or resistance band stretches). When the user then pushes their foot off the ground, the stored energy is transferred back to the user (i.e., the spring or resistance band is released and returns to its original position).

A key element for the success of the ankle exoskeleton is a clutching mechanism that allows the energy storage device to engage and disengage at the appropriate times in order to not interfere with the natural walking motion of the user. The exoskeleton is completely passive, meaning that it does not contain actuators, such as motors, and it does not require batteries or any other external source of energy. This gives the user the freedom to wear the ankle exoskeleton in any situation.

This is how the next-gen ankle exoskeleton is worn.

DENSO AUTOMATED MANUFACTURING AND ASSEMBLY CELL

DENSO engages in many educational outreach programs, demonstrating manufacturing techniques and robotics projects to teach basic engineering principles and inspire young students to pursue higher education and careers in STEM fields. This project aims to integrate a variety of systems in a cell that automatically manufactures cardboard figurines. Individual slices of a model are produced by a laser cutter, and a six-axis robot is utilized to move and stack the pieces. The cell also includes several custom-designed components which enhance the automation of the assembly process and display a wider range of electromechanical systems. Upon completion of the laser-cutting process, the robot applies tension to a cord that opens the laser cutter’s door, enabling easy access to the cut pieces. A vacuum chuck with suction cups is attached to the robot’s flange and used in conjunction with a compressor and vacuum generator to lift and move the cardboard pieces. Adhesive is affixed to the bottom of each slice before being added to the assembly. The completed figurines are given to students attending DENSO’s programs as souvenirs and reminders of the vast capabilities of engineering systems.

This is how the next-gen ankle exoskeleton is worn.

B)'
FISERV’S MAGNETIC STRIPE QUALITY PROJECT

Fiserv Output Solutions (FOS), a credit card manufacturer in Nashville, faces challenges in the factory. The FOS facility is responsible for manufacturing secure and non-secure credit, debit, gift, and other bank or membership cards. Using either or both an offset lithography or silk screen press, we print the desired image onto sheets of 56 cards. These sheets receive a plastic overlay, including the magnetic data stripe, and are laminated and die cut into cards. Cards are then inspected for defects before being sent elsewhere for personalization.

We have identified one common defect that affects the functionality of the cards, which is the location of the magnetic stripe on the back. When the mag stripe is not in the right location, it is called “mag float.” There are a number of possible sources of this error. When mag float occurs, cards no longer fall within ISO specifications for the location of the magnetic stripe on financial cards, which are set in place to ensure that any card reader can read the data from any mag stripe. If a job fails due to mag float, FOS incurs the cost of reprinting the entire job from the beginning.

The goal of this project is to build a system that can detect when mag float occurs on rolled overlay to prevent these defective cards from traveling through the finishing processes, wasting time, energy and money.

METRO ARTS PUBLIC ART COLLECTION: CONSERVING PUBLIC ARTWORKS

Metro Arts’ public artwork installations cover many notable pieces, including the large number of artistic bike racks seen throughout Nashville. These bike racks, despite each being unique, face the same problems such as paint chipping, metal rusting and disruptive removal from the ground. This daily wear and tear is the result of the racks serving as “usable artwork.” Additionally, commissioned artists have been making design decisions based on aesthetic, not sustainability, thus adding to the maintenance and upkeep required.

With the ultimate goal of extending the bike rack lifespan and time between maintenance, the team began to design subterranean mounting systems that would not detract from the artist’s original intentions but would allow for easy bike rack removal. This mounting system is welded during fabrication to the bike rack posts and consists of an industrial hidden hasp lock, subterranean compartment containing the lock and a lid covering the compartment. In addition to fabrication, the team collected data and research throughout the year to compile into an infographic series. This series will allow for the rack’s required technical specifications to be communicated to the artists in a clear, concise way.
Deep Sea Sample Collection Tool

Development of a Low-Cost Soft Robotic Deep Sea Sample Collection Tool

While deep coral reefs and other deep sea environments have impressive ecological significance, they remain largely unexplored due to limitations in exploration and sample retrieval methods. The primary obstacle to studying deep coral reefs is depth. SCUBA divers rarely dive deeper than 30-50m underwater. Deep sea environments, such as deep sea coral reefs, located between 50-200m underwater, have been mostly inaccessible.

