THE OREGON STATE ENGINEER
The College of Engineering trains a unique class of engineers who acquire a strong technical foundation coupled with well-developed leadership skills and a broad worldview. Oregon State engineers attain a breadth of knowledge in engineering fundamentals and a depth of technical expertise in a chosen discipline. They learn the value of and gain practice in clear communication and collaborative working processes. They become locally conscious, globally aware leaders who think critically and question assumptions. When they graduate, they join a community of high achievers whose collective efforts solve seemingly intractable problems, strengthen individuals and communities, and contribute to a better world.
Many technology leaders have likened the current growth of robotics to the growth of the Internet in the 1990s. Robots are now enlisted to heal people, explore outer space, aid emergency workers, support soldiers on the battlefield, teach our children, and keep our houses clean. Sales of manufacturing, medical, and service robots are increasing at annual rates of more than 30 percent, creating both supply and new demand for more robots.

IGNITION

The seeds of the Oregon State University robotics program within the School of Mechanical, Industrial, and Manufacturing Engineering were planted when the former head of the school, Belinda Batten, encouraged a group of students to participate in the 2005 DARPA grand challenge. Participants in the competition create a driverless car, using a chassis from an earlier student competition, the small team competed with programs that substantially outspent them and qualified for the semifinal stage.

Kagan Tumer came to Oregon State after a nine-year career as senior research scientist and group lead for the Intelligent Systems Division at NASA's Ames Research Center. At that point, although individual researchers at Oregon State were well known for their research in artificial intelligence, computer vision, machine learning, and other disciplines critical to robotics, the robotics program that exists today hadn’t yet been officially established.

In 2006, Tumer led the search to hire the first robotics faculty member, which resulted in bringing Jonathan Hurst to campus. Hurst had just completed a doctorate in robotics from Carnegie Mellon University and was drawn to the new program in Corvallis because he saw it as fertile ground for something big. “There was very good leadership in the department, and there was support and freedom to build a research group or a program or anything we wanted to do,” he recalled. “I got the sense that the sky was the limit.”

Hurst’s research focuses on the science of legged locomotion, specifically on the passive dynamics of the mechanical system. His group designed and built ATRIAS, a bipedal robot. ATRIAS has springs in just the right places and legs of just the right shape to take advantage of passive dynamics and enable high-performance running and walking outdoors. Of course, the robot will only function with a good control algorithm, so developing control theory that cooperates with the passive dynamics is another important research focus for Hurst.
ACCELERATION

Over the five years following Hurst’s arrival, the robotics program expanded at a fast and furious pace. The college renovated a space for Hurst’s laboratory, which he named the Dynamic Robotics Laboratory. By 2015, the research group had grown to encompass eight faculty members, and it is still hiring. For incoming professors, the draw includes the chance to work with other departments within the university, taking advantage of a priceless opportunity to cross disciplines, and ultimately to help countless others.

“I was really excited to come here,” said Ross Hatton, an assistant professor of mechanical engineering who also came to Corvallis following his doctoral studies at Carnegie Mellon. “There were good opportunities for collaborative, interdisciplinary research among the faculty.” Hatton is developing fundamental mathematical tools for studying locomotion. His research on snakes and spiders provides the creative foundation for models that manipulate movement from a single point of control and will support efforts to combine natural and robotic systems. “Biology has many examples of systems that move over rough and complex terrain, and we’re seeking to bring those ideas into robotics,” he said.

Ravi Balasubramanian, an assistant professor who came to Oregon State in 2011, draws inspiration from the human body for designing robotic systems, and his cross-disciplinary work brings together surgeons, biomaterials experts, and statisticians to create implants that can bring natural movement back to people with hand disabilities. His tendon transfer system has no motor or sensors and, once implanted, will be invisible to the patient and enable normal hand function. His design isn’t limited to the hand, but could be implanted wherever tendons connect to muscle.

Bill Smart and Cindy Grimm, both associate professors of mechanical engineering, joined the program in 2012 after spending 11 years on the faculty of the department of computer science and engineering at Washington University in Missouri. Smart’s work focuses on human-robot interaction, machine learning, and the software needed for robotics. Grimm specializes in the design of robot-human interfaces, computer graphics, and surface modeling. They were both drawn to Oregon State by the broad interdisciplinary nature of the robotics program, which has made it easy for them to collaborate with colleagues throughout the university.

Geoff Hollinger, assistant professor of mechanical engineering, is striving to develop planning, decision-making, and learning techniques to improve robotic systems in the air, on land, and in the ocean. One of his major research thrusts is the development of autonomous capabilities for underwater vehicles, which requires working at the intersection of robotics and oceanography.

“The autonomous robotic systems I design have the potential to revolutionize the way we gather scientific data, to improve the efficiency of our agricultural production, and even to save lives by assisting search and rescue teams,” Hollinger said.

CRUISE CONTROL

New master’s and Ph.D. programs in robotics begin this fall, and the robotics group is working together to recruit students, acquire a shared research space, and build an international reputation. Despite the program’s nascent stage, its reputation is growing. “The international robotics community knows the people we’ve hired,” Hurst said. “In addition, students are very excited about the robotics program, and companies are interested in hiring them.”

In late 2013, Oregon State assumed stewardship of the Robot Operating System (ROS) software infrastructure. ROS is an open-source software infrastructure for robotics that is rapidly becoming the de facto standard in academia and industry and is mandated in a number of well-funded government programs. The OSU Open Source Lab is now the primary hosting site for ROS, supporting an estimated 100,000 users worldwide. This is just one more step to cementing Oregon State’s position as a hub for robotics.

The continual contributions coming out of the program reflect the nature of the burgeoning robotics field. “This growth is a result of a few things,” said Hurst. “First, robotics is a growing field, with new funding opportunities, new industries, and top faculty candidates making new discoveries in this relatively uncharted territory. Second, OSU is growing, and the College of Engineering is responsible for a large percentage of that growth, which necessitates more hires. Third, the robotics faculty has been successful in creating strong, well-funded research programs. Finally, the department heads and the dean have supported the growth of the robotics group in an effort to help build on our success, stay ahead of technology trends, and make the school as a whole stronger.”

