Inspiring Greatness in Engineering and Computer Science

CEDARVILLE UNIVERSITY

In This Issue

Engineering Students Learn to Wait on the Lord

For the past few years, engineering students enrolled in the biomedical engineering minor at Cedarville have worked on a project to provide medical implants for femoral fracture fixation to a missionary hospital in Kenya. The project has two parts: remanufacturing intermedullary (IM) nails that were donated to the hospital but were too long to be used by the Kenyan people, and manufacturing Cedarville's own brand of fracture fixation nails.

Students worked for over two years designing and analyzing the "CU nail." With the help of some generous

donations, the plan, as described by the project's advisor Tim Norman Ph.D., Professor of Mechanical Engineering, was to pursue remanufacturing nails using local machine shops working in the biomedical field and to secure a manufacturer for Cedarville's nails. Funds were sufficient to remanufacture 90 donated nails and to produce about 12 trial CU nails at the cost of about $20,000. The 90 donated nails were finished with the help of recent graduate Leah Pernicano '12. However, the team was having difficulty securing a manufacturer for the CU nails.

"We were getting turned down from every manufacturer we contacted," Norman explains. "The financial bottom line was not enough to motivate a company to retool for our project. We were proposing too few units that could vary from year to year depending on donations and funds available from Kenya and the U.S."

After nearly two years of being turned down, Norman finally decided that the team would no longer pursue production of the CU nail. After this announcement, the team began looking at their options for supplying nails to Tenwek Hospital in Kenya. These options included continuing to remanufacture donated nails and looking for a foreign supplier of new IM nails of high quality but at reduced cost. Within a week of that announcement, Dr. Dan Galat, a missionary surgeon at Tenwek, learned that nearly 500 IM nails were being donated to the hospital, 300 of which needed remanufacturing. "These 300 nails will last us nearly five years," said Galat. At the current cost to remanufacture the nails, it will take about all of the $20,000 remaining to remanufacture these 300 nails.

"It's amazing how God worked in this situation," remarked Norman. "Instead of spending all our money on 12 sample nails, we are using the money to put 300 nails to use. That means 300 people will hear the Gospel that might not have otherwise heard it. I guess God felt that this was the better way to use the available funds."

While the team continues to pray for a long-term solution, they have learned how God can work in circumstances that seem beyond our control when we wait on Him.

"Academics at Cedarville are tough, but there is a lot of support and it's worth the effort. Cedarville not only trains a person to succeed in their major, but also to be a well-rounded person. Upon graduation, I will be equipped to be a leader wherever God sends me."

Quinton Paul '13
Mechanical Engineering
Katy, Texas

Efficient Vehicle Team Continues to Grow

Cedarville University's Efficient Vehicle Team entered three vehicles in the 2012 Shell Eco-marathon Americas competition. Along with two Prototype division cars, Gold Lightning and Sting, for the first time the team designed and built a vehicle for the new Urban Concept division, created by Shell to challenge students to design and build fuel-efficient vehicles that look similar to cars we see every day.

Vehicles in the Urban Concept division must have four automobile-size wheels, a minimum length, width, and height, and accessories such as windshield wipers. In contrast, Prototype division cars are designed for optimum aerodynamic efficiency, resulting in cars that are sleek, low, and skinny and require drivers to almost lie down in the car. They do not have head lights, turn lights, or trunk space and typically have only three bicycle wheels. They look like small airplanes without wings.

The Cedarville team also used three distinct types of drivetrains this year: a conventional fuel-injected gasoline combustion engine, an all-electric drive train, and a hybrid-electric drive train.

Urban Concept Vehicle

Eight mechanical engineering seniors tackled this project for their senior design project, and four electrical engineering seniors developed a hybrid-electric drivetrain for the vehicle. Both teams experienced real-world engineering challenges and real deadlines. The team came close to having the car ready for technical inspection, but encountered an unexpected problem at the last minute.

Gold Lightning

This year's team built upon the design of previous teams' work on this vehicle. They dyno tested and tuned the newest engine in the fleet, made advances on the wireless data link between the cars on the track and the pit crew, and developed a laser wheel alignment fixture to align the highly cambered front wheels. The team was able to achieve 1215.7 mpg, which was good enough for fifth place in the competition.

