Meeting ETIC's Goals: Recommendations for Pre-College Preparation

Oregon Pre-engineering and Applied Science (OPAS) Committees

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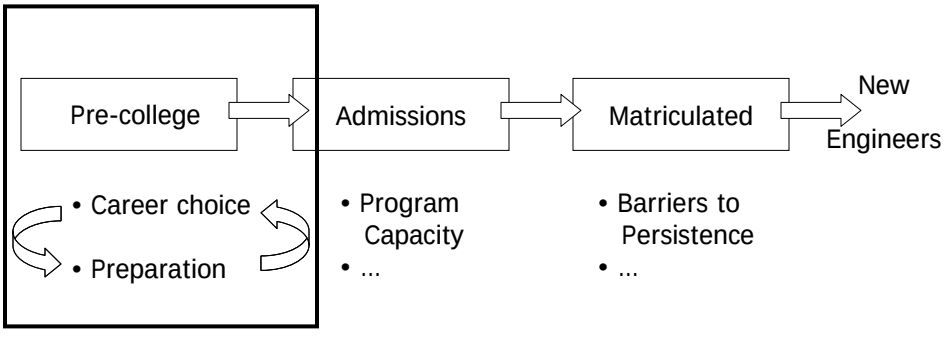
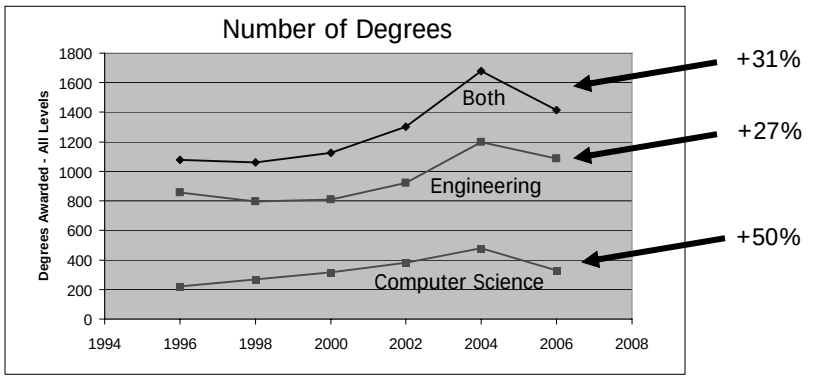
Pre-College Programs: Keys to Preparation and Choice



A Snap Shot of Progress

OUS Degrees Granted 1996-2006

Note: All OUS degrees increased by 37% in this period



	Bachelors	75%
Mix:	Masters	22%
	Ph.D.	3%

Source: OUS Data Book 1996-2006

Request to ETIC

Seize the opportunity to transform education in Oregon by launching a 6 year initiative to bring pre-college engineering to all students

- **In Class Programs**: expand opportunities to explore careers and master skills through rigorous pre-engineering and computer science classes
- **Out of School Time Programs**: expand OST clubs, challenge events, and internships (for students and teachers) with special focus on underrepresented students.

How can our students choose their futures wisely if they have never experienced the opportunities it holds?