Together with the world-class Intelligent Information Systems group in the School of Electrical Engineering and Computer Science, Oregon State is on its way to becoming one of the nation’s strongest academic players in the field of robotics.
Ocean currents as far away as Japan create the waves along Oregon’s approximately 350 miles of rugged and scenic coastline. The immensely potent Pacific Ocean never ceases moving, regardless of the time of day, the season of the year, or the weather. Harnessing power from this continual motion is not a new idea. But the world’s increasing hunger for sustainable energy solutions has researchers scrambling to discover innovative and Earth-friendly solutions for moving ocean-generated energy onto the grid.

Contributing to the development of renewable energy sources is a high priority for Oregon State University’s College of Engineering. “We really need to fully explore all forms of alternative renewable, fuel-free energy,” said Annette Von Jouanne, professor with the School of Electrical Engineering and Computer Science. Von Jouanne, her colleagues, and numerous student cohorts have been working hard for the past 16 years to ensure that Oregon and the United States claim leadership in wave energy research.

Oregon State and its affiliated facilities are uniquely located and equipped for wave research. Although Oregon’s coast represents less than one percent of the world’s coastlines, its characteristics make it immensely suitable for this work. The Wallace Energy Systems and Renewables Facility on campus is the highest capacity university-based energy systems laboratory in the nation, and the O.H. Hinsdale Wave Research Lab houses some of the largest wave basins in North America. Fifty-two miles away in the coastal town of Newport, the Hatfield Marine Science Center provides ready access for instrument deployment and retrieval, plus abundant opportunities for environmental impact studies. The Northwest National Marine Renewable Energy Center (NNMREC, pronounced “Nim-rec”) in Newport is a collaborative venture with the University of Washington and one of only three such centers nationally. The NNMREC conducts wave energy and tidal energy research, provides test sites and facilities for prototype devices, and assists developers with planning and permitting activities.
Josh Baker, an active-duty lieutenant with the U.S. Navy Civil Engineer Corps, gathered real-world data from the Ocean Sentinel that could be used to characterize the behavior of the mooring system in various ocean conditions and compare these data to model simulations. The mooring system uses three lines in a triangular configuration: one drops off the bow and the other two drop off each corner of the stern. Each line connects to an 8,500-pound concrete anchor that sits on the sea floor at a depth of about 150 feet.

“The mooring system is designed to keep the Ocean Sentinel within an imaginary boundary called the watch-circle,” said Baker. “You want the watch-circle to be small to prevent the Ocean Sentinel from running into the wave-energy device being tested, which requires tight mooring lines. However, the mooring lines should also be loose enough for the Ocean Sentinel to ride over large waves.”

Load cells — electronic instruments used to determine how much force each mooring line is subjected to — are installed between the Ocean Sentinel and each mooring line. The load cells are connected via instrumentation cables to computers onboard the Ocean Sentinel, where the real-time tension force on each line is recorded.

Simultaneously, a TRIAXYS™ Directional Wave Buoy measures environmental data. It logs information about the waves, including how big they are, what direction they are coming from, and how often they pass through. It also captures data about the current: how fast it is moving and in what direction. The data are sent wirelessly from the TRIAXYS™ to the Ocean Sentinel.

“The benefit is that you have all of this environmental data for the site throughout the deployment, and you’re able to couple it with the tension-force data,” said Baker. “Then you can compare the results to the design specifications of the mooring system and see how it performs.”

Typhoon Pabuk off the coast of Japan in September 2013 provided a perfect opportunity to test the mooring system’s limits. Thirty- to 40-foot waves off the Oregon coast caused the Ocean Sentinel to drag its anchors along the ocean floor and move out of its watch-circle.

“That’s a bad thing — you don’t want that to happen,” said Baker. “But it did happen, and it was actually a great time for this type of failure. The Ocean Sentinel was out there by itself, and it moved only about 400 feet. If we had been testing a wave-energy device, it could have been a real issue. But it ended up being a very useful study, because it showed the limits of the Ocean Sentinel’s current mooring system, without any major consequences.”

After several weeks of data were collected, Baker analyzed and interpreted the output, then made some preliminary comparisons to simulations using the updated computer model. “The model provided fairly accurate results in some areas, but it was way off in others, so the computer model needs some work,” said Baker. “And that’s not an abnormal thing — that your field conditions cannot be predicted exactly by a computer model — you’re going to see a margin of error.” Another graduate student will build on Baker’s work to fine-tune the model and improve its accuracy.

In 2012, Oregon State engineers completed a mobile seaworthy platform called the Ocean Sentinel that is designed to allow researchers to test scaled wave energy devices. In late summer that year, researchers used the Ocean Sentinel to perform a six-week test on a wave energy converter prototype called WET-NZ (Wave Energy Technology–New Zealand).

Although the WET-NZ device was not connected to the grid, the Ocean Sentinel allowed researchers to work with it as if it were. It measured and recorded power output from the device, collected and stored data transmitted from a wave-measuring buoy moored nearby, conducted environmental monitoring using onboard instrumentation, and wirelessly transmitted collected data to a station on shore.

Because no device manufacturers were ready for testing in 2013, the NNMREC decided to conduct studies on the Ocean Sentinel itself. Josh Baker (’13 M.S. Civil Engineering) used the opportunity to explore the effects of ocean waves and currents on the mooring system. Malachi Bunn, a Ph.D. candidate, tested an environmentally friendly method to prevent corrosion and biofouling. A faculty researcher, Sarah Henkel, studied how the presence of the test platform’s anchoring system affects life on the ocean floor.
Surveying Ocean Life at the Test Site

Sarah Henkel, assistant professor in the Department of Zoology and senior researcher at the Hatfield Marine Science Center, specializes in the biological effects of wave energy device installations. She conducts benthic surveys — studies of life on the ocean floor.

Henkel was excited about leaving only the mooring system in place after the summer 2013 tests of the Ocean Sentinel. Her team uses a 500-pound device with jaws that grab a square of sediment from the sea floor, and getting too close to the anchors during the 2012 deployment could have put the platform and the wave energy device they were testing at risk.

“Now I can do sampling very close to the anchors without being worried about my gear getting tangled up with the expensive equipment,” she said. “This has been an opportunity for me to look for potential changes to the benthic system very close to the mooring system.”

