Cal Poly, San Luis Obispo
College of Engineering
Turning ideas into achievements

2006–2007 Annual Report
On the cover: The Supermileage Vehicle achieved 1,902 mpg to win the U.S. Shell Eco-Car Challenge. The team members included: (standing from left) Tom Heckel, Vann Chau, faculty advisor Dr. Peter Schuster, faculty advisor Dr. Joe Mello, and Josh Kempenaar; and (kneeling from left) Kevin Fang, Jason Kempenaar, David Ulrich, Mike Kems, and Estevan Negrete.

Each year, dozens of projects like the Supermileage Vehicle are designed and built in the Bonderson Projects Center (photo at top).
<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Message from the Dean</td>
</tr>
<tr>
<td>6</td>
<td>Message from Dean’s Advisory Council Co-chair, Paul R. Bonderson, Jr.</td>
</tr>
<tr>
<td>8</td>
<td>College of Engineering Highlights</td>
</tr>
<tr>
<td>10</td>
<td>Program Highlights</td>
</tr>
<tr>
<td>21</td>
<td>Engineering Plaza Completion</td>
</tr>
<tr>
<td>22</td>
<td>Message from Dean’s Advisory Council Co-chair, Kathleen Holmgren</td>
</tr>
<tr>
<td>24</td>
<td>Honor Roll of Donors</td>
</tr>
</tbody>
</table>
Message from the Dean

Dr. Mohammad Noori, Dean of the College of Engineering stands in the beautiful new Engineering Plaza with Engineering IV in the background.
When I began my tenure as dean, I entered a construction zone. The Bonderson Projects Center, Engineering IV and the Plaza consisted of mud and steel girders, but in less than two years, the blueprints have come to life—and we couldn’t be more excited.

Excited, of course, to move into sparkling new, state-of-the-art facilities, to watch students grow their projects and stretch their imaginations as they take over the Bonderson Center workshops.

But we’re even more excited about the potential our new campus holds. More than giving us room to expand, these cutting-edge facilities give us the opportunity to lead the nation in engineering education.

We intend to create an engineering program that can address new global challenges and meet the needs of a changing social landscape. To help design the blueprint for this vision, I’ve called upon the Dean’s Advisory Council, faculty and staff. Together, we’ve taken up the inspiring but arduous task of writing a new strategic plan for the college.

A few key goals and concepts have emerged. Perhaps first and foremost is our steadfast dedication to Cal Poly’s hallmark hands-on, project-based learning, and we remain committed to expanding our strong partnerships with industry.

Also clear is the need to expose students to an interdisciplinary perspective and to emphasize the impact of technology on society. Development of a cross-college freshman experience that has a strong service-learning component is one way to address these goals, with the added benefit of helping to recruit and retain more women and underrepresented students, which is imperative.

To respond to the needs of industry and society, while building on our own institutional strengths, we have started identifying possible “thrust” areas for the college, including sustainable energy systems, air and space transportation systems, bio-engineering, engineering education, and engineering innovation.

To accomplish these ends, we must overcome barriers between departments and facilitate more multidisciplinary capstone and senior design projects. We see the Project Based Learning Institute as a principal catalyst in this effort, and we’re delighted that this centralized conduit for industry sponsored student projects and faculty applied research has already generated membership commitments from partner companies.

As we move forward, we welcome your input and feedback. Certainly, we cannot fulfill our mission and vision without the support of loyal alumni, generous friends and industry partners, and outstanding and devoted faculty and staff.

Dr. Mohammad Noori, Dean
Last June, I was privileged to give the commencement address at Cal Poly’s graduation. I was particularly honored because my daughter Trisha was a member of the graduating class. Although I don’t normally embrace public speaking, I found that the speech gave me the opportunity to clarify the important lessons of my life.

I realized that three of the primary things I have learned throughout my life and career have to do with learning, passion, and giving—which describe my relationship to Cal Poly as an alumnus, volunteer, and donor. And I can say, unequivocally, that my involvement with the university is both deeply satisfying and immensely enjoyable.

When I graduated, I had a set of skills that allowed me to start my career. But Cal Poly gave me more. My education instilled me with a thirst for knowledge, a desire for lifelong learning and the basics of how to learn. These are truly the keys to success. As an alumnus, I am ever more grateful to Cal Poly for making me a life-long learner and I want to make sure that this university continues to enlighten future generations with this important value.

My next big life-lesson was recognizing the importance of pursuing your passion. My passion, I’ve realized, is building things. Whether it’s a circuit board, a high speed switch, a company, a wetland habitat, or a family, I just love to build things! So my passion combined with my strong feelings about Cal Poly and engineering education led me to build a project center for the College of Engineering and to invest my time as a volunteer building the university.

The third lesson is about giving. Looking back, I realize the importance of those who were willing to give me their all, to share their knowledge and their time—professors who went the extra mile for my last paper, my senior project. So, now it’s my turn to contribute and to give back. Through my volunteer work and through gifts Sandi and I have made to Cal Poly, I’d like to think that I’ve benefited students, supported faculty and enabled the school to keep in touch with industry.

I have found my relationship to Cal Poly as an alum, volunteer and donor to be personally rewarding and, above all, fun! I’d like to thank all the donors listed in this publication for their support, and I’d like to encourage all fellow alumni to join me in building something extraordinary: a College of Engineering that will do for future engineers—perhaps your own daughter or son—what it did for you and me.

Paul R. Bonderson, Jr., Co-chair
Dean’s Advisory Council
2006-2007 Highlights

- The College of Engineering (CENG) was ranked No. 2 in the nation for public schools whose highest degree is a bachelor's or master's by U.S. News & World Report. Cal Poly's electrical and industrial/manufacturing programs were ranked as the top at a public university. Computer Science ranked No. 2, and Aerospace ranked No. 3.

U.S. News also named Cal Poly as the best public-master's university in the West for the 14th year in a row and recognized the university as a Program to watch for Undergraduate research/Creative Programs.

- In Fall 2006, CENG enrolled 4,706 undergraduates and 273 graduate students, admitting 63.9% of the 5,942 new student applicants. The average SAT for freshmen was 1,230 (math and reading); the average high school GPA for the class was 3.69.

- The Bonderson Projects Center opened, providing 1,900 square-feet of specialized space for faculty and student projects.

- The Project Based Learning Institute, which offers a centralized conduit for industry sponsored student projects and faculty applied research, received two industry memberships and pledges from six additional companies.