Oregon Opportunity: Increase Pre-college Exposure to Engineering

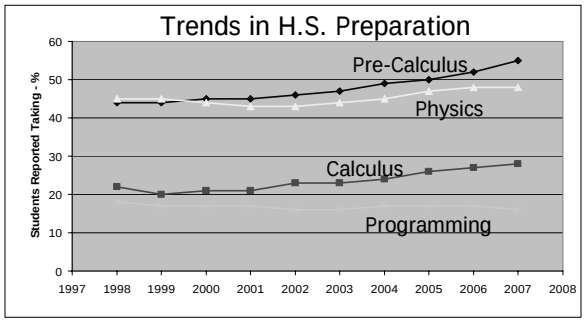
	Strategy	4-8	9-12	Teachers
	▪ Build on proven successes ▪ Address critical pre-college gaps ▪ System-wide expansion of opportunities			
In Class Programs	National exemplar program for high school and middle school engineering (OIT has provided Oregon leadership)	X	X	X
	CSTA/TechStart **SuperQuest** — Oregon collaboration between Computer Science Teachers Assoc. and the Software Association of Oregon	X	X	X
Out of School Time Programs	Expand proven programs addressing minority/under-represented Through collaborative team projects: ORTOP, SMILE (OSU), MESA (PSU), 4-H Tech Wizards, and similar high potential new programs	X	X	X
	Seed "engineering athletics" programs at schools to increase Engineering team challenge opportunities and scholarships	X	X	
	Summer internships for teachers and high potential students	X	X	
Marketing	State-wide communications/marketing of STEM education options and career paths to students, parents, teachers and counselors	X	X	X

A Program for Change

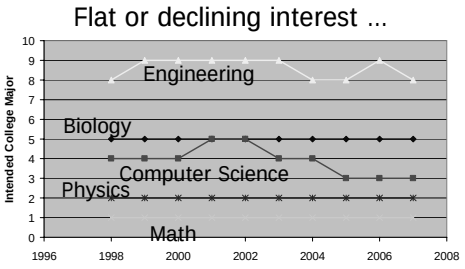
	Approach	Cost in Initial Biennium
	▪ Implement over 5-6 years ▪ Sustainable, system wide change ▪ Measurable impact of pipeline	
In Class Programs	Accelerate adoption of pre-engineering classes ▪ 64 new programs within 2 years ▪ Programs in 75% of schools within 6 years	$1.3 M
	CSTA/TechStart **SuperQuest** ▪ Increase qualified applications to OUS Engineering/CS programs	$0.7 M
Out of School Time Programs	Expand proven programs addressing minority/under-represented Double number of students reached by high quality programs	$1.4 M
	Summer internships for teachers and high potential students Create 70 high school internships and 10 teacher internships/year	$0.3 M
	Engineering team challenges modeled after high school athletics Challenge kits, s/w and tutorials for engineering teams. Extra duty stipend matching grants for Engineering Coaches at 30 schools	$0.6 M
Marketing	State-wide communications/marketing of STEM education options and career paths to students, parents, teachers and counselors	$0.2 M

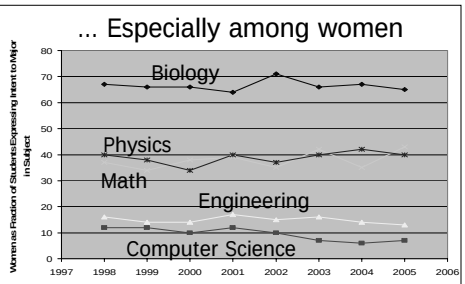
Pre-college Challenges

Academic preparation is improving...



...but career interest is not!





Example of Limited Pre-college Engineering Opportunity

Example:

Oregon public high school students	~170,000
CTE* high school students	74,803
Engineering CTE students	5,165
Number of Oregon high schools	>220
CTE Engineering Programs	33

*CTE is "Career and Technical Education", one of the opportunities to deliver pre-engineering and computer science classes in high schools.