Henkel’s team was able to get the first samples close to the anchors in October 2013 and April 2014. They analyzed the grain size of the sediment and identified and counted all organisms living in it. Results are preliminary, and Henkel has not drawn any firm conclusions. She was not surprised to notice some scouring around the concrete anchors, where the finer sediment particles had floated away. “It’s a situation that bears watching in the future because it could affect the communities of organisms that populate the nearby area,” she said. “The effects are extremely localized, and it’s unlikely to have population-level impacts on organisms or on any predators that might feed on the organisms that live in the sand.”

The question becomes scaling up. “When you deploy one device, you get a very localized effect. But if you were to deploy tens or hundreds of devices, each one with a small sphere of influence, they could potentially start overlapping and cause population-level impacts,” Henkel said. “That’s what remains to be seen.”

Looking for Biofouling Solutions

Malachi Bunn has been lab testing a method for preventing biofouling — the unwanted accumulation of organisms, algae, plants, and animals. He wanted to take advantage of the Ocean Sentinel’s deployment to subject his antifouling method to a real-world test.

“The ocean is what can be considered an extreme environment,” said Ean Amon, assistant professor in the School of Electrical Engineering and Computer Science, who was instrumental in developing and deploying the Ocean Sentinel. “Saltwater is very corrosive, and it’s a very live environment. Every time we pull equipment back out after even just a few months, it’s surprising how much growth there is on everything — everything from green slime all the way up to small-sized barnacles and kelp. So having devices out in that environment that have moving parts and can become entangled and bound up by growth makes the anti-biofouling coatings and other measures extremely critical for their success.”

Bunn is recycling an idea that has been in the literature for a couple of decades. He mixed graphite powder, which is extremely electrically conductive, into polyurethane paint, and applied an electrical charge to it. “The voltage causes a chemical reaction that generates a small amount of bleach at the surface, and the bleach prevents barnacles and algae from growing,” he said.

Antifouling coatings used today contain copper oxide and organic biocides, which are toxic to marine life, and they have relatively short life spans. “You’ve got somewhere in the range of three to five years at the most with any of those kinds of paints,” said Bunn. “But with the electrochemical antifouling, you never run out; assuming that the paint doesn’t break down, which is one of the things I’m studying, so you don’t have to take it in your wave energy device — you can just leave it until some other source of failure occurs.”

Bunn said that the small amount created using his antifouling method is easily and quickly dispersed, and it is not an environmental concern.

Although the big storm was a boon to Josh Baker’s research project, Bunn wasn’t so lucky. He applied his electrically conductive paint to some plastic slabs and hung them off the side of the platform last summer. “Unfortunately, I don’t have a whole lot to say about the results of that, because the extreme storm ripped off the plates,” he said. But he’s not giving up. He expects to have another opportunity to try again.
Unraveling the tangled and politically charged threads of global climate change requires a comprehensive portfolio of research efforts. Dorthe Wildenschild, professor in the School of Chemical, Biological, and Environmental Engineering, is advancing the fundamental science that underpins carbon dioxide (CO2) capture and storage — also known as sequestration. She has been sharing her work at universities around the world as part of the Henry Darcy Distinguished Lecture Series in Groundwater Science.

Current sequestration technologies capture CO2 that power plants and other large industrial sources would otherwise release into the atmosphere. They compress the CO2 into its supercritical (fluid) state and inject it deep underground, often a mile or more below aquifers and beneath geologic structures.

Once supercritical CO2 is injected underground, four trapping mechanisms can take place: structural, solubility, mineral, and capillary (also called residual trapping). Among these, Wildenschild sees the most promise using capillary trapping, and she is looking for ways to optimize the method.

Because supercritical CO2 is usually less dense than underground brine (subsurface water containing high concentrations of dissolved mineral substances), supercritical CO2 will migrate up until it hits an impermeable rock and, hopefully, stay there. This is called structural trapping, but it’s not a perfect solution.

“The problem comes in when there’s a geologic fault or an old well bore,” said Wildenschild. “The CO2 can then migrate upward, acidity aquifers, and make the groundwater undrinkable.”

In the best-case scenario where the supercritical CO2 does remain trapped, the hope is for it to slowly dissolve (called solubility trapping), sink, and eventually precipitate out as carbonate minerals (called mineral trapping).

“That is the ultimate sequestration,” said Wildenschild. “But we’re talking about thousands of years. It’s not going to solve the problems for us here and now.”

Wildenschild’s research method involves injecting supercritical CO2 into a porous underground medium. The underground brine is pushed out of the way, only to return when the injection stops, and capillary forces hold the CO2 in tiny clusters in the pore space.

“It’s basically like holding liquid in a straw, and because of the interfacial tension (capillary forces), the CO2 can’t go anywhere,” said Wildenschild. “To me, that provides a lot more security than having to rely on a stratigraphic trap not being compromised. The other advantage is that the CO2 is distributed in many tiny little pores instead of one large volume, significantly increasing the surface-to-volume ratio, and making the dissolution and precipitation steps go much faster.”

In the lab, Wildenschild mimics different injection scenarios by varying parameters such as pressure, temperature, salinity, flow rate, and volume. She uses X-ray microtomography, a technique similar to CAT scanning that yields 3-D information on the internal features of an otherwise opaque medium. The technique allows her to “see” inside the pore space in order to fully understand and maximize capillary trapping efficiency.

Wildenschild’s research is unique in the field, because it provides an understanding about how things work at the level of individual fluid-to-fluid interfaces. Results so far indicate that the injection can be manipulated to maximize the amount of supercritical CO2 trapped. The size and local connectivity of the tiny pores affect subsequent dissolution and mineralization mechanisms.

Wildenschild hopes that the fundamental understanding of how small-scale capillary trapping takes place will ultimately lead to implementation recommendations for actual large-scale injection processes, and thus advance efforts to address climate change at a global level.

“I hope to contribute to solving the short-term problem,” she said.
The 6.7 temblor that struck Northridge, California, 20 years ago caused an estimated $20 billion in damages during 20 seconds of shaking. Collapsed overpasses and pancaked buildings stood as mute, deadly testimony to the fact that the modern construction techniques used at the time were no match for the forces of nature.

"The Northridge earthquake began to open our eyes to the possible effects of design flaws," said Armin Stuedlein, assistant professor at Oregon State University’s School of Civil and Construction Engineering.