Sting

This year's team continued the work of the 2011 team, which designed and built a carbon fiber chassis for the body of the all-electric vehicle. This year's team designed a new front suspension and steering system for the vehicle, but complications at competition forced them to reinstall the original solid axle suspension. The team took third place in competition by achieving 222.9 km/kwh.

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Few universities — Christian or not — offer the modern facilities, extensive hands-on experiences, and one-on-one faculty interaction that characterize Cedarville's programs. The rigorous classroom experience combined with a campus environment openly committed to Christ prepares our graduates to find jobs in a wide range of engineering and technology fields or to succeed in graduate school.

Faculty

- Sam SanGregory, Ph.D. (Chair)
- Robert Chasnov, Ph.D. (Associate Chair)
- Gerry Brown, Ph.D.
- Timothy Dewhurst, Ph.D.
- Vicky Fang, Ph.D.
- David Gallagher, Ph.D.
- Hardy Hegna, Ph.D.
- Nan Jiang, Ph.D.
- Jay Kinsinger, M.S.
- Clint Kohl, Ph.D.
- Tim Norman, Ph.D.
- George Qin, Ph.D.
- Keith Shomper, Ph.D.
- Jeff Shortt, Ph.D.
- Thomas Thompson, Ph.D.
- Timothy Tuinstra, Ph.D.
- Tim Yao, Ph.D.
- Larry Zavodney, Ph.D.

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Internships

Cedarville's Career Services staff will help you prepare for your career through discipline-related experiences, or internships. You will have an advantage in a competitive job market because of real-life, hands-on experience. Students in our department have enjoyed internships with organizations including:

- 3M
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- Air Force Institute
- Amazon.com
- Avetec
- Belcan Corporation
- Boeing
- Booz Allen Hamilton
- CAT
- Century Engineering
- Comcast Media Center
- Honda Research and Development
- Microsoft
- NASA Glenn Research Center
- Reynolds and Reynolds
- Rockwell Automation
- Wright-Patterson Air Force Base

Department Chair Greeting

Greetings, and thank you for your interest in the Elmer W. Engstrom Department of Engineering and Computer Science at Cedarville University. We rejoice in the Lord for the many ways that He has blessed us again during the 2011–2012 academic year and are pleased to share some of our highlights with you.

To quote from our department vision statement, we "seek to honor the Lord Jesus Christ in every endeavor and earnestly desire to cultivate technical professionals who are committed to moral excellence, and who are exemplary in character, conduct, and skill." As you read this newsletter, you will see how we live out our vision statement on a day-by-day basis. Whether setting the foundation through lectures, or putting engineering to practice in design competitions or laboratory exercises, we strive to provide our students with an excellent education founded on biblical principles and morals. The effort put forth is clearly paying dividends.

Although most people never give it a thought, it is hard to imagine our world without engineers and computer scientists. It is very easy, for example, to always expect the next cell phone or GPS unit to be better, faster, smaller, or "cooler" than the one before it. What is forgotten is that there is an army of engineers and computer scientists behind the design of every new gadget. From the electronics that enable the phone to communicate wirelessly, to the software that makes it "cool," to the nifty sliding door that exposes a hidden keypad, each is a design masterpiece. Here at Cedarville, we offer majors in electrical, computer, and mechanical engineering and in computer science; the same disciplines that are most applicable to many of today's marvels.

As you read this newsletter, you will not see our students designing cell phones, but you will see how well prepared they are to tackle very difficult problems. From winning awards for technical presentations to designing and competing with boats, planes, robots, and cars, our students continue to demonstrate how well our programs are preparing them. But don't take our word for it, read through this newsletter and discover it for yourself.

Sincerely,

Sam SanGregory, Ph.D.
Chair, Elmer W. Engstrom Department of Engineering and Computer Science

Teams Continue Aero Design Success

Cedarville University engineering students have been competing in the SAE Aero Design competition for over two decades and have placed in the top five multiple times. In 2012, two Cedarville teams sought to continue that success.

