OPAS Proposal to ETIC

Achieving a Bright Future in Engineering and Applied Sciences: Oregon's K-12 Opportunity

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What Is Needed?

The technology sector is widely recognized as a critical and growing component of the Oregon economy. Jobs in engineering and applied sciences in the high-tech and other industrial clusters represent some of the most attractive family wage employment opportunities in the state. This segment now employs over 83,000 people with an average wage over $72,000, which is more than twice the average salary for Oregonians working in the private sector[1]. There is considerable potential for growth in this employment sector: engineers and computer specialists comprise 4.2% or the workforce in Washington, and 3.6% in California, but only 2.8% of the workforce in Oregon[2]. From its initiation, ETIC has focused on assisting the Oregon higher education system in expanding its production of technical graduates in order to meet the needs of industry and to ensure that Oregon citizens have the education to benefit from the opportunities provided by this growing sector.

After a decade of investment, bachelor's degrees have grown by approximately 40%, far short of the ETIC's goal of 2X or 100%. Furthermore, key fields such as computer science have declined after reaching a peak in 2004, as shown in Figure 1. This proposal recommends actions that should be taken to increase the number of college-bound students who prepare for, select, and succeed in the demanding degree programs that form the gateway to these economically vital technology jobs and careers.

OPAS recommends a six-year initiative to expand the pool of well-prepared high school students who choose to pursue engineering and applied science majors in college. A high impact, but achievable, goal is to provide enough high school graduates in these fields to allow the OUS to double its growth rate in engineering and applied science degrees compared to the OUS historic growth rate.

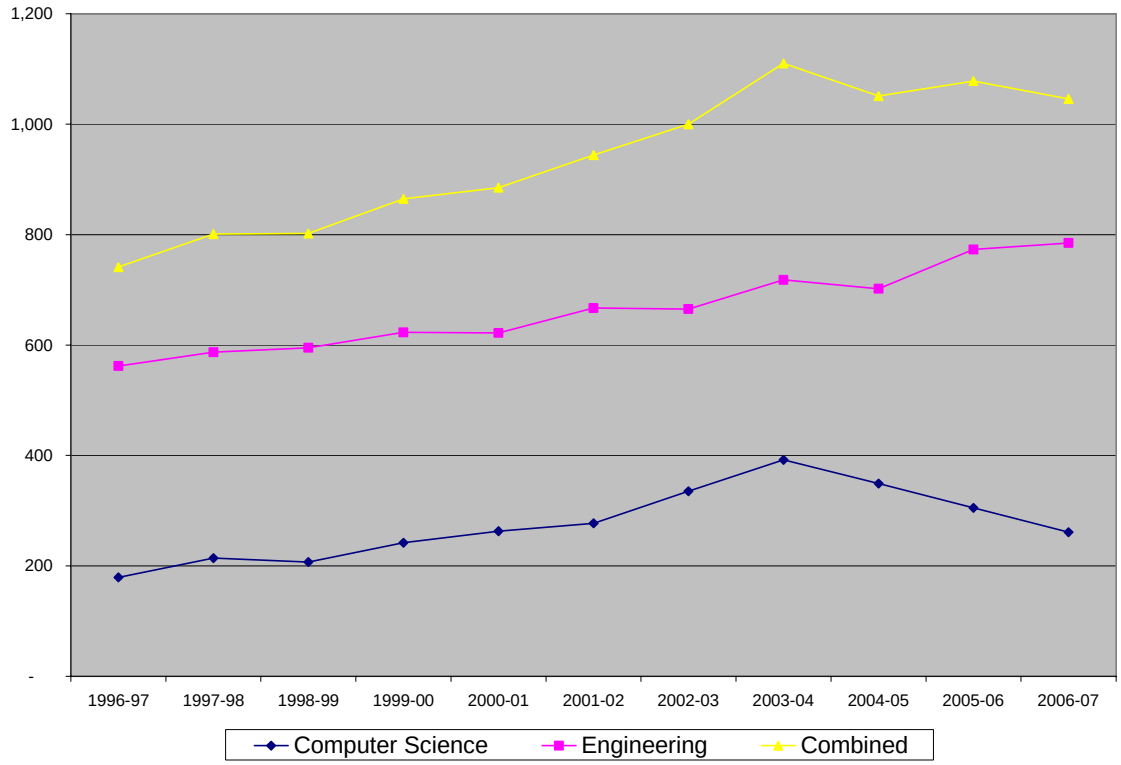

Figure 1: Engineering and computer science bachelor's degrees have grown by 41% from 1997 to 2007. But recently computer science degrees have been dropping, and growth in overall engineering and computer science degrees has stalled.

What Should Be Done?