Using a growing selection of small remote operated vehicles (ROVs), biologists are able to collect samples at these previously unattainable depths. Despite these advancements, this research has been limited by a lack of low-cost, lightweight tools that can be mounted on a ROV and used to collect biological samples without damaging them. Conventional grippers, modeled after the Jaws of Life, are unfit for the delicate collection of soft biological samples — some of which are hundreds of years old and rare.

Using the previous work of our sponsor, our team has redesigned these tools to improve the process of gathering biological samples through the implementation of a gravity-driven, over-under material-handling system that allows for three containers to be stored in the footprint of two. This system will allow for a full container to be ready and easily accessed after the emptying of the previous container. The worker will be able to switch out empty and full containers with minimal effort, which will improve the efficiency of the Nissan assembly line.

Junctional Hemorrhaging Control Device

Modern-day military body armor provides defense to critical areas such as the abdomen, thorax and head, but it does not protect the limbs or their areas of attachment to the torso. Consequently, these areas are prone to injury from energized fragments such as IED shrapnel, blasts and gunshot. Trauma to junctional zones is particularly troublesome because they are inaccessible with traditional tourniquets, thus hemorrhaging from major blood vessels cannot be controlled. In fact, 20 percent of U.S. soldier casualties deemed savable in Middle Eastern conflict from 2001-2010 were caused by junctional injuries.

The First Responders Junctional Hemorrhaging Control (JHC) team is addressing this area by focusing on a low-cost, hand-sized rapidly deployable junctional tourniquet that is an improvement over FDA-approved JHC devices, which are rarely used by military field medics due to high manufacturing costs, bulk, unreliable hemorrhaging control and cumbersome application procedures. Application of this new device relies on a custom-made ratchet mechanism, which allows a simple turning motion to tighten straps around a specifically designed pressure application block. This device has the potential to save hundreds of lives by equipping field medics with a quick and easy method for stopping junctional hemorrhaging.

Laparoscopic Tool Development

Laparoscopic surgery is a minimally invasive surgical technique with many advantages to the patient. The surgery is performed through small incisions, approximately 1 cm in length, in the abdomen of a patient. By operating through these small incisions rather than an open procedure through a large incision, surgeons can reduce the overall pain and recovery times for the patient.

The overarching goal for our project was to develop a new laparoscopic instrument set that features intuitive assembly, ratcheting and non-ratcheting ergonomic handles of different sizes, comfortable operation and sturdy overall design. We also focused on designing modular tips that could be easily disposed of. These will provide surgeons the ability to quickly interchange tips, minimizing cost and effort.

The main issue with Symmetry Surgical’s current laparoscopic tool line is the vast quantity of tools. In many cases, they have several tools that represent similar functionalities, which makes customer interactions more difficult. We created a basic package that can be purchased to perform most laparoscopic surgeries.
Airplane wings are constructed from wing skins, ribs, spars, stringers and thousands of Hi-Lite pin/collar fasteners. The fasteners are installed manually to connect the wing ribs to other components, and thus, there is innate human error associated with drilling holes into difficult-to-reach locations. These holes are unintentionally drilled at an angle instead of perpendicular to the parent aluminum material. This phenomenon is called a slant-drilled hole and is the basis of this design project.

Triumph currently fixes slant-drilled holes by installing an angled block of metal, called a taper block, under the head of the fastener in order to recreate a perpendicular surface and regain some of the lost joint strength due to the angled configuration. The team performed a full analysis of various sized Hi-Lite pin/collar fasteners for both perpendicular and slant-drilled holes. The analysis involved analytical by-hand calculations, finite element modeling solutions and physical testing in order to determine the loss of joint strength from the perpendicular configuration to the angled configuration—a quantitative value that has been coined as the knock-down factor. The goal was to prove a consistent loss of strength across all three analysis platforms.