A senior design team, Andrew Dirks '12, Daniel Lewis '12, Andrew Schrank '12, Danny Staudt '12, and their advisor, Tim Norman, Ph.D., Professor of Mechanical Engineering, made history at the 2012 SAE Aero Design competition by being the first team to introduce a glider into the competition. A change in the rules for the 2012 Micro Class competition opened the door for the team to begin researching and designing its glider. An underclassman team made up of Byambadorj Bird '13, Daniel Cape '15, Mark Edmonson '15, and John Morton '14 also competed with a more tradition design.

The goal of the Aero Design competition is to design, build, and fly a remote control aircraft within design and performance requirements set by the SAE. There are three divisions: Open, Regular, and Micro Class. Micro Class requires a lightweight, efficient flight, while the Regular Class requires a primary focus on maximum lifting capability. A winning score requires points from each of three categories: flying, presentation, and a design report.

The students receive design requirements in August, at the start of the school year. The teams design their plane from September to December, build it during January and February, and perform testing during the month of March to prepare for the April competition.

For the glider to be successful for the senior design team, it had to be very light (less than half a pound), have a high glide ratio (at less 20 feet of horizontal distance for every foot loss of vertical distance), and have an elastic launch system that would propel it high enough to complete the course. These were large challenges for a team that lacked experience with gliders. The team worked tirelessly using all the resources they had to obtain a successful flight, including flight testing in the Doden Field House in the Recreation Center where they could avoid wind gusts that would contaminate the glide ratio data.

The team's experience at the competition near Atlanta, Georgia, was bittersweet. While the team could boast of launching and flying the first glider ever in competition, they were not successful launching the plane high enough to complete the full circuit of the course because of less than optimal air field conditions.

The underclassman team experienced some success at the competition. While a crash on the first day of competition prevented their plane from achieving its design maximum with only five rounds of flying, even after an overnight rebuild, this team earned third place in the Most Payload Lifted category with their hand-launched design. Achieving this award was a major victory for this young group of engineering students.

According to Norman, both teams can count themselves as successful because of the major hurdles they had to overcome to successfully fly their planes, and the real-world experience they received.

"The competition gives students exposure to situations they might encounter in the real word such as working on a team, communication of ideas, and working under pressure," stated Norman. He added, "It also gives Cedarville University students interested in aviation an outlet to develop their skills in aeronautical engineering."

TechFest

Eight engineering students from Cedarville participated at TechFest 2012 in Dayton, a fun, family event that exposes young people to science, technology, engineering, and math (STEM). The event hosted 70 hands-on STEM exhibits, demonstrations, and games.

Cedarville students manned a booth that demonstrated basic circuit theory using conductive play dough. When mixed with salt, play dough has sufficient free electrons to make a good conductor (twice as conductive as regular play dough). On the other hand, play dough is about 150 times more resistive than regular play dough when mixed with sugar. The group explained and demonstrated basic series/parallel circuits using LEDs and the play dough. They also built a circuit using a 555 timer that produced different tones on a speaker depending on the variable resistance of the play dough. The kids that visited the table loved the hands-on experience the exhibit gave them, making the day worthwhile and rewarding for the team.

Cedarville Roboboat Team Makes Strides

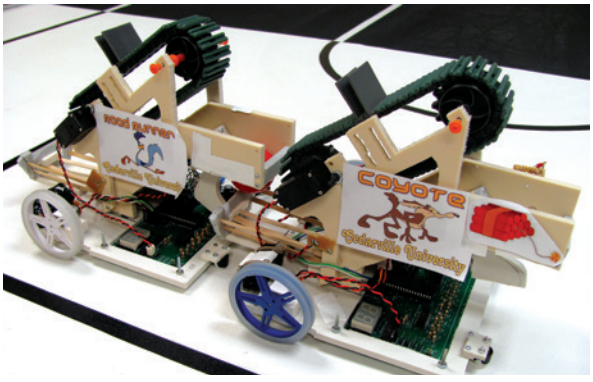
A team of Cedarville electrical engineering students and one robotic boat traveled to Virginia Beach, Virginia, to compete in the fifth annual International Roboboat Competition sponsored by the Association for Unmanned Vehicle Systems International (AUVSI) and the Office of Naval Research. This competition requires students to build a small autonomous surface vessel capable of navigating an aquatic course and completing various tasks while controlled by its onboard computers.