Stuedlein, Professor David Trejo and Associate Professor Jason Ideker are researching new construction techniques and more resilient building materials that will reduce the risk of future bridge and building failures.

The Right Foundation

The 9.0 quake and tsunami that struck the northern coast of Japan in 2011 added a sense of urgency to Stuedlein’s and Trejo’s research projects.

"The Pacific Northwest is expected to have an extremely significant earthquake like Japan within the next 50 years," Stuedlein said. "It will have a magnitude of 8.5 to 9.0. The Northridge quake lasted only 10 to 20 seconds; ours will last for three to five minutes. There will be many cycles of horizontal loading. I want to understand how the horizontal forces are transferred to the subsurface."

To develop stronger, more resilient bridge foundations, Stuedlein and his team are constructing four test shafts on campus property. Into those holes, they will drop steel reinforcing cages, some made with typical steel and some made with high-strength steel. They will pour in concrete, creating the equivalent of a bridge support that can withstand a lateral loading equal to the weight of about 125 cars.

The resilience and stabilizing effect of the drill casing — the metal cylinder that lines the shaft to prevent the walls from collapsing during drilling — is often ignored, so Stuedlein’s team will be paying particular attention to that aspect of the project.

"The casing can be an effective way to transfer lateral loads into soils that are stronger at depth," he said. "If leaving the casing means we can reduce the amount of reinforcing steel used, that would be very cost effective, and would reduce the potential for defects associated with concreting difficulties."

The Right Materials

Concrete and steel have complementary strengths. Concrete is strong and resists compression, but it crumbles when flexed. Steel is much more flexible, so reinforcing concrete with steel bars combines the strengths of both. However, in many cases there is so much reinforcing steel in bridge supports that it becomes difficult to place the reinforcing bars. If the concrete fails to flow around the steel bars, air pockets can form and weaken the structure.

Trejo advocates using high-strength steel because it would require less material to do the same job and leave more space for the concrete to flow.

"The reason high-strength steels are not used already is because we don’t understand them well," Trejo explained. "We don’t understand how they perform in concrete. Our research, and Professor Stuedlein’s research, is assessing whether high-strength steels can and should be used in bridge structures." Early results are promising.

For Now: Rapid Repair

Ideker is concerned with the daily strains of expansion and contraction that continually cause cracks in bridge decking. These cracks allow air, water, and road salt to invade the concrete and weaken it. His research characterizes early-age volume changes in rapid-repair materials, which has enabled civil and construction engineers to ensure the long-term durability of those materials.

"When a catastrophic event occurs, rapid-repair materials can be used to get critical infrastructure back into service again," he said.
Of the 27,000 children each year who reach the age of 18 in foster care, only six percent successfully earn a college degree, so the odds were stacked against Charles Hill. He was raised in foster care, where he experienced abuse, neglect, and hunger. Now he copes with attention deficit hyperactivity disorder (ADHD) and depression. He has had no family support to attend college.

Even so, Hill graduated this year with a degree in computer science and will go on to pursue a doctoral degree. His goal is to become a professor.

Margaret Burnett, a professor of computer science who does research in how to improve human and computer interaction, has been Hill’s strongest supporter, offering him a position as an undergraduate research assistant.

“I’ve never met anyone more intellectually curious than he is,” Burnett said. “He just drinks in knowledge.”

Hill’s first two years of college were a struggle, personally and financially. Rather than give up, he sought therapy, turned his grades around, and worked in as many as three jobs while going to school.

“Having someone so accomplished as Professor Burnett believe in my abilities has helped me embrace my potential,” Hill said.

Malwina Gradecka began researching nuclear power as a master’s student at Warsaw University of Technology in Poland. Now she is a Ph.D. candidate at Oregon State University, and her work has established an international cooperation between the two universities. The partnership aims to advance next-generation nuclear power technologies and provide expert training for future practitioners, leaders, and scientists.

“The collaboration addresses important global energy challenges,” said Brian Woods, an associate professor and research advisor for Gradecka. “The problems of energy and the environment are global problems. Partnerships of the type between Oregon State and WUT represent the future of how these problems will be addressed and ultimately solved.”

Gradecka is working with Woods on a high-temperature gas-cooled test facility that uses helium as a coolant, rather than water. The $4.9 million project is part of an ambitious effort to bring new nuclear technology to market by 2030.

“Nuclear engineering became a chance for me to help make electricity cheaper, more efficient, and cleaner,” she said.

Even heat distribution is one crucial aspect to enhancing the facility’s performance and maintaining structural integrity. As gas heats up in the core and exits to a mixing chamber called a plenum, it can become uneven in temperature and develop hot spots. Gradecka is investigating ways to optimize gas mixing in the lower plenum to improve thermal uniformity. “The more uniform the exiting gas is, the longer the turbine’s lifespan,” she said.

Gradecka is simultaneously earning degrees from WUT and Oregon State, and her research has given her valuable hands-on experience. “Oregon State is giving me opportunities to perform applied research, and the university in Poland provided the basis of my studies in nuclear power,” said Gradecka. “It’s a bridging experience that also offers an international perspective.”
Oregon State University is proud to nurture a strong culture of collaboration among its students and faculty, and nowhere does that value become more evident than at Formula SAE (Society of Automotive Engineers) events.

Formula SAE is an automotive design competition that attracts teams from about 500 universities worldwide. Each year, teams build a race car from the ground up and race it in competitive events around the world.

Oregon State’s team, Global Formula Racing, is a cooperative venture with Duale Hochschule Baden-Württemberg – Ravensburg (DHBW–R), Germany, and it consistently leads the pack.

“We’re the most successful team in the world,” said Bob Paasch, Boeing professor of mechanical engineering design and U.S. advisor for Global Formula Racing. “We have won more competitions in the last five years than any other team in the world.”

This is an amazing accomplishment, considering that Oregon State doesn’t offer a degree in automotive engineering. Many of the universities Global Formula Racing competes against do have strong automotive engineering programs and are located in areas where automobile manufacturing is one of the major industries.