- Engineering IV was completed, providing 104,000 square feet for mechanical, industrial and manufacturing, civil and environmental, and aerospace engineering programs.

- A new Dean's Advisory Council convened with more than 50 representatives, including university presidents, corporate CEOs, engineering deans, entrepreneurs, distinguished researchers, and a former congresswoman.

- Donors Dale Nix and Don Heye provided new scholarships, including five $4000 scholarships for freshmen and a $17,500 merit-based grant to an entering or current student. The scholarships are distinct in being renewable for up to four years.

- A $500,000 gift from Paul Bonderson (EE ’75) established the Bonderson Fellowships providing two five-year scholarships for students earning master's-doctoral degrees at Cal Poly and UC Santa Barbara in biomedical and materials engineering.

- Engineering student scholarships increased from $180,000 per year in 2005-06 to $250,000 for Fall 2007, including $180,000 for freshman recruitment.

- Cal Poly, Seoul National University of Technology and six other universities from around the world established a partnership to address the future of engineering education.

- The Engineering Plaza was completed.

- A significant increase and expansion of outreach activities included service learning programs in several departments and a new engineering summer camp for girls.

- Donald E. Bently, president of the Bently Pressurized Bearing Company, received an honorary degree of Doctor of Science. His support to the college included $6 million in 2003 to establish the Bently Center for Engineering Innovation.

Student Team Achievements

- The CubeSat program launched two picosatellites from the Baikonur Cosmodrome. AERO graduate students traveled to Kazakhstan to assist in launch preparations.

- For the fifth straight year, Cal Poly's Society of Women Engineers (SWE) was named the nation's best “large” student section. The group also took 2nd for Team Tech.

- The Cal Poly Supermileage Team won the U.S. Shell Eco-Car Challenge by achieving an astounding 1,902 miles per gallon.

- A CENG multidisciplinary design team was selected as one of three North American winners of the Enhanced Safety of Vehicles International Collegiate Student Safety Technology Design Competition for its Pre-Crash Sensing Demonstration System.

- Cal Poly’s Society of Civil Engineers placed fifth at the National Concrete Canoe Competition.

- Engineers Without Borders undertook projects on two continents, working to improve conditions in Nueva Vida, Nicaragua, and rebuild a struggling community on the Indonesian island of Nias.

- The Cal Poly Human Powered Vehicle Club (HPV) won 1st place in the female sprints, 1st in men's and women's mixed sprints, 3rd in design, and 2nd place overall at the 2007 American Society of Mechanical Engineers (ASME) HPV Competition.

- Cal Poly’s ASME (American Society of Mechanical Engineers) won the Ingersoll Rand Competition for the West Coast Region for the tenth year in a row.
**Student Success**

- ME senior Todd Maki served as Associated Students Inc. (ASI) president.

- EE student Jessica Kiefer received a $10,000 scholarship from Google for her efforts to inspire young women to consider careers in engineering.

**Faculty Achievements**

- Dr. Diana Franklin (computer science) received a five-year, $300,000 NSF Early Career Development (CAREER) Grant.

- Dr. Lynne Slivovsky (electrical and computer engineering) was named a Faculty Fellow in the Service Learning for Political Engagement Program.

- Dr. Trevor Harding (materials engineering) was one of three researchers from Cal Poly, University of Michigan and Lawrence Technological University, to receive a three-year NSF grant for a curriculum innovation project.

- Drs. Jianbiao Pan (industrial engineering), Albert Liddicoat (computer engineering) and James Harris (electrical engineering) were awarded a $199,030 NSF grant to incorporate multidisciplinary, project-based learning in the computer engineering curriculum.

- Helene Finger, WEP director, was awarded a Doctoral Scholars Fellowship by UC Santa Barbara and an NSF Graduate Research Fellowship.

- Drs. Mei-Ling Liu (computer science) and Jose Macedo (industrial and manufacturing engineering) were named Fulbright Scholars.

- Dr. Dan Biezad (aerospace) received Cal Poly’s Distinguished Scholarship Award.

**Alumni Success**

- Paul R. Bonderson, Jr. (EE ’75) received an honorary degree of Doctor of Science in recognition of his support of project-based learning. He and his wife Sandra established the Bonderson Projects Center with a gift of $8.5 million.

- Rick Sturckow (ME ’84) commanded Space Shuttle Atlantis on a mission to the International Space Station.

- Burt Rutan (AERO ’65), and British entrepreneur Richard Branson announced plans to carry “tourists” to space on Virgin Galactic.
AERO
Aerospace Engineering

- Seven picosatellites, including two Cal Poly CubeSats, were successfully launched into space on April 17 from the Baikonur Cosmodrome in Kazakhstan. The CubeSats were deployed by Cal Poly-built P-Pods, which were affixed to the Dnepr-1LV rocket with the assistance of AERO grad students Roland Coehlo, Lori Brooks, and Jonathon Brown.

- Design expert Dr. Robert McDonald joined the department.


- Dr. Dan Biezad received Cal Poly’s Distinguished Scholarship Award.

- AERO faculty, including Drs. Eric Mehiel and Rob McDonald, worked with inaugural Project Based Learning Institute (PBLI) members, Edwards AFB and Northrop Grumman, to develop specifications for several PBLI projects.

- The Boeing Company, Edwards AFB, JPL, Lockheed Martin, Northrop Grumman, and Raytheon provided generous support for the CubeSat Project and senior design courses.

- The department opened new design studios and a distance learning facility in Engineering IV, and got the new flight simulator up and running.

- The first group of ten students graduated from the Space Systems Master’s Program, the distance-learning program offered in collaboration with Lockheed Martin in Sunnyvale.

- The AERO Design Symposium was held in the new Engineering IV facilities with upwards of 100 industry attendees.

- Cal Poly participated in the 2007 Cessna Aircraft Company/Raytheon Missile Systems Student Design/Build/Fly competition in Tucson, AZ, along with teams from all over the U.S., Scotland and Turkey.

- Under the guidance of Dr. Rob McDonald, students Jennifer Chan, Bryan Morrisey and Chaz Morantz entered the Raytheon Strike Weapons Competition. The team was selected to compete at the finals held in Tucson, AZ.

- Students founded the Cal Poly Unmanned Aerial Systems club. The team goal is to build an autonomous aircraft that will guide itself back to earth after being carried aloft to 100,000 feet by weather balloon, and to photograph its journey home.