The Cedarville entry was built and programmed by students over the course of the 2011–2012 school year. The design incorporated live video for locating colored buoys and channel markers as well as a digital compass and GPS system to augment navigation. All of the sensor data is fed into an onboard laptop computer that makes all navigational decisions for the boat. The navigation software was written by students and comprised more than 3,000 lines of computer code.

Since this was Cedarville's second year to participate in the competition, students were able to build upon the lessons learned in a previous competition. During qualifying, the Cedarville boat successfully navigated through the speed gates and then through four channel gates earning them a berth in the wildcard run to be held the next day. With some revisions to the navigation computer code, the boat was able to navigate the speed gates and an impressive six channel gates during the wildcard run very nearly catching the Virginia Tech boat for a slot in the finals.

"I'm extremely happy with the progress we made this year," reflected team advisor Tim Tuinstra, Ph.D., Associate Professor of Electrical Engineering. "To build any kind of autonomous system is extremely difficult and takes a great amount of ingenuity and innovation. These students have made significant strides toward that goal. I look forward to what we'll be able to do in the 2013 competition building on the groundbreaking work accomplished by this dedicated team."

Fastest Handoff in the West Earns Third Place



A team of 13 engineering students entered robots in the American Society of Engineering Education (ASEE) Autonomous Robot Competition, held in June 2012 in San Antonio, Texas. Focusing their efforts on speed and reliability, the team named their robots "Coyote" and "Road Runner" after the fast-chasing cartoon characters. The team had a big challenge to meet for the competition. They would have to design a robot that would carry a golf ball (signifying a mail bag used by the pony express) around an 8 x 8-foot curving track with both a white line on a black floor and a black line on a white floor. It would then have to hand off the golf ball to the second robot, which would continue around the same track. A round is complete when the robots have run four laps, two by each robot, with three hand-offs in between.

The team knew early on that it needed to work on speeding up the robot from previous years. In 2011, Cedarville's team earned fourth place with a track time of 25 seconds. The first place team had a time of 9.5 seconds, so they knew they would have to increase their speed in order to win. The 2012 team did just that. With significant changes to the drive train and motor control systems, along with some great programming and a software proportional and derivative control algorithm, the team's robot completed a single lap in about 9 seconds, more than two and a half times faster than the previous year. A conveyor belt lift system and spring-loaded delivery mechanism to a large hopper allowed the robots to transfer the ball safely with significant miss aliment, and faster than any other team in the competition.

The team designed a custom-printed circuit board to house the needed electronics and provide the connections, sensors, logic, and a socket for the motor controllers. This compact design kept things neat, light, and reliable.

Because the overall team score was the sum of four independent runs, reliability was a high priority. Coyote and Road Runner performed well in competition, correctly functioning in three of the four rounds. In the first round, the receiving robot had its lift paddle in the wrong spot and was unable to receive the pass from the lead robot. Although this was disappointing, other teams had similar issues. Cedarville's robot pair ended with the third fastest time and won the third place prize in the competition.

Solar Boat Team Tops All Universities in Netherlands Race

The Cedarville University Solar Boat team outraced all other universities at the Dong Energy Solar Challenge (DSC) in the Netherlands. Cedarville took third place in the Top Class, behind only two professional boats.

The DSC is a six-day, 220 km solar boat race that follows the course of the famous Elfstedentocht, a skating race around the province of Friesland. Over 40 boats raced in this challenging competition with teams coming from the Netherlands, Finland, Poland, China, Brazil, and Turkey. Cedarville had the only boat from the U.S. The Top Class is for the fastest and most competitive boats.