“Oregon State isn’t focused on motor sports; we’re not focused on automotive; we’re just focused on good engineering,” said Chris Patton ('06 B.S., '09 M.S., '12 Ph.D. Mechanical Engineering), who was a student leader with Global Formula Racing when it first got started. “We try to engineer the car as best we can, and then we go out and compete against teams that are focused on automotive engineering and racing. And we’re beating them.”

Students at Oregon State have been involved in Formula SAE competitions since 1987, long before Global Formula Racing got started, but the teams had limited success in the early days.
The OregOn STaTe engineer excelS

"For the first few years I was on the team, it was really kind of a struggle," said Bill Murray (’09 B.S., ’12 M.S. Mechanical Engineering) who joined the team as a freshman in 2004. "We were a small group with lots of ambition, but despite our best efforts, we didn’t seem to be able to complete a competition.”

In 2005, Oregon State alumna Thomas Nichol (’96 Ph.D.), who had become a professor at the DHBW Ravensburg, called Paasch looking for United States internship opportunities for two students. Paasch placed the students on the Formula SAE team. The collaboration between the universities really began when the students went back to Ravensburg and convinced their university to start a Formula Student team.

For the next few years, Oregon State students traveled to Ravensburg as instructors or project advisors and German students came to Corvallis as interns. Since the German students were competing in Europe and the Oregon State team was competing in the United States, they freely shared ideas about how to build a successful car. "The collaboration just kept getting closer and closer," said Paasch.

By 2008, Paasch was noticing that industry was looking for engineers who were adept at working in a globally distributed design environment. "Companies like Boeing distribute design and manufacturing throughout the world," he said, "and we weren’t giving students exposure to this while they were in university. So that was the motivation: to give students experience in global distributed design and manufacturing, with the idea of making our graduates more competitive."

In summer 2008, a student leadership team traveled to Germany and began developing the foundation for the fledgling partnership. "We went to competitions and really began laying the seeds for the collaboration between us by building those personal relationships,” said Murray.

The two universities signed a memo of understanding and developed a five-year plan for working together. "The first year was really proof of concept," said Murray. Initially, the Germans and Americans built separate cars. "At the end of it, we evaluated which car did better, which concepts did better in competition, and used that information to decide what kind of car GFR was going to build going forward."

The consensus among the three former students is that their involvement with Global Formula Racing helped them build global awareness and a valuable set of professional skills on top of the skills and knowledge they needed to be successful in their engineering disciplines. They were prepared to step into positions that required experience in and an understanding of what it takes to work in a globally distributed engineering environment.

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Kristina Milaj was the first girl in her village to go to high school, much less college. But thanks to a chance encounter with an instructor at Oregon State University, she was able to continue her schooling as part of a program that supports improved educational opportunities for youth.

As a first-year student, Milaj seized every opportunity to get a well-rounded education. “I felt privileged to have the education and opportunities that OSU provided,” Milaj said. “Also, I like to challenge myself, and getting involved helped me give back to others.”

One of the ways Milaj has given back is to become a board member with the student volunteer organization Engineers Without Borders. In collaboration with community members and teammates, Milaj helped install a well and rainwater catchment system that brought safe drinking water to people in the small rural community of Lela, Kenya.

Milaj and her peers endured conditions that would send many tourists fleeing for home, including bat-infested pit latrines and no running water. But these dedicated students weren’t on a tour, they were on a mission to make life easier for people less fortunate.

In Lela, women and children had to walk three miles to haul drinking water that was contaminated with coliform bacteria and nitrates. In collaboration with local experts, the Engineers Without Borders team helped to dig a well and engineer a backup rainwater catchment system to ease the community’s dependence on distant, contaminated water.

The team faced uncertainty and challenges, including where to place the well for the community’s 2,000 residents, who are spread out over two square miles. After hundreds of hours of planning and fundraising from countless students, they successfully installed both systems.

“Not only has the project directly benefited many of the community residents, but it has also benefited professionally and personally all of the many students who have worked behind the scenes as well as those lucky few who were able to travel to the site,” said Jeff Randall, a retired hydrologist whose mentorship and expertise were crucial to the project.

The well provides roughly 50,000 liters of water per month and the capacity of the rainwater catchment system is 40,000 liters. The rainwater storage tanks feature a first-flush system that captures and removes sediment from the roof. Combined with solar disinfection, the catchment system provides drinkable water for more than 400 students at the Lela primary school.

Although the two systems are not an end-all solution to Lela’s water needs, they reduce the burden on women and children and will help prevent waterborne disease. They also provide clean water during the community’s two dry seasons.

Fellow Engineers Without Borders members credit Milaj for her keen leadership skills.

“Kristina is always willing to step into a leadership position by thinking critically and organizing the team’s thoughts so that they can be put into action efficiently,” said Jordan Machtelinckx, former president of Engineers Without Borders, who traveled with Milaj to Kenya.

The American Society of Civil Engineers recently recognized Milaj’s achievements in 10 New Faces of Civil Engineering – College Edition. The program promotes young civil engineers by highlighting their academic success, volunteerism, and dedication to making a positive impact on society through a chosen profession.

The Lela project also has been nationally recognized. It earned both the Engineers Without Borders–USA Premier Project Award and the American Academy of Environmental Engineers and Scientists (AAEES) Student Team Award in 2013.
It’s a story that seems made for Hollywood:
- An engineering student stumbles across a notice about an international rocket competition and casually asks a couple of his roommates if they want to build a rocket. The roomies collectively respond, “Cool! We’re in!”
- Several other engineering students get wind of the project and sign on to the fledgling team. Initial planning meetings draw more than 40 students, all excited to be part of the rocket project.
- The only problem is that none of the students has any experience designing and building high-powered rockets, let alone a 10-foot-tall, 50-pound, solid fuel Level III rocket capable of reaching 10,000 feet while carrying a payload of at least 10 pounds.
- But that doesn’t deter them.
- Nor does it deter the middle-school student who signs on when the team does some K-12 outreach. The eighth grader wants to design a special payload that includes a GoPro camera that will deploy at peak trajectory and film the rocket’s descent back to Earth, slowed by two parachutes.
- Twenty-seven undergraduates in mechanical and electrical engineering put forth a Herculean effort that includes countless meetings, long hours of research in libraries and labs, late nights with gallons of Red Bull, hands-on testing and retesting, successes and setbacks.
- Nine months later, the team packs up and drives cross-country to the ERS Intercollegiate Rocket Engineering Competition in the desert near Green River, Utah.
- They beat 22 other teams from around the world with an almost perfect launch of 10,280 feet and take home the $1,000 prize in the Basic Category. They also win the $100 Payload Prize, thanks in part to the middle-schooler’s contribution and the team’s ingenuity. Many team members land prestigious summer internships in the aerospace industry at places like Boeing, SpaceX, NASA Ames, and elsewhere.
- This is no Hollywood movie — it’s a true story that happened at Oregon State University, and it just might alter the course of aerodynamics at the College of Engineering.