- AERO students contributed to multidisciplinary team projects, including the Society of Automotive Engineers (SAE) Formula car and the Human Powered Vehicle.
BMED/GENE
Biomedical & General Engineering

- Dr. Robert Crockett was named interim department chair.
- Dr. Robert Szlavik joined the department, bringing an expertise in neural-modeling.
- Undergraduate BME majors almost doubled to 143, and General Engineering enrollment was close to 200. Likewise, both biomedical and general engineering graduate programs grew.
- The strong master’s degree program, now with close to 60 students on-campus and off-site at St. Jude Medical, awarded eight diplomas to its first distance-learning enrollees.
- 2006-07 set the stage for tremendous departmental growth—it was the first year that every BME course in the catalogue was offered.
- In response to the increasing complexity of engineering and needs of industry, the department is developing more individualized courses of study in areas such as alternative energy sources, technology management, and engineering entrepreneurship.
- Meditech transitioned from a pilot program with St. Jude, to a biomedical engineering consortium with three industry partners: St. Jude, Edwards Life Sciences, and Advanced Bionics. Consortium members provide real world projects for multidisciplinary teams of students working on senior projects or master’s degree theses. The students undertake the applied research in an industrial environment replicated in on-campus departmental facilities.
- Student-committed Department-Based Academic Fees and the California Central Coast Research Partnership (C3RP) provided funds for a new tissue engineering lab. The facility enabled a project in which faculty and students from BME, Animal Sciences and the Dairy Products Technology Center are developing three-dimensional scaffolds to grow functional mammary epithelial cells.
- More industry leaders recruited BMED/GENE students for coops, internships and full-time employment, including St. Jude Medical, Abbott, Alcon Labs, Boston Scientific, Advanced Bionics, and Edwards Life Sciences.
- Lisa Wertenberg was named college-wide Outstanding Graduating Senior for Contributions to the College of Engineering.
- BME honors student and Team Tech co-director Emily Hakun was named an Outstanding Woman in Engineering & Technology.
- Administrative assistant Sondra Gorman received the 2007 CENG Outstanding Staff Award.
Program Highlights

**CE/ENVE**
Civil & Environmental Engineering

- Dr. Gregg Fiegel was named department chair.
- Drs. Tryg Lundquist and Sudeshna Mitra joined the department.
- Professor Emeritus Harold Cota received the Charles W. Gruber Association Leadership Award for service to the Air & Waste Management Association.
- Dr. Robb Moss and co-authors won the American Society of Civil Engineers (ASCE) Middlebrooks Award, the group’s highest honor for published work.
- Dr. Gregg Fiegel won the 2007 ASCE Region 9 “Faculty Advisor of the Year” for mentorship of Cal Poly’s Society of Civil Engineers.
- Kiewit Pacific sponsored the newly refurbished Kiewit Civil Engineering Materials Laboratory, enhancing CE’s project- and design-centered curriculum.
- The National Science Foundation awarded Cal Poly $190,500 to acquire an 110,000 lb. capacity materials testing machine, which will serve as the centerpiece of the department’s new Pavement and Advanced Materials Laboratory.
- New CE/ENVE labs opened in Engineering IV, including CAD-equipped Smart Rooms, the Advanced Computational Mechanics Lab, and the Advanced Water Resources Lab.
- The Society of Civil Engineers placed third in the 2007 Pacific Southwest Regional Conference (PSWRC), and Cal Poly’s Concrete Canoe paddled to 5th in the nation at the National Concrete Canoe Competition.
- Cal Poly Society of Environmental Engineers (SENVE) placed 2nd at the ASCE Water Treatment from Your Kitchen…and Beyond competition.
- SLOMobility won the “City of the Future” contest with a design for a transportation system for the Los Angeles of 2106.
- Engineers Without Borders (EWB) continued its work in Thailand and undertook two new projects. The group will redesign the water storage system for the community health clinic in Nueva Vida, Nicaragua, will also help redevelop two communities in Indonesia that remain devastated by the 2004 Indian Ocean tsunami.
- Rachel Severn was named college-wide Outstanding Graduating Senior for Contributions to the University, and Patricia Compas received the college-wide Outstanding Graduating Senior Award for Service to the Community.
- EWB co-founder Patricia Compas was named an Outstanding Woman in Engineering & Technology.
- ENVE senior Cash Fitzpatrick won a $1000 award for “Use of AERMOD and Google Earth,” a paper submitted for the 100th Anniversary Meeting of the Air and Waste Management Association.
- Shawna Von Stockhausen won a Best Paper presentation award from the Association of Engineering Geologists.
- The CE/ENVE Industrial Advisory Board presented its 2007 “Professional Advancement Awards” to Cash Fitzpatrick (Environmental) and Phaidra Rice (Civil).
CPE
Computer Engineering

- Dr. Al Liddicoat was appointed program director.
- Robotics expert Dr. Chris Clark (CSC/CPE) joined the faculty.
- Dr. Diana Franklin (CSC/CPE) received a five-year, $300,000 NSF Early Career Development (CAREER) Grant.
- Dr. Lynne Slivovsky was named Faculty Fellow for the California Campus Compact - Carnegie Foundation: Service-Learning for Political Engagement Program.
- The program enrolled 175 freshmen, bringing the total program enrollment close to 500.
- The CPE Capstone Lab was upgraded with funds provided by Bert and Candace Forbes.
- NSF funded a $50,000 research infrastructure proposal by Dr. Franklin for a 64-processor computer cluster that will benefit CPE, AERO CSC and ME.
- Drs. Al Liddicoat, Jianbiao Pan (IME), and James Harris (EE) received an NSF grant to enhance multidisciplinary, project-based learning in computer engineering.
- Faculty undertook sponsored projects with numerous industry and government partners, including the Jet Propulsion Lab, Caltrans, Raytheon, Cisco, and Google.
- CPE capstone projects were expanded to include multidisciplinary, sponsored, and service learning projects. For example, Dr. Lynne Slivovsky directed a multidisciplinary project facilitated by alumnus Kelly McClure (CPE ’89) and sponsored by Second Sight Medical Products to design a test device for use in the development of prosthetic retinas.
- CPE teams swept Roborodentia at Open House with 1st, 2nd, and 3rd place winners.
- Senior Duane Howard participated in a multidisciplinary team that represented North America at the Enhanced Safety of Vehicles International Collegiate Student Safety Technology Design Competition in Lyon, France.
- Dr. David Atkins, deputy program executive for NASA’s Lunar Precursor Robotic Program, gave the keynote address at the CPE Banquet, where Kelly McClure (CPE ’89) received the Excellence in Computer Engineering Award.
- Outstanding EE students for 2007 included Jonathan Gandi (Academic Excellence), Derek Lockhart and Steven Cary (Excellence in Representing CPE), and David Arellano (Service to the Community).
- Students named Bryan Mealy “Outstanding CPE Lab Instructor,” Diana Franklin “Outstanding CPE Advisor,” and John Seng “Outstanding CPE Instructor.”
- James Harris, David Braun, and Lynne Slivovsky received CPE Directors Awards.
- Freshman Jeremy Riddell-Kaufman organized “400,000 Faces,” which had a national impact on raising awareness of the violence in Darfur.
- Administrative assistant Rhonda Walker received the CENG Outstanding Staff Award.
- CPE thanks faculty retirees Lew Hitchner, Marty Kaliski, Len Myers, and Dan Stearns for 76 combined years of service to Cal Poly.
Program Highlights