None of this is possible without God's blessing; all we do, we do for his glory, and freely confess that our success is totally due to God's grace. While God has chosen to bless us, we acknowledge also the huge commitment from the students, faculty, university trustees, and sponsors. Each year a new team of mechanical engineering seniors undertakes the task of continuing this legacy. This past year 11 seniors averaged over 20 hours per week on the project during the school year and after graduation a large portion of the team worked almost daily for two months. Tim Dewhurst, Ph.D., Professor of Engineering, is the overall project advisor. Gerry Brown, Ph.D., Associate Professor of Engineering, co-advises the project and provides the guidance necessary to allow mechanical engineering students to undertake complex electrical engineering problems. This year Jay Kinsinger, Assistant Professor of Engineering, also worked with the team to provide essential expertise on manufacturing issues.

Cedarville University has maintained "world-class" status in solar boat racing over the past decade, winning the Solar Splash World Championship six times, and now placing first among universities in the Dong Solar Challenge.

The success of the team depends on commitment and ingenuity; the project is designed and built by students under the steady guiding hand of a very involved faculty. The students provide the diligence, time, and willingness to learn, while faculty members provide the vision, skills, motivation, and accountability. Dewhurst explains that this culture creates an "internship" feel to the project and is "why Cedarville can compete with any university in the world."

The Boat

Cedarville's DSC entry had several innovative features, designed and built by the students, which allowed it to finish ahead of all other universities. In addition to a hull design and motor from 2010, the 2012 boat included:

- Flexible, lightweight solar panels designed and built by Tom Poore '12
- A lightweight carbon fiber hull with construction led by Jordan Oakes '12
- A highly efficient propeller designed and manufactured by Sam McLeod '12
- A complex commercial Li-ion battery package, designed by Zak Zieglar '12, integrated with a printed circuit board, designed by Andy Koch'12, for data processing and energy management system
- Integrated microcontrollers, GPS unit, and data recording designed by Kirsten Nicolaisen '12
- A hybrid peak power tracker (PPT) to optimize solar power management using modified commercial PPTs and incorporating custom hardware PPT designed by Tim Ronco '12, building on the work of Mike Loosa '10.
- Extensive backup systems to incorporate redundancy in case of failure of any particular system

The Race

Ben Yeh '12 was the driver for all legs of the race. Yeh did not have much boat

Professor Joins International Solar Boat Racing Community

Tim Dewhurst, Ph.D., Professor of Engineering, was selected to be the Dong Energy Solar Challenge Ambassador to the Americas. Dewhurst, already a member of the faculty advisory board for Solar Splash, was selected because of experience with international boat racing and the continued success of Cedarville's Solar Boat Team in the Solar Splash World Championships.

As ambassador, Dewhurst will actively promote international solar boat racing and encourages teams from the U.S. to compete in the Netherlands.

During the Dong Solar Challenge, Dewhurst met with 18 others from around the world to coordinate solar boat racing throughout the world, including the U.S., the Netherlands, Brazil, Italy, and Bahrain.

driving experience, but he was a quick learner and had a good understanding of all the parts of the boat. While Yeh drove, his support team of Koch and Nicolaisen plotted his GPS location on their maps and determined how fast he should drive to optimize boat speed and battery range. This was done as Brown maneuvered their van and 20-foot trailer through the tiny towns along the Friesland waterways in order to reach the boat at all stops.

Dewhurst chronicles the team's progress during the race:

- Day 1 – By the end of the day, one of the fastest boats had dropped out with a "blown motor" and several others had lost time with weeds in their hydrofoils.
- Day 2 – Sloten to Bolsward (56 km). The race wound through the cities of Balk, Stavoren, Hindeloopen, and Workum, before finishing in Bolsward. The fastest boat in the competition, Private Energy, burnt out its motor and was unable to finish the leg. Cedarville again finished the day in third place.
- Day 3 – Rest Day in Bolsward. The team worked on fixing problems with the peak power trackers while answering questions from the public during Energy Valley Days.
- Day 4 – Bolsward to Franeker (30 km). Cedarville's batteries had almost as much energy storage capacity as th faster boats, but their power limitations would not allow them to deliver energy rapidly. This was a real problem when going under bridges; the solar power would suddenly disappear and the system would sometimes shut down. Cedarville ended the day in fourth place.
- Day 5 – Franeker to Dokkum (44 km). This was a long day in a heavy rain. The team was able to manage energy well and sustain the race through the rain. Cedarville was able to advance against all other teams except the leader and finished the day in second place.
- Day 6 – Dokkum to Leeuwarden (28km). This final, short leg was not suited to Cedarville. The boat could not drain its batteries by the end of the race. Although Cedarville had the second shortest time of all the boats that finished all legs of the race, competition rules allowed the Private Energy boat to have a faster time than Cedarville. The team was ecstatic to finish third overall