The team project fostered camaraderie and a sense of collaboration that the team’s faculty advisor, Nancy Squires, called “absolutely amazing.” Squires came to Oregon State in 2005 following a career in the aerospace industry, interspersed with teaching stints. She said the students made every part of the rocket, except one retaining ring, from scratch.
“They rolled the carbon fiber into tubes, built the motor, mixed the fuel — everything including how to collaborate as a team and network with industry,” Squires said. “My role was really just to provide moral support, give mission success speeches, and bring cookies to the launches. They did everything themselves.”

Pretty impressive, given that Oregon State doesn’t even have an aerospace engineering program — something many of the competing teams were part of. But Oregon State does have an American Institute of Aeronautics and Astronautics (AIAA) student club, founded two years ago by Roberto Albertani, associate professor of mechanical engineering, and engineering students Brandon Thoennes and Michael Roos.

In addition to Squires and Albertani, the team found mentorship from three members of the Oregon Rocketry Club, which has a launch site near Brothers, Oregon.

Michael VanderPutten, a senior who served as project lead on the team and has been working an internship at Boeing this summer, said the biggest challenge was the lack of knowledge and experience.

“Our team’s main hurdle was the fact that none of us had done anything like this before,” he said. “Other schools had been participating in the competition for several years. So our biggest challenge was the learning curve and knowing how things had to work for the entire system.”

The team addressed this lack of knowledge by traveling to the Brothers launch site, where they camped and networked and ultimately met the mentors — Joe Bevier, Steve Cutonilli, and John Lyngdal — who would work closely with the team.

“They were so helpful...Steve let our team into his mobile lab, where we formulated and mixed our own solid fuel — jet black to go with the Beaver orange flames,” VanderPutten said. “Joe taught us how to lay fiberglass for coupler tubes, and we rolled our own carbon body tubes at Innovative Composite Engineering.”

VanderPutten said the project definitely prepared him for work in industry and changed his perspective on classroom lessons. “When I applied what I was learning in class to this hands-on project, I was suddenly much more interested in the coursework and worked as hard as possible.”

The project also influenced VanderPutten’s decision to return for graduate school this fall, where he will study thermal fluid flow.

“I wasn’t even considering grad school before this project,” he said. “But it has changed lots of things. I’ll be involved with the rocket team again this year, in a managerial role. This summer, after his internship ended at Boeing in Seattle, he logged a couple hours each evening planning for next year’s project.

Sierra Bray, who will be a senior and serve as the team’s vice president this year, credits the project with helping her land a summer internship at NASA Ames Research Center, where she worked on a new flight simulator for helicopters.

“One of the key things we learned is that testing is really important,” she said. “A lot can go wrong.”

The team did two test launches in Brothers leading up to the competition. On the first one, the main parachute deployed too early, so the rocket, named “Terminal Gravity,” drifted a long distance, making recovery challenging. But it didn’t explode into a ball of fireworks, which happened to some rockets at the ESRA Competition — one before it ever left the launch pad.

Whitney Hopple, a senior on last year’s team, said she will never forget the late nights working in the lab. “Even at the most difficult moments, someone would make a joke, we’d all have another Red Bull, and enjoy staying up another few hours until the job was done,” she said. “No one ever lost sight of the end goal.”

Hopple says the project helped her secure an internship at SpaceX in Los Angeles this fall, where she will work on composites for rockets.

Squires said that student participation in competitions is a big plus to prospective employers, and Oregon State students stand out as industry-ready.

“I’ve taught at Stanford, U.C. San Diego, the Colorado School of Mines, and elsewhere, and the students here at Oregon State are the best I’ve ever worked with,” she said. “They have a work ethic and a desire to succeed that companies notice. They’re competing with graduates from top aerospace programs, and our students are getting the jobs.”

Next year, the team plans to compete in the Advanced Category at the ERSA Competition, which means they need to build a rocket that can reach 25,000 feet.

“It will be a bigger challenge,” Bray said. “But since we did so well this year, we want to see how well we can do at the next level.”

With so many members from last year’s tight-knit and talented team returning next year — including four as graduate students, it just might make for another happy, high-flying Hollywood ending. Stay tuned for the sequel.

**The Oregon State Engineer**

THE OREGON STATE ENGINEER EXCELS
When the College of Engineering broke ground on a new home for the School of Chemical, Biological, and Environmental Engineering in September, it was just the latest chapter in Peter and Rosalie Johnson’s book of giving. They have provided leadership gifts to all three priority areas of The Campaign for OSU: students, faculty, and facilities.

The Johnsons made the lead gift of $7 million for the $40 million, 58,000-square-foot engineering building that will bear their name. Designed to be a place of collaboration and innovation, Johnson Hall will include labs for interdisciplinary research and a center focused on improving recruitment and retention of engineering students.

After earning a degree in chemical engineering from Oregon State in 1955, Peter started his career at Shell Chemical and founded Tekmax, Inc. in 1980. He revolutionized battery-manufacturing equipment with his trademarked invention for making battery separator envelopes, a method used by every battery maker in the United States.

Generations of Oregon State engineering students will benefit from the Johnsons’ generosity, which stems from their belief in the power of education. “My education at Oregon State has served me very well in my life,” Peter said. “Rosalie and I believe that with hard work, persistence, and education, anything is possible.”

Since its creation in 1998, more than 200 students have participated in the Peter and Rosalie Johnson Undergraduate Internship Program. Each year, at least two dozen first-year students in the School of Chemical, Biological, and Environmental Engineering complete paid summer internships at Oregon companies or university research labs.