Pre-college academic preparation has improved during the past decade with increases reported in both SAT scores and in advanced math and science course completion[3.] Oregon has mandated more rigorous math and science for high school graduation[4], requiring three years of science, including laboratory and science inquiry experience and three years of math at or above the Algebra I level for the class of 2014. These changes should further improve college preparation and the potential pool of engineering and applied science students. However, these changes have not translated to a corresponding increase in student interest. Interest in engineering and applied technology degree programs among college-bound high school students has been flat in engineering and has shown a significant decline in computer science[5]. OPAS Committees have repeatedly heard input from high school teachers and administrators that opportunities have been reduced for K-12 students to explore engineering and applied science careers, contributing to a lack of student interest in these fields.

The available data supports this assessment. For example, of the 170,000 Oregon high school students in over 220 high schools, fewer than 5,200 students in only 33 high schools take even a half credit in "Engineering and Technology"courses[6]. Similarly, fewer than 60 Oregon students took AP computer science exams in 2007, about one-third the national average as a percentage of AP tests taken. With regard to gender and ethnicity, it is worth noting that only six of the students taking the AP computer science exams were women and, of the 57 students who reported ethnicity, all but one were white

or Asian[7]. This is consistent with other data indicating low rates of interest and participation in engineering and applied science in high school and college by women and non-Asian minorities.

The opportunity is clear. Women currently attend college at a considerably higher rate than men, are comparably prepared in math and science, but are proportionately far less likely to show interest in choosing these technical fields. Under-represented ethnic minorities are a rapidly growing component of the Oregon population but face multiple well documented challenges (social, academic, financial) in achieving success in technical fields. Many Oregon students attending rural schools face challenges with limited resources and lacking opportunities to learn the personal relevance of these technical fields. Success in addressing these situations and populations will expand the pool of engineering and applied science college students as well as achieve desirable goals for economic inclusion and mobility.

From this and similar data and discussions we have drawn the following conclusions:

- **In-Class Offerings**: Engineering, computer science and applied science courses should be offered much more broadly as a part of state-wide college preparatory programs. In-class programs have a high impact on students since they provide a content rich curriculum, significant contact hours, and teaching by trained educators. Assessments demonstrate the high correlation between students participation in in-class technology programs and subsequent choice of college majors:
  - Oregon students should have increased opportunities to explore engineering and applied sciences careers through classes offered in high school. Proven exemplar programs such as Project Lead the Way and Advanced Placement® (AP) Computer Science exist nationally and in Oregon and can be expanded to many more high schools;
  - These opportunities must be of sufficient academic rigor to be of value to college-bound students (i.e., substantive content and, where applicable, opportunities for International Baccalaureate [IB], AP, or other advanced placement credit or recognition);
  - Scheduling must be coordinated with other classes taken by college-bound students to make these courses realistically accessible and attractive;
  - Special attention must be given to encouraging and supporting successful participation by women and under-represented minorities;
  - Innovation will be required to provide quality pre-engineering and applied sciences programs in rural and Title I schools;
  - Impact and accountability require a systems approach including quality curriculum, teacher development, and objective evaluation.

- **Out of School Time Offerings(**OST): Investment in engineering and applied science OST programs should target in-depth experiences that provide the contact hours, mentoring, and hands-on engagement required to significantly impact student interest, academic engagement and college plans.
  - **Team-based programs for high school students**. This program provides incentives and financial support to increase the number of high schools that successfully adopt one or more high-value engineering and computer science OST

programs. The approach is modeled after high school athletics with the following key elements:

- A Head Engineering Coach is selected by the school's principal and paid by a performance-based extra-duty stipend.
- In this case the "sport" is an engineering challenge organized and hosted by a statewide group typically affiliated with a national organization. Coach workshops, engineering kits, publicity, websites, fee collection, literature, etc. are expected from these organizations.
- Initially three types of challenges are planned:
  - Computer Programming Challenge
  - Design Challenge
  - Robotics Challenge
- Assistant coaches may be recruited for a specific challenge, and challenge "season" typically lasting a school term (10 to 15 weeks).
- Coaches will receive training on both how to effectively develop students' technical skills in an after-school setting, and the specifics of the particular challenge(s)
- Parent booster clubs, adult volunteer mentors, summer camps, coaching councils, and other supporting groups are expected to develop as they do for established athletic programs.
- Active student participants are expected to be awarded an engineering letter, similar to letters awarded for athletic or band participation.