The Outcomes

According to Dewhurst, competing internationally is extremely challenging and is a costly venture in terms of money and time. Despite that, he sees the experience as beneficial because it:

- Provides students with the opportunity to interact with and learn from different cultures.
- Provides opportunities to represent Christ.
- Further establishes the credibility of Cedarville's engineering program as world-class.
- Promotes the name of Cedarville across the globe.

Solar Splash

While the boat team focused on competing in the Netherlands at the DSC, Cedarville had another team that defended its Solar Splash World Championship title. Team members worked hard to prepare for the competition: Will Sorensen '12 focused on redesigning the drivetrains to achieve a significant weight reduction; Eric Lamb '12 developed a new Sprint propeller; and Ben Yeh '12 made a second motor, a duplicate of the highly successful motor built by Ryan Hokuf '10.

Before competition the team was able to achieve sprint speeds of over 29 mph with the new Sprint propeller, the fastest it has ever reached. However, at competition, the boat never exceeded 22 mph, which was a serious setback in the quest to win a seventh Solar Splash title. Air was reaching the propeller, and it could not generate enough thrust. The team made several on-site changes to regain the higher speeds, nothing was effective and the team fell behind.

The last day of the competition was the premiere event, the four-hour Endurance race. Here, Cedarville delivered one of the most dominant performances in Solar Splash history, beating the closest competitor by almost five miles. For this event, the team used a new propeller designed by Sam McLeod '12. The incredible performance in the high-scoring Endurance event allowed Cedarville to leap-frog over all other teams except one, Istanbul Technical University.

Cedarville's team ended the competition with first place in both the Endurance event and the Technical Report, second place in the Solar Slalom, third place in Qualifying and Visual Display, and second place overall.

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Engineering Students Hone Presentation Skills

Two recent Cedarville engineering graduates were invited to present at a competition sponsored by the American Society of Mechanical Engineer (ASME) Old Guard. Erik Kane '12 and Luke Fredette '12, both mechanical engineering majors, were sponsored by the Dayton section of the ASME to attend the District B regional conference in Toledo. The competition encourages engineering students to improve their communication skills. Students are selected based on an undergraduate design team experience.

Erik's senior design team took on the challenge of reverse-engineering a hip implant. In his presentation, Erik explained the process of dimensioning an existing implant. He then used that information to perform a series of stress analysis of the implant under a variety of loading conditions. Following his 15-minute talk, Erik answered a number of questions posed by the judges. He was awarded the fourth place prize for his efforts.

Luke Fredette's senior design team was challenged to design and construct a prototype engine for one of Cedarville's high-mileage competition teams. Luke developed a unique timing sequence for the opening and closing of the engine's valves using cams. Luke won the first place award and was given the honor of Best Technical Presentation, providing Luke with additional prize money. He also won the privilege to present his paper at the annual ASME fall conference in November 2012 where he will compete for the $2,000 grand prize.

VEX Robotic Competition

Cedarville's Society for Women Engineers (SWE) and Institute of Electrical and Electronics Engineers (IEEE) organizations teamed to host a VEX Robotic competition. VEX Robotics Competition is the largest and fastest growing middle and high school robotics program with more than 3,500 teams from 20 countries competing in over 250 tournaments worldwide. VEX robotic competitions encourages students to succeed in STEM areas.

The event took a great deal of teamwork. Engineering faculty served as judges and students served as referees and performed robotic inspections. The competition was successful, with 24 teams and 125 high school students competing.

Cedarville will be hosting the event again in January 2013.

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