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Prepare extra slides

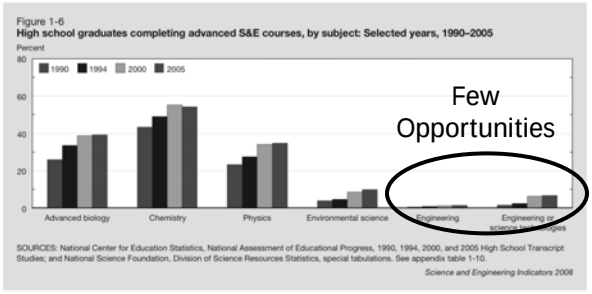
Supporting Data for Exemplar Program

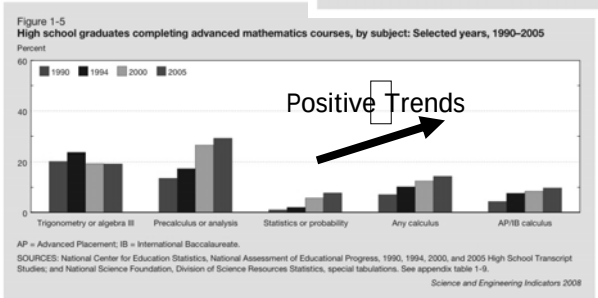
Project Lead the Way

A Window of Opportunity

NSF Indicators for Current High School Programs

Students are better Prepared in math And science ...





...but have few opportunities for Early engineering classes or experience.

Project Lead the Way

"The project has developed a 4-year sequence of courses that, when combined with college preparatory mathematics and science, introduces students to the scope, rigor, and discipline of engineering and engineering technology.

Students participating in PLTW courses are better prepared for college engineering programs than those exposed only to the more traditional curricula."

Rising Above the Gathering Storm
The National Academies
pages 128-129

Project Lead the Way Profile

"Project Lead The Way is all about teaching and learning. The hands-on, project and problem-based PLTW approach adds rigor to traditional technical programs and relevance to traditional academics"

High School Biomedical Sciences
- Principles of Biomedical
- Sciences
- Human Body Systems
- Medical Intervention
- Scientific Research

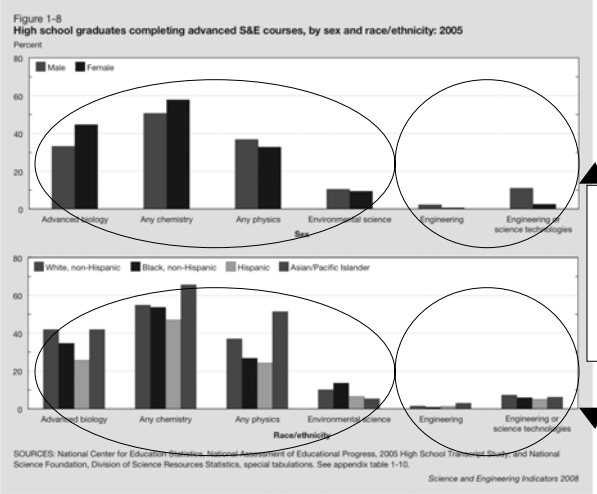
High School Engineering
- Intro to Engineering
- Principles of Engineering
- Digital Electronics
  Civil, CIM
- Capstone: Engineering Design And Development
- Plus: Aerospace, Biotechnical,

Middle School Technology
- Gateway to Technology
  - Magic of Electrons
  - Science of Technology
  - Automation and Robotics
  - Flight and Space

technical courses.
PLTW 's curricula make math and science relevant for students. By engaging in hands-on, real-world projects, students understand how the skills they are learning in the classroom can be applied in everyday life. This approach is called activities-based learning, project-based learning, and problem-based learning (or APPB-learning, for short). Research shows that schools practicing APPB-learning experience an increase in student motivation, cooperative learning skills, higher-order thinking, and student achievement.

Under Represented Student Participation

NSF Indicators for Current High School Engineering Programs



- Women are currently under represented. PLTW plans expanded curriculum to respond.

Coursetaking rates for engineering and engineering/science technologies differed less by race/ethnicity than they did for other course categories. The introduction of engineering-related courses in secondary schools is fairly recent and they remain uncommon; one national organization that promotes and supports such courses, Project Lead The Way, includes in its goals achieving proportionate racial/ethnic and sex composition of program participants (see sidebar "Project Lead The Way").

+ Race/ethnicity show greater inclusion than traditional math and science programs.