These internships provide real-world work experience, which the Johnsons believe is necessary for students to become fully educated by melding their technical knowledge with practical, professional work skills. The couple has given $2.4 million to endow the program and provide a permanent source of funding. “We are so pleased to meet the Johnson Scholars, who make us and OSU very proud of their leadership abilities, work ethic, and accomplishments,” said Rosalie. “And it is exciting to see women enthusiastic about engineering and other courses previously dominated by men.”

Student success is also a significant factor in the Johnsons’ support for faculty. In 1997, they established the Linus Pauling Chair in Chemical Engineering to honor Oregon State’s most renowned graduate.

The endowment supports a faculty member with industry experience who mentors students and helps them develop skills in communication, organization, project management, and leadership. Philip Harding, who spent 10 years in product development at HP before coming to Oregon State in 2007, currently holds the position.

“This is our way of investing in future students,” Peter said. “I wanted to fund the Linus Pauling Chair because I feel I received a good, solid education at Oregon State, and Linus Pauling represents the scholarly quality I hope the department will continue to attract among its faculty.”

Johnson Hall is scheduled for completion in the fall of 2016. It will house interdisciplinary groups of students, faculty, and industry professionals working together to address important global problems that affect human health, energy, and the environment.

“We are so pleased that this new facility will honor the Johnsons and be a place dedicated to supporting the same areas they have always emphasized: collaborative research and hands-on learning for students,” said Scott Ashford, dean of the College of Engineering and Kearney Professor. “Their investment, and that of our other generous donors, will have a powerful impact on Oregon and our world.”
When Martin Kelley gave $20 million to the College of Engineering in 2000 to build what became the Kelley Engineering Center, it was the largest single gift in the history of Oregon State University. But that’s not all it was. Kelley’s philanthropic leadership was the tipping point that transformed the College of Engineering and Oregon State University.

“It wasn’t just the money,” wrote former dean Ron Adams in the college’s 2008 Annual Report. “It was his vision of what could be and his energy in helping to bring others on board, to instill the belief that we really will deliver the impact of one of the nation’s top engineering programs.”

Kelley’s gift — originally anonymous — was the cornerstone of The Campaign for OSU, the university’s first capital campaign. Publicly launched in October 2007, by 2010 the original 2011 goal of $625 million had already been exceeded. The goal was raised to $850 million and later to $1 billion, and that goal also was achieved ahead of schedule, in January 2014. The campaign formally concludes in December 2014, having raised $1.08 billion to date. So far, it has funded 25 facilities projects, 77 faculty endowments, and $182 million for student scholarships.

Kelley personally oversaw much of the construction of the building, which opened in 2005. Featuring a four-story atrium, sky bridges and hallway spaces with glass-walled conference rooms and offices clustered around research laboratories, the building’s layout is designed to drive collaboration and innovation among faculty, students, and visiting business partners.

Kelley Engineering Center is also the first academic engineering building to earn a Leadership in Energy and Environmental Design (LEED) Gold certification by the U.S. Green Building Council. It incorporates more than a dozen green building features, including extensive use of natural light and ventilation, rainwater catchment, waste-heat recovery systems, and nontoxic and recycled building materials.

Although Kelley died in 2008 at age 80, he was able to see his vision come to life. Not just in the building that bears his name, but in the many accomplishments of the students, faculty, and alumni who are proud to call themselves Oregon State Engineers.

THE GIFT THAT TRANSFORMED A COLLEGE

Breeding Success One Student at a Time

He founded one of Silicon Valley’s most successful startups. Now a $4.3 billion technology powerhouse with 8,800 employees worldwide, his company, NVIDIA, invented the graphics processing unit (GPU), which revolutionized gaming, film production, mobile devices, supercomputers, medical diagnostics, and other applications.

And Jen-Hsun Huang’s remarkable success story began at Oregon State University.

“I enjoyed computer programming, but OSU opened up my eyes to the magic behind them,” said Huang. “This is where I really fell in love with technology, thanks to a few great professors and some classes that sat my mind on fire. Everything I have learned over the past decades is built on the strong foundation I gained here.”

Huang fell in love with more than technology at Oregon State. In an electrical fundamentals class of about 80 students — only three of whom were women — his assigned lab partner was Lori Mills. They married five years later, and both graduated with electrical engineering degrees — Jen-Hsun in 1984 and Lori in 1985.

The Huangs have been generous toward their alma mater. At the grand opening for the Kelley Engineering Center in 2005, the university announced that the couple had given $2.5 million to the College of Engineering. The building’s soaring four-story atrium is named in their honor, and the gift helps fund the NVIDIA Graphics and Image Technologies Laboratory.

At the time of their gift, Huang pointed to the College of Engineering’s emphasis on basic principles, work ethic, collaboration, and business acumen — important assets that helped Huang grow NVIDIA into the powerhouse it has become.
When Lee Kearney was a student at Oregon State University in the early 1960s, he took most of his civil engineering classes in the building that now bears his name. Built in 1900, the former Apperson Hall was one of the oldest buildings on campus — and it showed. Students were learning state-of-the-art design, engineering, and construction techniques in a building with creaky stairs, dim hallways, and classrooms with view-blocking columns.

So when the College of Engineering identified goals for fundraising, facilities, and faculty support, Kearney and his wife Connie stepped up to make them happen. Not only did they help turn a venerable campus icon into a showcase for innovative engineering and sustainability, they created two endowments to support faculty in the School of Civil and Construction Engineering.

The Kearneys’ lead gift of $4 million launched a two-and-a-half-year, $12 million renovation project, enabling the college to erect a modern steel structure that meets seismic codes within the building’s gorgeous granite and sandstone façade.

Bringing a 21st-century learning environment to the historic building creates a unique bridge from the past to the future. When the building was reopened in 2009 as Kearney Hall, a light-filled three-story atrium, 120-seat auditorium, and state-of-the-art classrooms welcomed students and faculty. The building also serves as a teaching tool, with portions of some ceilings and walls exposed to give students real-world examples of structural, mechanical, and electrical features. The use of recycled materials, nontoxic finishes, salvaged wood, efficient lighting, low-flow fixtures, and native landscaping helped the building earn a Gold rating from the Leadership in Energy and Environmental Design (LEED) program of the U.S. Green Building Council.

The Kearney Faculty Scholar was awarded to Jason Ideker, an associate professor in civil and construction engineering whose research focuses on high-performance concrete materials and the durability of cement-based systems.

