

Cal Poly Pomona
Bronco Engineering

Inspiring and Engaging the Next Generation in STEM through PLTW and REAL

California State Polytechnic University, Pomona
College of Engineering
Cordelia Ontiveros, Ph.D., Associate Dean, College of Engineering
Elena Alvarez, MPA, Outreach Programs Coordinator



Cal Poly Pomona
Bronco Engineering

Cal Poly Pomona
Bronco Engineering

National Engineering Shortage

- Globally, the United States is trailing behind other countries in the number of science and engineering bachelor degrees being awarded, accounting for only 11% (NSF, 2011).
- Greater emphasis on increasing the number of underrepresented groups that would account for a diverse pool of well qualified engineers (Genalo et al., 2000).*
- "Interest in science and math is fading in American children, resulting in fewer students seeking education and professions in engineering" (Crawford et al., 1994; Jeffers et al., 2004).

*U.S. Census Bureau demographic trends indicate that by 2050 ethnic and racial minorities will account for approximately half of the population (NSF, 2011).

Cal Poly Pomona
Bronco Engineering

Cal Poly Pomona
Bronco Engineering

Factors Inhibiting Interest in Engineering

- There "is limited understanding of the engineering profession...[and]...many K-12 teachers have no idea what engineers actually do" (Fadali et al., 2000; Jeffers et al., 2004).
- Exposure*: exposing K-12 students to engineering at an early age is key to creating a successful educational pipeline that will eventually lead to a higher education institution (Kimmel et al., 2007).

Cal Poly Pomona
Bronco Engineering

Cal Poly Pomona
Bronco Engineering

Cal Poly Pomona Outreach Components

- Components meant to inspire and engage K-12 students in engineering (with focus on underrepresented groups and women):
 - Project Lead The Way (PLTW)**: exposes and engages middle and high school students to engineering by training their teachers with a "project-based" curriculum and the implementation of said curriculum.
 - Robotics Education through Active Learning (REAL) Program**: exposes elementary students to engineering through robotics curriculum.
 - Student-organization run outreach**: current engineering students expose K-12 students to engineering through hands-on activities that engage and inspire students.

Cal Poly Pomona
Bronco Engineering

Cal Poly Pomona
Bronco Engineering

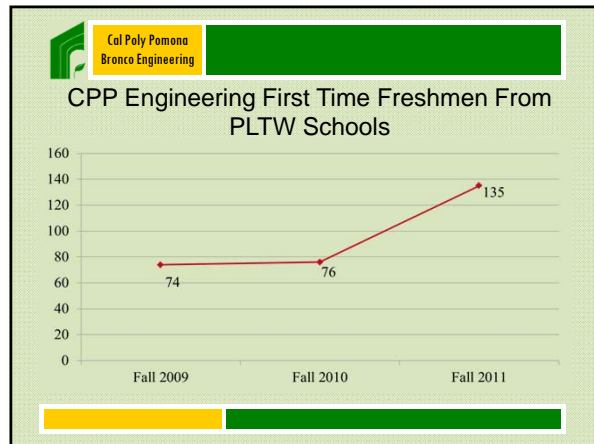
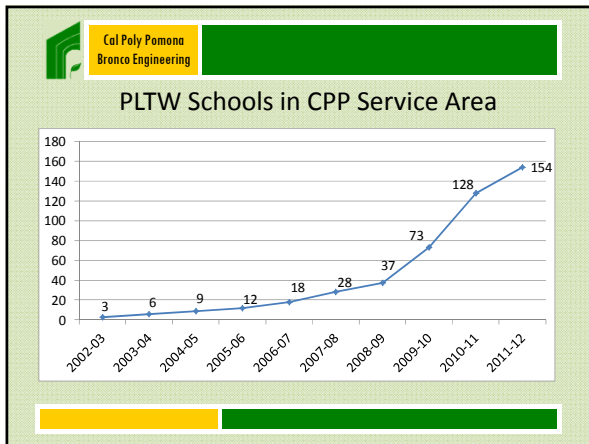
Project Lead The Way

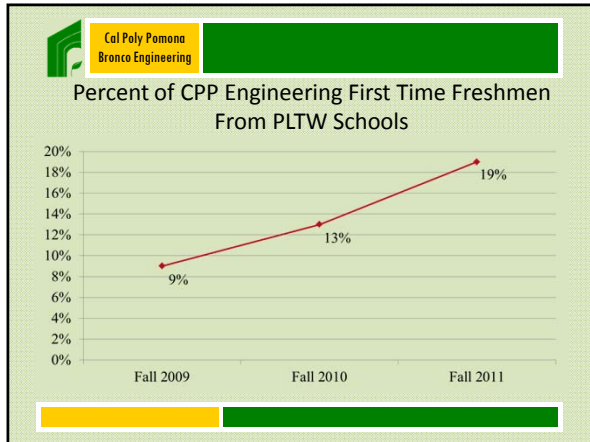
- College of Engineering (CoE) is a regional training center for the national non-profit organization PLTW that provides project-based, engineering and engineering technology curriculum to middle and high schools in order to "Inspire" and "engage" students in engineering fields.
- PLTW creates a sustainable form of engagement and outreach in engineering: teachers are trained to offer the engineering curricula starting at the middle school level and continuing into participating high schools.
- CoE works closely with PLTW schools to provide students with outreach through visiting our college laboratories and interacting with current engineering students and engaging in hands on activities.