CSC/SE

Computer Science & Software Engineering

- Dr. Ignatios Vakalis joined the department as chair.
- New faculty included assistant professors Dr. John Bellardo, Dr. Chris Clark, and Dr. David Janzen.
- U.S. News & World Report named Cal Poly’s computer program second in the nation for public, largely undergraduate universities.
- Dr. Diana Franklin won a five-year, $300,000 NSF Early Career Development (CAREER) Grant.
- The department advanced curriculum development in new areas, including parallel programming, scientific visualization, computational science/modeling, and interactive entertainment. These represent growing fields of computing and capitalize on partnerships with industry, such as game development companies and DreamWorks.
- Dr. Chris Clark worked on developing a multidisciplinary master’s degree program in Robotics/Autonomous Systems.
- The department replaced and upgraded computer hardware, software, workstations and servers. In addition, Dr. Franklin received a $50,000 NSF grant to acquire a 64-processor “Ravel” computer cluster.
- Faculty received grants for applied research: Dr. Clark received funds for mapping of underwater tunnels and autonomous underwater robot systems; Dr. John Clements joined colleagues at multiple institutions on an $500,000 NSF project to redesign the introductory computer curriculum; Dr. Franz Kurfess was awarded an NSF grant for a multidisciplinary honors student project on human-robot interaction; and Dr. John Seng obtained funds from Raytheon and Teradyne for RoboRodentia, the IEEE-CS club project.
- CSC partnered with Intuit on the University Collaboration Project in which students developed a payroll web application for company employees.
- A team of software and computer engineering students, including Alexandre Mattos, Aaron Favinger, Kyle Haughey, Ryan Murphy and Tawa White, was one of three winners of grants from Innovation Quest for their project, “Brew KVM – Game Porting from J2ME to Brew Cellular Phones.”
- CSC contributed to the successful launch of Cal Poly CubeSats into orbit with student-written software developed under the direction of Dr. Clark Turner.
- Graduate student Christine Le was named an Outstanding Woman in Engineering & Technology. She served as president of the Association for Computing Machinery and social coordinator for the Vietnamese Student Association.
EE
Electrical Engineering

• Dr. Art MacCarley was named chair, replacing Mike Cirovic, who returned to full-time teaching after serving in that position for six years.

• U.S. News & World Report named Cal Poly’s electrical engineering program first in the nation for public, largely undergraduate universities.

• Enrollment in the EE master’s degree program increased to more than 50, nearly 10% of the overall department enrollment. Forty-three of those graduate students were Joint BS/MS Honors Program candidates.

• Dr. Lynne Slivovsky was named a Faculty Fellow in Service Learning for Political Engagement, a program sponsored by the California Campus Compact and the Carnegie Foundation.

• In her first year as the Hood Endowed Professor, Dr. Slivovsky conducted technical research in embedded systems and haptic (touch-based) interfaces. She also incorporated service learning into her capstone design class and required K-12 outreach from all of her senior project students.

• Dr. Xiaozheng Zhang received a $10,000 Wang Faculty Fellowship, which will enable her international collaboration with Shanghai Jiao Tong University.

• EE professors Drs. Al Liddicoat and James Harris, along with Dr. Jianbiao Pan (IME), received a $200,000 NSF grant to enhance multidisciplinary, project-based learning in the computer engineering curriculum.

• Lecturer Silvia Liddicoat served on the Steering Committee for STEMCAP, the collaborative action plan to boost K-University participation in science, technology, engineering and math. STEMCAP is supported by a WIRED (Workforce Innovation in Regional Economic Development) grant from the U.S. Department of Labor.

• The department developed a multidiscipline, team approach to senior projects and launched a successful pilot program for electrical/mechanical engineering joint projects. Some of these projects included a Light Weight Portable X-Ray System, a Human Bike Power Generator, Optical Vector Network Analysis, and a Repetition Counter for Exercise Systems.

• EE students elected to use their Department-Based Academic Fees to provide additional course offerings.

• Erin Matsumoto, a 4 + 1, B.A./M.A. student was named an Outstanding Woman in Engineering & Technology by the Society of Women Engineers. She serves as a teaching associate, college ambassador, chair of the EE Student Fee Allocation Committee and board member of the IEEE.

• EE student Jessica Kiefer received the $10,000 Anita Borg Scholarship from Google in recognition of her efforts to inspire young women to consider careers in engineering.
Program Highlights

IME
Industrial and Manufacturing Engineering

• **U.S. News & World Report** named Cal Poly’s industrial and manufacturing engineering program first in the nation for undergraduate universities.

• Dr. Jose Macedo received a Fulbright Fellowship to undertake projects at the Technological University of Panama.

• Dr. Sema Alptekin and Dean Phil Bailey (College of Science & Mathematics) received a $500,000 NSF grant for project-based, interdisciplinary learning. Throughout the four-year grant, 22 NSF-funded scholarships will be awarded annually to engineering and science and mathematics Honors Program students.

• Dr. Jianbiao Pan, along with EE colleagues Albert Liddicoat and James Harris, received a $200,000 NSF grant to develop project-based learning for the computer engineering curriculum at Cal Poly.

• Dr. Dan Waldorf received a $100,000 Small Business Innovative Research NSF grant with industry partner Scott Liu of Genius Metals to work on the design and testing of carbide cutting tools with alternative binder metals.

• With the help of the Manufacturing Consortium, the department acquired a $40,000 coordinate measuring machine programmable for automated inspection.

• Selected as one of the country’s best young engineers, Dr. Pan was invited to participate in the National Academy of Engineering’s Frontiers of Engineering symposium. He also received the 2007 Emerald Literati Network Award for the most outstanding paper published in a nationally respected journal.