Scott Ashford, dean of the College of Engineering, was named the Kearney Professor of Engineering in 2012. Ashford’s research focuses on enhancing public safety and reducing potential economic losses from earthquake and coastal hazards worldwide. His latest efforts are targeted at improving the resilience of the Weflo systems in the Pacific Northwest to better withstand potential earthquakes and tsunamis.

“It’s a pleasure to a donor to see how the money is being used in such a positive way, for the benefit of not only Oregonians, but many others,” Kearney said. “The fact that the Northwest is anticipating a future big event makes Scott’s work all the more important. We were glad to help him carry forward his research.”

Lee Kearney earned his degree in civil engineering from Oregon State in 1963. He worked for Kiewit, one of the largest construction and mining organizations in North America, for 32 years, holding several executive positions and serving on the company’s board of directors. He was inducted into the Oregon State University College of Engineering Hall of Fame in 2001.

Connie Kearney started at Oregon State in 1961 and finished her degree at the University of Washington. She became the first woman commissioner in Clark County, Washington. She served in that position from 1976 to 1980 and then earned a law degree from Creighton University in Omaha.

Lee continues to serve on the College of Engineering advisory board and the OSU Foundation Campaign Steering Committee. Connie, an OSU Foundation Honorary Trustee, serves on the board of trustees of the Oregon 4-H Foundation. They were awarded the E.B. Lemon Distinguished Alumni Award by the OSU Alumni Association in 2008.
Darry Callahan ('64), spent nearly 40 years in the energy industry, serving as president of Chevron Chemical Co. and executive vice president of the School of Electrical Engineering and Computer Science in 2012.

Mike Olsen
Assistant Professor | Civil and Construction Engineering

Mike ('68) and Judy ('65) Kaufe created the first endowed faculty fund in the College of Engineering in 1997 to promote research and teaching that integrates classroom instruction with direct, practical exposure to industry.

Lee Kearney ('63) held several executive positions in his 32-year career at Kiewit, one of the largest construction and mining firms in North America. The Kearneys served as co-chairs of the College of Engineering’s Top-25 Campaign. Lee also serves on the College of Engineering Advisory Board and the OSU Foundation Campaign Steering Committee. Connie is a member of the OSU Foundation Board of Trustees.

Stuedlein’s research focuses on the performance and reliability of geotechnical structures such as foundations, improved ground, reinforced earth, and pile and caisson installations. His approach combines instrumented testing, lab-based soil characterization, numerical modeling, and statistical methods.

Armin Stuedlein
Graduate Research Assistant | Civil and Construction Engineering

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Hal Pritchett Chair in Construction Engineering Management

David Trejo
Professor | Civil and Construction Engineering

Trejo’s expertise is in construction materials design and development. His research background includes investigating, testing, assessing, and evaluating mechanisms of deterioration for materials and structural systems such as pipes, walls, foundations, bridges, and water tanks.

The chair honors Professor Emeritus Hal Pritchett, who taught at Oregon State for 45 years and who was instrumental in establishing the Construction Engineering Management program in 1969. Originally funded by 120 engineering alumni and industry partners, the endowment nearly doubled in 2010 with commitments from Mike (’76) and Terri Phelps and the Beavers Charitable Trust.

Linus Pauling Chair in Chemical Engineering

Philip Harding
Chemical, Biological, and Environmental Engineering

Harding focuses on undergraduate student success, helping students develop skills in communication, organization, project management, and leadership. Prior to holding the Pauling Chair, Harding spent 10 years in product development at Hewlett-Packard.

Peter (’55) and Rosalie Johnson established the Pauling Chair in 1997 in appreciation for what he called a “good, solid education” at Oregon State and to invest in future students. As president and owner of Tekmax, Inc., Johnson developed the method for making battery separator envelopes that is used by every battery manufacturer in the United States.

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James R. Welty Professorship in Thermal-Fluid Sciences

James Liburdy
Professor | Mechanical, Industrial, and Manufacturing Engineering

Liburdy’s expertise is in fluid mechanics and thermal management systems for electronics and other applications. His research emphasizes fundamental aspects of technology development and technology transfer to industry.

Jim (’54, ’62) and Sharon Hastings-Welty (’75) created the professorship in 1997 with the goal of keeping Oregon State at the forefront of critical technologies such as inkjet printing, microscale energy conversion processes, electronic equipment cooling, and property measurements related to electronic equipment design.

Welfty Faculty Scholar

Vinod Narayanan
Associate Professor | Mechanical, Industrial, and Manufacturing Engineering

Narayanan’s research focuses on improving energy efficacy using techniques in heat and mass transport in thermal-energy systems. Potential applications include renewable energy, space technologies, and distributed heating and cooling.

Professor Emeritus Jim Welty (’54, ’62) established the fellowship fund in 2011. Recognized worldwide for his contributions to research in heat transfer, fluid mechanics, and thermodynamics, Welty taught at Oregon State for 38 years and headed the mechanical engineering department from 1970 to 1986.

Henry W. and Janice J. Schuette Endowed Chair in Nuclear Engineering and Radiation Health Physics

Jose Reyes
Professor | Nuclear Engineering and Radiation Health Physics

Reyes has earned an international reputation for cutting-edge research in developing passive-safety nuclear reactors and the use of MRI technology to track toxins in environmental cleanup and other industrial applications.

Hank (’50) and Janice Schuette established the endowed in 2003 to advance research in nuclear power and meet future energy demands. Together, they built Welkons, Inc., into an international leader in designing, manufacturing, and installing systems that turn waste wood from the lumber industry into electricity.

Tom and Carmen West Faculty Scholar

Brian Paul
Professor | Mechanical, Industrial, and Manufacturing Engineering

As co-director of the Microproducts Breakthrough Institute (MBI), Paul has pioneered new manufacturing methods for reducing the costs of microchannel arrays with channels no wider than a human hair, nanomaterials, and liquid-deposited thin films.

Professor Emeritus Tom West (’76) spearheaded establishment of Oregon State’s manufacturing engineering degree program and the highly successful Manufacturing Engineering Co-op Program that would later evolve into MECOP/CECOP. West and his wife Carmen, a longtime manager at Hewlett-Packard, established the endowment in 2012.