Project Lead the Way Profile

National Science Foundation Science and Engineering Indicators 2008

PLTW claims 2,300 schools and 50 states

Project Lead The Way

Some prominent STEM professionals have expressed concern that, as members of the current engineering and science workforce retire, they will not be replaced in adequate numbers (Business Roundtable 2005; Committee on Prospering in the Global Economy of the 21st Century 2006). In the former report, 15 leading business organizations called for the nation to double the number of STEM graduates by 2015.* These organizations argue that not only has the total number of engineering degrees awarded in the United States decreased in recent years (NSB 2006), but the proportion of doctoral degrees in engineering earned by U.S. citizens or permanent residents has also been dropping.†

Project Lead The Way (PLTW) is a pre-engineering program that aims to attract more students to engineering and train them for college study. It requires students to tackle challenging academic content in middle and high school to prepare for postsecondary study in engineering and related technologies. The program, started in 1997–98 in a few schools, has expanded to more than 1,300 schools in 45 states plus the District of Columbia.

PLTW seeks participation by students of both sexes and all racial/ethnic groups roughly in proportion to their share of the population. Evaluation data show that in 2004–05, Asian/Pacific Islander and white students were overrepresented, and black and Hispanic students underrepresented, when compared with their proportions in the sampled schools. However, compared with the distribution of students completing postsecondary degrees in engineering, each group (particularly Hispanics) had closer to proportional representation in PLTW. Females are seriously underrepresented among PLTW completers, constituting about 15% of the total. Program planners expect that female participation will increase as they introduce four new biomedical science courses in 2008–09. The biomedical courses will address topics in microbiology, physiology, public health, and legal issues.

The curriculums reinforce high-level mathematics and science content aligned with national standards using engineering applications in electronics, robotics, and manufacturing processes. PTLW participants are required to study college-preparatory mathematics every year in grades 9–12. Students work, often in teams and using computers, on challenging problemsolving and analysis tasks. Students can qualify for college credit through performance on course exams, final grades, and project portfolios. The project provides curriculums for five 9-week units for grades 6–8 and eight high school courses. Middle-grade units address topics such as modeling, electrons, automation, robotics, the science of technology, and flight. High school courses offered currently include foundation courses such as Principles of Engineering, Engineering Design, and Digital Electronics; and specialization courses including Civil Engineering and Architecture, Computer Integrated Manufacturing, Aerospace Engineering, and Biotechnical Engineering. A capstone course requires advanced students to develop a solution to a complex engineering problem with guidance from a mentor and to defend their project to external reviewers.

* Organizations contributing to the report (Tapping America's Potential) include the Business Roundtable, the U.S. Chamber of Commerce, the National Association of Manufacturers, and the Council on Competitiveness.

† Although the report presents a dire picture of sharp declines in STEM degrees earned (particularly in engineering), in reality STEM degrees as a percentage of all degrees has fluctuated in a fairly narrow range from 1994 to 2004 at the bachelor's, master's, and doctoral levels, and near the top of the four-decade range for all but master's degrees (NSB 2006). Indeed, doctorates in engineering were 13.7% of all doctorates awarded in 2004, near the high end of their range since 1966.

Motivate Extra Slides

Student Internships

- *What:* Internships in technical fields (CS, MechE, IT, Software Eng, Computer Hardware, Physics, EE, ChemE, Optics & Signaling, BioTech, Civil); mainly corporate, some research
- *Rationale:* Important to motivate students all along the pipeline and close the deal with the best students; students will be well prepared because of work in PLTW & competitions
- *Metrics:* 75% will declare major in same field upon entering college
- *Number of students:* 100
- *Cost:* $220,000 ($7/hr/student) (320 “contact hours”/student)
- *Match:* $100,000 (student stipends paid by companies)
- ***Sustainability:*** Transition companies to cover more costs as they experience successes; costs per student decline the more companies participate

Educator Internships

What: Provide K-12 teachers with first-hand knowledge of the business workplace through summer internships

Rationale: 1) improved curriculum that makes learning relevant to students—math science and technology studies linked to "real world;" 2) teachers are more prepared to excite students about engineering/ technical professions and provide career guidance.