• PolyHouse, the annual multidisciplinary service-learning project undertaken by Dr. Roya Javadpour’s project management class, served a disabled community member while giving students hands-on experience in all aspects of planning and managing a technical project. The students raised more than $50,000 dollars for home improvements.

• Students in Liz Schlemer’s IE class developed a brick press to address critical housing problems in Zambia—the course included a visit from Zambian ambassador, Inonge Mbikusita-Lewanika. Dr. Unny Menon, IE professor and interim assistant vice provost of academic programs, is helping the students take the product from prototype to reality.

• Lecturer Rod Hoadley was issued a patent for his Dual-Level Bicycle Rack designed with the help of IME students.

• Dr. Roya Javadpour and the Persian Students Club facilitated a university-wide presentation by 2003 Nobel Peace Prize recipient Shirin Ebadi.

• Edward Clements won Best Student Poster at the 9th International Symposium on Microelectronics with “Design of a High Speed Data Acquisition System for Lead Free Solder Joint Drop Testing.”

• Senior Jessica Eggleston received a Toyota Material Handling Honor Scholarship. She holds the fourth all-time career scoring record in Cal Poly Women’s Basketball, and was named Scholar-Athlete of the Year.

• Susan Mooney Johnson (IE ’78) was named College of Engineering’s 2006 Honored Alum.
Program Highlights

MATE Materials Engineering

- Dr. Kathy Chen was appointed department chair.
- Dr. Trevor Harding and post-doctoral scholar Dr. William Hughes joined the department.
- Dr. Richard Savage received the Raytheon Excellence in Teaching and Applied Research Award.
- Dr. Linda Vanasupa and MATE colleagues launched Educating Global Engineers (EdGE) with a five-year commitment by the College of Engineering to design learning experiences that enable engineers to serve society through innovation.
- Facilities opened in Engineering IV, including a modernized metallography lab, a state-of-the-art classroom designed to support team-based learning, and a projects lab to enable curricular project-based learning.
- A service learning emphasis was incorporated into the freshman sequence. As a result, students came away with a better understanding of the practical world of engineering and the freshman student retention rate increased.
- NSF funded a four-year investigation by Dr. Trevor Harding and colleagues at the University of Michigan and Lawrence Technological University on the ethical development of engineering undergraduates.
- Dr. Hughes received a grant from Cal Poly’s Office of Research & Graduate Programs to acquire a research-grade Atomic Force Microscope, enhancing the university’s materials characterization capability.
- MATE Outreach Ambassadors were established and MATE students volunteered at numerous outreach events; in fact, approximately 20% of MATE students participated in K-12 outreach during National Engineers Week.
- Graduate student Brian Wright won the Best Student Poster Award at the 39th International Symposium on Microelectronics for “Assembly and Characterization of Surface Mount Components on Silicon Substrate.”

- Amanda Runciman placed 2nd in the CSU Student Research Competition in the graduate engineering and computer science division for “The Effect of Hydrogen on the Atomic Structure and Behavior in Nickel Titanium Shape Memory Alloys.”
- MATE students were recognized with scholarship awards: Senior Nicholas Vickers was awarded a scholarship from the Society of Vacuum Coaters Foundation, graduate student Katherine Miyashiro received the M.J. Schiff Fellowship Award sponsored by the National Association of Corrosion Engineers and Intel, graduate student Michael Leonard received a scholarship from SAMPE/ASM, the Materials Professional Societies, and undergard Casey Weathers received a USA Snowboard Association scholarship.
Program Highlights

ME
Mechanical Engineering

- Dr. Brian Self, Dr. Patrick Lemieux and Dr. Tom Mase joined the department.
- Dr. Joe Mello won the Northrop Grumman Excellence in Teaching Award.
- Dr. Louis Rosenberg was honored as one of San Luis Obispo’s “Top 20 Under 40.”
- Visiting professors included Wolfram Englberger from Munich University of Applied Sciences and Jim Tobias, founder of a chip emulation program. Tobias developed a course on building systems modeling using the Cal Poly Solar House.
- Dr. Patrick Lemieux transformed the IC Engines Lab, and Drs. Bill Murray and John Ridgely revised and updated the mechatronics curriculum.
- Dr. Jim Widmann initiated the biannual ME Projects Expo, which showcased 70 student projects, many of which were sponsored by industry.
- ME faculty undertook research on a wide variety of subjects, including ethanol testing, advanced golf technologies, cartilage modeling, an energy efficient juice machine, bent rotor shaft modeling, student learning outcomes, engineering education experiments, vehicle pre-crash detection, robotic pattern recognition, advanced rocket nozzle thrust vectoring, and more.
- The Flexible Fastener became available for licensing—the patented, bendable bolt was designed and built by ME students under the direction of Dr. Saeed Niku.
- The Cal Poly Supermileage Team won the U.S. Shell Eco-Car Challenge with 1,902 miles per gallon.
- The Cal Poly Human Powered Vehicle Club (HPV) took 1st in female sprints, 1st in mixed sprints, 3rd in design, and 2nd place overall at the 2007 American Society of Mechanical Engineers (ASME) Human Powered Vehicle Competition.
- Cal Poly ASME was the nation’s top student chapter, winning the Ingersoll-Rand Award for the 10th straight year. The group also placed 2nd in the Student Design Competition for presenting a human-powered water distillation system.
- SAE International selected the Cal Poly Society of Automotive Engineers (SAE) as an “Outstanding Collegiate Branch” for 2005-2006.
- Drs. Charles Birdsong and Peter Schuster led a multidisciplinary student design team that represented North America at the International Collegiate Student Safety Technology Design Competition in Lyon, France.
- The Cal Poly Robotics Club won the RoboMagellan Competition at the International RoboGames with Spybot, an autonomous navigation vehicle.
- Kyle Cormany was the college-wide Outstanding Graduating Senior for Academic Excellence.
- Students David Ulrich, Nick Wile and Ryan Johnson traveled to Korea to take part in a design exhibition sponsored by Seoul National University of Technology.
- ME senior Todd Maki served as Associated Students Inc. (ASI) president.
- Rachel Santee was named an Outstanding Woman in Engineering & Technology.
**MEP Multicultural Engineering**

- MEP served over 300 Cal Poly students and 400 pre-college students from the Central Coast area.

- Silvia Liddicoat joined the program as the pre-college coordinator and recruiter/counselor.

- MEP director David Cantu, was recruited to serve as the campus coordinator for PIQE, the Parent Institute for Quality Education, which is partnering with Cal Poly and the CSU to help parents support their children’s educational efforts in order to set them on the path to college.