Cal Poly Pomona
Bronco Engineering

California PLTW (as of August 2011)

- 116 School Districts
- 470 PLTW Teachers
- 290 Middle or High Schools, and Community Colleges (up from 65 in 2006)
- 154 Schools in Cal Poly Pomona service area





How Well is PLTW Working?


- **95%** intend to pursue a post-secondary degree
 - Vs. 67% nationally (National Center for Education Statistics)
- **70%** say they will study a STEM related post-secondary degree program
 - Vs. 32% nationally (Center on Education and Work)
- The percentage of female students in PLTW engineering programs continues to be about **19%**
 - Vs. 18% nationally (American Society for Engineering Education)

National PLTW Statistics

- PLTW alumni are, “5 to 10 times more likely to pursue engineering and technology classes than other first-year college students,...[in addition to having] on average a GPA 0.21 points higher” (PLTW, 2011).


REAL Program

- REAL:
 - is an innovative approach to training elementary level teachers and providing them with age appropriate curriculum for their students to learn and apply robotics.
 - incorporates multidisciplinary fields that develop critical thinking skills, problem solving strategies, and team skills, and provides hands-on experience that can build confidence .
- After 20 weeks of learning, the participating schools participate in the culminating annual Robot Rally that allows students to show off their creations in four events that are fun, engaging, and demanding.




REAL Program (Cont.)

- Research shows that “young children are inherently active with strong impulses to investigate...construct things, and to create, in other words a child is a natural engineer” (Genalo et al., 2000)
- A cultivation of hands-on activities, such as those employed by the REAL program, assist students with the development of the skills necessary to, “develop their engineering intuition” (NRC, 1996; Erwin, 1998; Jeffers et al., 2004)




REAL Program History

- 2003: Mentoring high school FIRST Robotics teams
- 2004 : After school program for a group of young students in Pomona
- 2005 — 2006 : After school program for 30 students
- 2007: 50 students from 2 schools, 1st Annual Robot Rally
- 2008 — 2009: 60 students, 2 schools, 2nd and 3rd Annual Robot Rally
- 2010: 160 students, 4 schools, 4th Annual Robot Rally
- 2011: 450 students, 7 schools, 5th Annual Robot Rally
- 2012: 600 students, 12 schools, 6th Annual Robot Rally




REAL Program Statistics

- 85% of participating students are underrepresented minorities and 50% are girls
- Currently work with seven school districts
- Served over 1,000 students including after school programs
- 30 teachers trained
- 60 undergraduate engineering students participated as mentors
- 7 faculty members from 3 colleges (Engineering; Science; Letters, Arts, and Social Sciences) collaborate on the project




REAL Program Highlights

- The largest event of this kind in the nation
- Cal Poly Pomona faculty members train teachers and lead robotic sessions (40+ hours)
- Fully developed, age appropriate curriculum from elementary level to high school
- Curriculum correlated with state and national standards
- Hands on, specialized training for teachers
- Use of various robot platforms including Lego, VEX, Bioloid, Fischertechnik and Basic STAMP
- Undergraduate engineering students mentor elementary level to high school students
- Service learning experience for Cal Poly Pomona students




Outreach Led by Student Organizations

- CoE also fosters K-12 outreach activities organized by student club organizations that serve a dual purpose, including retention through the increase of student involvement on campus (Astin, 1999).
- CPP Society of Women Engineers: Youth Engineering Success (YES!) day exposes middle and high school girls to engineering disciplines, generating a pipeline of women who may one day choose engineering as a career. Nearly 200 attendees, almost all from PLTW schools



Outreach Led by Student Organizations

- Women's Reception: invites prospective female engineering students to interact and engage with female faculty, alumnae, and students. Learn about their chosen engineering fields, group projects, and provides a foundation for female engineering students.
- Individual School Outreach: work closely with SWE to provide outreach to schools and schedule hands-on activities/tours for our campus.



Conclusion

- Great efforts are being placed on bringing exposure of engineering to K-12 students and creating awareness for all groups, including underrepresented students.
- In an effort to produce quality programs, we survey event attendees and/or program participants along with implementing debriefing sessions for faculty and staff involved in order to provide recommendations and improvements for the programs.
- An in depth analysis through quantitative and qualitative data of the impact that these components are having is our next step in developing a best practices plan.