Cost: $25,000 ($2,500/educator; 10 educators per year)

Match: $25,000 (business contribution)

Number of students: Highly leveraged investment—each teacher reaches ~150 students/yr. Multiplier effect year over year (1,500 students in Year 1; 3,000 in Year 2 . . .)

Research: Reporting on teacher internships, Columbia University validates the "significant positive impact on their student's interest and achievement in science"

Engineer Coaches

- *Goal*: Create an OST Engineering program that becomes as successful as the current athletics/sports programs
- *How:* Provide matching "extra duty stipends" to High Schools to hire after school Engineering Coaches to draft and coach FTC engineering teams
- *Rationale:* Develop engineering faculty champions while increasing student contact hours , engineering visibility, and recognition of student engineering achievement
- *Metrics:* 25 (out of 30) High Schools will assume full funding of engineering coaches in year 2011, 70% of students receiving "Engineering Letters" will pursue engineering studies in college
- *Number of students:* 450 (30 schools, 15 students/school, 175 contact hrs/student)
- *Cost:* Stipends $150,000/year ($5K for 30 Schools), Materials: $90,000/year First Tech Challenge Kits for 30 schools
- *Match:* Schools match $150,000 Extra duty stipends (10K stipend for Engineering Coaches at a given school)
- ***Sustainability:*** Schools commit to 75% funding 2nd year and 100% funding following 2 years

Engineer Coach Details

- *Extra Duty Stipend of $6-12K based on Head Football Coach stipend*
- *Leads team OST Practice*
- *Competes in Organized events, such as FTC, MIT InvenTeam, PDX BOT, Electrothon, Robothon*
- *Brings focus and importance to engineering*
- *Feeds College Engineering Programs*
- *Scholarships for outstanding engineering students*
- *One week summer engineering camps to develop skills*
- *Assistant coaches for specialized areas (software engineering, mechanical design)*
- *Develops parent/community support organizations*
- *Coaches can be recruited from outside current faculty pool, as with athletic coaches, teaching accreditation is not required*
- *Students could earn a Letter in engineering*
- *A Middle School coaching program could also be developed on FLL*

First Tech Challenge

- ***Goal*: Duplicate success of FLL at High School level**
- ***How*: Model challenge more on FLL and less on FRC - some early ideas:**
  - **Yearly challenge tied to current world issue to show human value of engineering**
  - **Increase Autonomous competition element, consider eliminating remote control element**
  - **Add Product Marketing/Business Plan component**
  - **Require H.S. team to mentor/coach FLL team**
- ***Staffing*: Use extra duty stipends for faculty coaches**
- ***Metrics*: 30 High Schools and 50 other groups will field FTC teams in year 2010**
- ***Number of students*: From Coaching program 300, Other groups: 500**
- ***Cost*: FTC Materials: $60,000/year - 20 scholarship FTC kits**
- ***Sustainability*: Industry sponsorships , team fund raising, and admission charges to competitive events to offset costs**

Succeed Extra Slides

Oregon's Weakness: Limited Pre-college Opportunities in Engineering

In Out-of-School Time:

Work through OPAS over the past three years has confirmed that a number of proven pre-college engineering programs are offered in the OST arena.

For the most part, the programs are isolated and limited in the numbers of students served annually.

Misc. Unused

ETIC Vision Statement

"Oregon's engineering & technology education and research programs are strategic assets for Oregon's economy and Oregon's residents by providing unique programs of the highest quality that meet the needs of Oregon's industry clusters; attracting resources to Oregon from throughout the world; doubling the number of bachelors, masters, and PhDs receiving a globally competitive engineering education performing innovative research that gives existing and new businesses a competitive advantages in the global economy."

Leverage for Accelerating Undergraduate Degree Growth

- Career choice
- Preparation

- Program Capacity
- ...

- Barriers to Persistence
- ...