- With an 89% retention rate for first-year students, MEP hit a three-year average high comparable to the retention rate for the college as a whole.

- Cal Poly’s MEP program received $160,000 from the U.C. Office of the President to offer the pre-college MESA Schools Program to low-income students and additional funds to host the 2007 MESA Day event.

- Cal Poly hosted the Regional MESA Day, which brought more than 450 students from 23 middle and 20 high schools to campus. More than 70 Cal Poly staff, faculty and student volunteers facilitated the event.

- The program partnered with Lockheed Martin on outreach at Santa Maria High School.

- Corporate sponsored scholarships totaling more than $75,000 were awarded to approximately 30 students at the MEP Corporate Social and Academic Recognition Banquet. The event was made possible through generous contributions to MEP from Boeing, ChevronTexaco, Frito-Lay, Hewlett-Packard, Lockheed Martin, Northrop Grumman, PG&E, Raytheon, and Xerox.

- Along with other regional universities, Cal Poly participated in a two-day MEP Leadership Workshop hosted by Northrop Grumman, Lockheed Martin, Disney Imagineering, and Frito Lay. Attendees included executive officers of campus professional societies, including SHPE, the Society of Black Engineers and Scientists (SBES), the American Indian Society of Engineers & Scientists (AISES), and the Society of Women Engineers (SWE), as well as corporate representatives.

- Over 31 SHPE members participated in the NTCC conference in Denver, and SBES sent fifteen members to the National Society of Black Engineers (NSBE) conference in Columbus, OH.

- Five Cal Poly SBES members are active with the NSBE regional board—two were elected and three were appointed to the regional posts.
Program Highlights

**WEP**

**Women’s Engineering**

- For the fifth straight year, Cal Poly Society of Women Engineers (SWE) was named the nation’s best “large” student section. Cal Poly also won the Membership Program Award, Best Collegiate Membership Recruitment Campaign, Collegiate Upgrade Award, Best Collegiate Section Website, Boeing Multicultural Program Award, and Best Region Collegiate Newsletter Award.

- SWE Team Tech took second in the nation for the design of a jet engine inspection system, a project sponsored by Northrop Grumman.

- With 464 members, Cal Poly SWE remained the largest student section in the nation.

- Helene Finger, WEP director for nearly a decade, was awarded a Doctoral Scholars Fellowship by UC Santa Barbara and a National Science Foundation Graduate Research Fellowship.

- Evening With Industry (EWI) featured a keynote speech by Violettee Brown, CEO of the Prophecy Consulting Group, and the awarding of $4,000 in scholarships.

- In cooperation with Hewlett-Packard, SWE named five Outstanding Women in Engineering and Technology, including Christine Le, master’s student in computer science; Emily Hakun, honors student in biomedical engineering; Rachel Santee, honors student in mechanical engineering; Patricia Compas, civil engineering senior; and Erin Matsumoto, a 4 + 1, B.A./M.A. student in electrical engineering.

- With the support of Lockheed Martin, WEP awarded two $500 scholarships to High School Shadow participants Jessica Gerard and Sheila Noii.

- Committed to increasing the number of female engineers, WEP/SWE invited all accepted female engineering students to spend a night in the dorms with SWE hosts, and also sent a congratulatory video to women admitted to the College of Engineering.

- Education efforts by SWE included Building An Engineer attended by 240 students and parents, 4th Grade Outreach during National Engineers Week, and Girl Scout Engineering Day, in which troops earned “Discovering Technology” badges.

- Cisco, Google, and Raytheon provided funds to launch host Engineering Days at Cal Poly. WEP/SWE initiated the Summer 2007 “day camp” to introduce engineering to local students.

- SWE officer Kate Van Dellen helped organize the Minority Leadership Training Seminar hosted by Lockheed Martin and Northrop Grumman and attended by members of SWE, the American Indian Society of Engineers & Scientists (AISES), the Society of Black Engineers & Scientists (SBES), and the Society of Hispanic Professional Engineers (SHPE).

- Cal Poly’s Joint Membership Program took off: SWE partnered with SHPE, AISES, and NSBE to offer a 50% discount for joint membership dues. SWE also created a diversity brochure. Cal Poly’s pilot program spurred similar efforts by the National SWE. In addition, numerous joint events resulted from the diversity partnership efforts, including social events, outreach activities, and seven industry tours.
Engineering students and faculty have a new place to meet, collaborate, and dream. Completed in 2007, the Engineering Plaza is bordered by the Bonderson Projects Center, Engineering IV, and the Advanced Technology Laboratories.

Much of the Plaza costs were donated by you, our friends and alumni. The multidisciplinary activity and energy apparent in the new engineering hub show that your generosity provides a valuable and beautiful resource to the College of Engineering.
Kathleen Holmgren, Co-chair of the Dean’s Advisory Council, leans against with newly completed Engineering IV Building. The Engineering Plaza and the Bonderson Projects Building can be seen in the background.
A Message from Kathleen Holmgren, Co-Chair

When I arrived on campus as a freshman in 1976, I could not know how large a part Cal Poly would play in my life. Not only would it help open the doors to a wonderfully challenging and fulfilling career, but I would also meet my future husband, Robert, a fellow major in industrial engineering. Years later, my daughter Allison enrolled and is now an IE junior, and my son Tom will be a freshman this fall.

Why has my family made Cal Poly a legacy? Because we sincerely believe it offers the best well-rounded and comprehensive engineering education possible. We also know Cal Poly faculty have a passion for teaching, and we trust the vision of the college to produce engineers who can tackle the challenges and meet the needs of society.

Over the past 27 years, my appreciation for Cal Poly has increased and I’ve become more and more active in helping advance the College of Engineering. In that time, I have seen Cal Poly grow from a totally State-dependent institution to a world-class university that must raise millions of dollars.

As one looks around Cal Poly’s engineering campus, generosity is evident. Two new buildings have just been completed in the Engineering Plaza, one of which was entirely funded by Paul and Sandi Bonderson. In addition, the Advanced Technologies Laboratory (ATL) is outfitted with corporate-funded labs, and all departments have facilities supported by our industry partners. Just this year, donors Dale Nix and Don Heye established new student scholarships; in fact, privately-funded scholarship support increased by more than 70% in 2006-2007.