**MECHANICAL ENGINEERING**

**TEAM**
- Dustin Howser, ME/Math
- Jimmy Pan
- Brian Ramsey
- Derek Phillips
- Nina Campano
- Paul Register, ChemE/Physics

**ADVISERS**
- Amrutur Anilkumar, NASA Student Launch Competition Team Adviser, Professor of the Practice of Mechanical Engineering, Professor of the Practice of Aerospace Engineering

**SPONSOR**
- Vanderbilt Aerospace Design Laboratory

**SUBORBITAL LAUNCH VEHICLE ROLL CONTROL SYSTEM AND ATOMICS**

The ability to control the movement of a rocket or other aircraft can improve vehicle performance and provide mission-critical maneuverability. Thus, the team’s design directive is to successfully design, build, test and fly a fully integrated electromechanical payload that imparts two rotations about a rocket’s vertical axis during ascent by using an onboard cold gas thruster system. Design of a control system for the rocket is a large portion of this challenge. This control system consists of a sensor that will detect when the primary rocket engine has stopped burning and inform the onboard computer that it is time to start firing the aforementioned thrusters to perform the roll experiment. After two rotations, the control system will fire the counter-roll thrusters to halt rotation. Using an onboard sensor and controller allows the rocket to make decisions in real time and thus be robust to any disturbances such as a sudden wind. This control scheme has been and will continue to be tested and refined on a ground-based test facility designed and built by the team, known as the FRAME, to ensure success on launch day.

**MECHANICAL ENGINEERING**

**TEAM**
- John Booker
- Thomas Agger
- Allison Bielawski
- Nikolaos Gkotsis
- Taylor Larsen

**ADVISER**
- Bryan I. Hartley, M.D., Instructor in Radiology

**SPONSOR**
- Vanderbilt School of Medicine, Department of Radiology

**THE NEEDLESCOPE OPERATION FOR SINUS ENDOSCOPY (THE NOSE)**

Chronic sinusitis is a condition characterized by the swelling of the sinuses that affects over 29.4 million Americans, with symptoms including congestion, sinus pressure, runny nose and headaches. Currently, doctors use patient-reported symptoms and larger endoscopes that only reach the entrances of the sinuses. This limitation commonly results in a misdiagnosis. The goal of this project is to develop a tool that navigates a fiberscope through the nasal passage to observe the various sinus cavities. This will prevent unnecessary antibiotic or steroid medication and radiation exposure through CT scans for the patient.

The project is divided into two components: the handle and the flexible tip. The handle needs to be intuitive, ambidextrous and capable of housing a bending mechanism and ports for the camera, catheters or balloon sinoplasty device. The design of this is refined through an iterative 3D printing process. The tip, made of a biocompatible material, has a mechanical wrist (small notches cut by CNC and a wire tendon) that can bend up to 135 degrees to enter the various sinuses. The final device is expected to prove its viability, after phantom and cadaver testing, as a better alternative to current nasal endoscopes.

**MECHANICAL ENGINEERING**

**TEAM**
- Amrutur Anilkumar, NASA Student Launch Competition Team Adviser, Professor of the Practice of Mechanical Engineering, Professor of the Practice of Aerospace Engineering

**ADVISER**
- Amrutur Anilkumar, NASA Student Launch Competition Team Adviser, Professor of the Practice of Mechanical Engineering, Professor of the Practice of Aerospace Engineering

**SPONSOR**
- Vanderbilt Aerospace Design Laboratory
We take great pride in recognizing these faculty members who are the core of our design program. Their outstanding contributions and excellence as instructors, advisers, and mentors in our senior design and project courses have led to the work exhibited at Design Day 2017 and have transformed our Class of 2017 into young professionals.

**DESIGN AND PROJECT FACULTY**

- **Ralph Bruce**
  Professor of the Practice of Electrical Engineering

- **Jules White**
  Assistant Professor of Computer Science and Computer Engineering

- **Robert Webster III**
  Associate Professor of Mechanical Engineering

- **Thomas Withrow**
  Assistant Dean of Design

- **Matthew Walker III**
  Associate Professor of the Practice of Biomedical Engineering

- **Scott Guelcher**
  Professor of Chemical and Biomolecular Engineering

- **Lori Troxel**
  Associate Professor of the Practice of Civil and Environmental Engineering

- **Russell Dunn**
  Professor of the Practice of Chemical and Biomolecular Engineering

- **Matthew Walker III**
  Associate Professor of the Practice of Biomedical Engineering

- **Lori Troxel**
  Associate Professor of the Practice of Civil and Environmental Engineering