Yet, our challenge persists. To fulfill our vision as the nation’s premiere provider of engineers, we need to finish Engineering IV, equip the Bonderson Center, support faculty, provide scholarships, and develop the programs and curriculum that keep the college on the cutting edge. These costs, along with funding for student projects and organizations—which make Cal Poly unique as an educator—are not funded by the State of California.

In this annual report, you’ll read the list of individuals and organizations that have answered the call. You have helped Cal Poly stay on top. To each and every one of you, thank you. Please know that a gift of any size will directly benefit Cal Poly students.

Kathleen Holmgren (IE ’80), Co-chair
Dean’s Advisory Council

To discuss how to become involved with or support the College of Engineering, call Joe Donahoo or Donna Aiken, 805-756-6870 or 805-756-6601.
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If you would like to learn more about corporate matching programs, or determine if your employer would match your gift to Cal Poly, please visit: http://www.giving.calpoly.edu/matching
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Herman & Sandy Hui
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Maxine Littlejohn
Frank Maciel

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Audrey & Dennis Silber
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Timothy & Janet Thomas
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James & Kathleen Thomson
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Michael & Sally Kennedy
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– 26 –
Donor: Don Heye

An alumnus establishes a scholarship to see students through

Don Heye believes in following through on a commitment. Not only has he offered scholarships that are renewable for up to four years—a first for the College of Engineering—but he is also personally committed to helping select the recipients of those scholarships.

This year, the 1958 aerospace engineering alum established the Marvin Arnold & Irene Jaquetta Heye Scholarships, which will provide up to $17,500 per year to two Cal Poly engineering students. Named for Heye’s parents, the scholarships are administered through the San Diego Foundation.

“I’m very proud of Cal Poly, and because I’ve reached a time in my life when I can provide help to others, I thought the scholarships were a good idea. I especially hope that the grants will encourage individuals to attend Cal Poly and become engineers.

“So, I tried to find students who are dedicated to the Cal Poly approach. We had about 60 applicants and I reviewed them all and visited the two awardees. They were both selected by several prominent universities but chose Cal Poly because of its super reputation, and they are very enthusiastic about Aerospace Engineering.

“Cal Poly’s reputation has been built on engineers who work in the field in hands-on engineering, people who do get things done. I have high hopes for these two young people.”

Don Heye’s own impact on industry has been considerable, starting with his first job at Ryan Aeronautical, where he did early testing for “short take-off,” “vertical take-off,” and unmanned aircraft. Along the way and at various companies, he helped develop gas turbines, components for the Saturn rocket engines and lunar landing module, and other systems for aerospace vehicles. In 1968, he founded Hyspan Precision Products Inc. Hyspan is a global manufacturer of industrial products operating four plants in the U.S. and one in Mexico.
“I became sold on Cal Poly when I visited Open House and found all the students so knowledgeable and happy to be here. I was especially impressed with the CubeSat program. Now I’m a CubeSat program manager—it was surreal the night our Polysats were launched into orbit from Kazakhstan this spring. We didn’t have a visual link-up, but we sat listening by the phone with our fingers crossed and everyone just erupted into cheers when the CubeSats made orbit. It was so great to realize all the hard work paid off.

“Cal Poly has met my expectations and then some. I really appreciate the opportunities it has given me, including involvement in CubeSat. And thanks to Dr. Sema Alptekin and the Honors Program, I received an NSF grant to study algorithms for low-powered satellites.”
Andrew Moya
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Daniel & Deborah Need
Melvin Nelson
David Newarez Jr.
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Gary Boehm
Holly & Christopher Bolling
Evelyn & John Bolton
Sheila & Robert Bonstead
John Borders
Cynthia & John Bowen
Benjamin & Arlene Boychuk
“We arrived at Cal Poly in 1946 and lived in a little trailer on campus. I worked in the Poultry Department, selling eggs and fryers, and keeping the books on projects. We were very happy.”

Ruth Renihan’s husband, Lawrence, was one of the many World War II veterans who attended Cal Poly on the G.I. Bill. When he graduated in 1950 he received a degree in electronic engineering, while Ruth was awarded a “P.H.T.” or “Putting Hubby Through” certificate. It was Cal Poly’s way, in those days, of honoring the women who played a vital role in supporting their student-husbands.

After leaving San Luis Obispo, Larry found a job with Hewlett-Packard, where he spent his entire career. Quite possibly the very first Cal Poly graduate to join HP, Larry Renihan paved the way for almost 1,000 alumni who have worked for the company and its spin-off, Agilent.

Throughout their years in the Bay Area and especially after retirement to Santa Barbara, the Renihans continued their connection to Cal Poly, coming back many times for reunions and Homecoming.

“We made life-long, lasting friendships there, and even though Larry is gone, I still enjoy making the trip,” says Ruth.

“I think it’s wonderful how the university has grown; I’m so impressed with what it’s become. I’ve known a lot of young people who have attended and gone on to successful careers; in fact, I’ve helped two go through, one of whom is an elementary teacher and the other an electronic engineer, like Larry. I hope my gift helps more students follow his footsteps.”
Scholarship Recipient

Jessica Eggleston
Industrial and Manufacturing Engineering

Boeing Scholarship
George E. Hoffman Scholarship
Toyota Material Handling Honor Scholarship

“I came to Cal Poly because my mom said I should — and that’s some of the best advice I’ve ever received! When I was a high school senior in Oceanside, California, I first heard about Poly when I was recruited to play basketball. It was one of several colleges I was looking at, but mom said she loved Poly and that made the decision much easier. It’s been a great experience.

“Because I’m super competitive in everything I do — maybe even to a fault — I’ve worked hard both athletically and in the classroom. It has paid off. I was the starting power forward on the basketball team and got a performance management job with PG&E at Diablo Canyon. I’m definitely open to a career path with PG&E after I give pro basketball in Europe a shot. Obviously, the scholarship is very helpful financially, but it’s also great to be recognized for your hard work.”
Emmet Woods
Materials Engineering

William B. Turner Scholarship
Helen Sandercock Scholarship
Cal Poly Outreach Scholarship

“Engineering classes at Cal Poly are not all theory — I really like to work on real-world projects — and I have to say the ‘Learn by Doing’ philosophy was a big attraction for me when I began looking for a college. I was fortunate that my high school in Olympia, Washington, had an introduction to Materials Engineering course that sparked my interest in the subject. I was looking at all the engineering schools in the West when I discovered Cal Poly’s MATE website and saw the program was stressing sustainability and studies in alternative energy Poly just seemed like the perfect fit.

San Luis Obispo now feels like home even though I’m hundreds of miles from Washington. I really appreciate the opportunities given to me so far by the engineering program and groups like the Hydrogen Energy Club, along with the scholarship money. My freshmen year, we built a solar water heater that worked really well. How cool is that?”

Scholarship Recipient
Donor: Chuck Dana

A professor establishes a record of giving that stretches over twenty-five years

Chuck Dana’s first gift to the Computer Science Department was his teaching.

“Teaching was the fun part of my graduate studies at U.C. Santa Barbara,” he says; “so, in 1982, I came to Cal Poly, where the primary focus is on students.

“I wasn’t disappointed; in fact, the highlight of my career has been interacting with students and colleagues. It’s always a pleasure when a student comes to my office and we sit and gab for an hour.”

Dr. Dana’s first cash gift to his department in 1987 was practical: funds to purchase a copying machine, “so that professors wouldn’t have to requisition every single page they needed.”

“In general, I’ve given over the years to make it easier for my department and the university. As a professor, I know that State Budget funds need to be supplemented with private gifts in order for department chairs to have the flexibility to make things happen. You can’t worry about every ten-dollar expenditure if you want to develop new programs and new curricula.”

In the last several years, Dr. Dana has made his gifts to Cal Poly in the form of charitable annuities. “I was really attracted to the benefits of deferred giving—it increases my retirement income while reducing my taxes, and it allows me to give a bigger gift than I would be able to otherwise.”

“I hope the word gets out about annuities because they make so much sense and they’re a great vehicle for giving back,” notes Dr. Dana. “I grew up around schools—my dad was a grade school principal and my mom was a teacher—so I’ve always figured that you should put more into a job than you take out of it. I hope my gifts continue to benefit Cal Poly and the students long after I’m gone.”
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Civil Engineering

Kimley-Horn Scholarship
Regnar Hessellund Scholarship

“Cal Poly’s Engineers Without Borders has literally opened up a new world of experiences for me. As EWB president for 2006-07, I have had a chance to work on two projects: water resource development for a village in Thailand and a soil brick press for building homes in an Indonesian coastal village in Sumatra. The type of projects Engineers Without Borders gets involved with really make a difference in people’s lives and I’m inspired to continue this type of work after college.

“Scholarships have been vital to my education both at Cabrillo College in Santa Cruz and Cal Poly. Scholarships and financial aid are huge! They’re extremely important and I’m extremely appreciative!”
Himanshu Parmar
Electrical Engineering

Raytheon Company Scholarship

“I’m a hands-on type of student and I like to get my hands dirty. Well, at least as dirty as electrical engineering projects will allow. It was the reputation for hands-on education that attracted me to Cal Poly from Mission Santa Clara College and I have a lot of appreciation for the program. I’ve been able to focus on my two areas of interest — digital design and signal processing — while working on some very interesting projects.

“It’s easy to see why I’m not your typical Cal Poly student. I was born in Rajkot, India and I am a practicing Hindu. I have the Hindu marking called Swaminarayan on my forehead. It’s a red dot that means devotion and a ‘U’ that signifies the feet of God. Like my religion, my education is vitally important to me. The scholarship is greatly appreciated because any financial help allows me to concentrate more fully on my classes.”
He remembers nights and weekends spent working on projects at Cal Poly

“In my senior year I was in a manufacturing processes class with about ten other guys;” recalls Frank E. “Bud” Pilling. “We were paired up in different projects and we spent classroom time and also nights and Saturdays working on them. Francis Whiting, our wonderful instructor, kept in touch with us though the years.”

Having earned a degree in mechanical engineering in 1950, Bud went on to a career in which he rose through the corporate ranks, primarily at Borg-Warner, to become president of the company’s Automotive Group.

“I have always recognized that the education I received at Cal Poly was a major factor in my career movement at Borg-Warner,” he says. “Now I want to help the college provide the best for its students, so they may have a chance to be successful as well.”

Bud and his wife Lauri established an Endowed Fellowship for Senior Projects. The endowment will provide up to $10,000 per year when fully funded to support students working on individual or group senior projects. The gift continues a Pilling legacy to the College of Engineering, including a $1 million gift in 1993. In 1994, Cal Poly dedicated its Computer Science Building as the “Frank E. Pilling Building” in recognition of Pilling’s generosity and support.

“We really enjoy seeing what the students at Cal Poly are doing, and we have a grandson there now, in business agriculture,” says Bud. “Lauri and I feel that it’s especially important to support engineering and agriculture, which are vital for the country. We need to feed people, and to be a leader in the world, we need engineering know-how.

“We want to encourage students who are curious, ambitious, and willing to work hard. We wish them—and Cal Poly—our best.”
We would like to thank the following donors for their in-kind gifts:

Nicholas Fortune
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Eva Young
Pui Ying “Andrea” Lam
Industrial Engineering

George E. Hoffman Scholarship
Herbert E. Collins Scholarship
Material Handling Education Foundation Scholarship

“I came to the U.S. from Hong Kong at 16 to take advantage of the educational opportunities. My parents stayed behind because of their jobs, but my sister also attended high school here, at San Luis High, so I’ve been her acting guardian throughout her high school years. I’m proud to say she’s going to UC Davis next fall, while I’m joining Cisco in San Jose.

“I have loved Cal Poly and learned so much. It has changed me and made me a better person. I was very shy, but I’ve learned to be more outgoing. For my senior project I was the project manager for an RFID system. It was a little overwhelming, but I got a lot out of it. My professor, Tali Freed, has been a great mentor, always saying, ‘Andrea, you need to be more assertive!’ Plus, I have a wonderful department—even people outside the major see us as tight. My favorite part of IME is the people.”
<table>
<thead>
<tr>
<th>Endowment</th>
<th>Amount</th>
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Langchen & Wulian Chou Endowment $51,934
Mechanical Engineering Endowment $51,594
Anderson Family Outstanding Freshman IE Scholarship Endowment $47,487
Aero Engineering Building Fund Quasi Endowment $38,864
Horace C. Morana Scholarship Endowment $38,810
MEP Endowment $38,444
Civil & Environmental Engineering Advisory Board Professional Advancement Award $37,079
George & Tonny Murray Scholarship Endowment $34,130
Aerospace Systems Scholarship Endowment $34,049
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Accenture Scholarship Endowment $26,798
APWA/Herbert E. Gerfen Endowment $26,778
John Stephen Larson Memorial Scholarship Endowment $24,865
Clinton Schwieker M.E. Endowment $23,462
Accenture Outstanding Junior Industrial Engineering Scholarship Endowment $22,961
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