- **Intensive internships for high school students and teachers.** Such programs have proven beneficial for students who have demonstrated high potential and preparation when these internship experiences are at the time they are preparing to make key post-secondary education decisions like choice of college and major. One program of this type, Saturday Academy's Apprenticeships in Science and Engineering, has shown that 70% of participating students choose a college major in the field of their high school apprenticeship. Once funded, apprenticeship programs can be rapidly expanded and quickly impact the college applicant pool. Similarly, teacher internships provide high leverage because every teacher that gains a better understanding of a technical field through an internship can impact hundreds of students by bringing new insights back to the classroom. Investments will be made in programs that
  - have a history of placing students and teachers in engineering internships that offer real-world problem-solving and open-ended learning with intensive interaction with practicing engineers.
  - have a history of outreach to underrepresented groups.
  - have a central organization through which activities can be coordinated, metrics can be collected and reported, and expenditures are well controlled.
  - have existing infrastructures for recruiting and using volunteers, especially mentors.
  - offer internships of sufficient length, focus and type that the intern emerges able to articulate the impact his or her field of engineering has upon society.
  - require culminating events that cause the intern to reflect on and report to others the learning that has occurred.
  - require teacher interns to develop a plan to incorporate the teacher's experiences into the classroom.

- mentors are given training on how to effectively perform their role and are supported throughout the internship.
- have a plan for making the program sustainable over time.

- **Team-based activities for younger students—fourth grade to ninth grades.** Social context is important to students' participation and engagement in engineering and applied science programs. OST programs, such as the Oregon Robotics Tournament and Outreach Program (ORTOP), engage teams of students in demanding and socially relevant technical challenges and bring groups of students together for culminating contests and events. Such programs have proven successful in engaging students in authentic learning experiences that influence academic and career choices. Expanding such opportunities state-wide will require start-up funding and collaborations with schools to provide the necessary access to school facilities and provision of OST engineer coaching staff and engineering challenge kits. Other programs designed to reach under-represented groups include OSU's Science and Math Investigative Learning Experiences (SMILE) and PSU's Mathematics Engineering Science Achievement (MESA). We will make investments in such programs to expand the total group of students prepared for and motivated to choose engineering and applied science degree paths in college.

  Impact and accountability require a systems approach including quality program design, teacher development, and objective evaluation.

- **Communication & Marketing**

  Goal: Increase student participation and degree completion in OUS engineering and related degree programs by expanding capacity of, and awareness of, educational and pre-career opportunities in engineering related fields.

  Audiences: The primary audience will be pre-college students, families, teachers, counselors and community members. Our goal will be to enhance awareness and understanding of the opportunities represented by engineering and applied science. We will also increase the awareness of in-class and out-of-class pre-engineering and applied science opportunities in Oregon. Secondary audiences include (a) OUS campuses, community colleges and K-12 as partners in our efforts. (b) The business community, nonprofit or community organizations as partners and co-sponsors of our efforts.

Top 3 Messages:

1. Many of the fastest growing, highest-paying, and most rewarding Oregon careers require degrees in engineering, computer science, and material science.

2. Technical careers are attractive and possible for students from any background and Oregon colleges and employers encourage all young men and women to explore degrees in these fields

3. Oregon offers

    - strong college engineering and computer science programs that prepare Oregon students for solid careers; and
    - a growing number of pre-college programs, tools, and resources for students to explore and further their interests and prepare for success in college and their career.

Communication Tactics

- Web Presence. Develop an increased and more dynamic web presence for pre-college outreach-related communications using websites and social networking technology, aimed to increase youth awareness and participation in educational and pre-career opportunities in engineering related fields.
- Print material and distribution. Develop and distribute printed marketing materials in companion with the web presence.
- Speakers' Bureau. Create a speakers' bureau and develop and expand speaking opportunities and materials. Increase arenas for adults with engineering/computer science expertise, including industry professionals, alumni, and/or college students, to present to classrooms and other K-12 student venues.
- Advertising Campaign. Create and implement advertising campaign to expand awareness of and participation in engineering and computer science educational paths and careers. Recruit private funds to underwrite this campaign. Engage advertising firm to design and implement campaign that compliments the design and content of web, print, and presentation efforts.
- In all of the above, we will
    - Draw on any relevant market research on intended audience.
    - Emphasize opportunities for women and minorities.
    - Connect to campus outreach and recruitment efforts.
    - Connect to national campaigns, e.g. ASEE, JETS, ACM CSTA, and NAE. Leverage recent increase in television programs that feature engineering, e.g. Myth Busters, Design Squad.
    - Connect to broader outreach programs including enhanced Oregon Opportunity Grant / Shared Responsibility Model outreach, campus "pathways" programs, and scholarship programs offered by colleges of engineering, etc.
    - Connect other elements of OPAS strategy to assure that a broad range of students, teachers, etc. know about pre-college opportunities.

How to Go Forward?

OPAS recommends a multidimensional program containing In Class, Out of School Time, and Communications elements as described in figure 2. This strategy will build on proven community resources by leveraging collaborations and programs which have already proven themselves locally and/or nationally. While drawing on historical successes, it breaks with past approaches by recognizing the **critical importance for college-bound students to have the opportunity for career exploration in engineering and applied sciences.**

A six-year program is proposed to achieve a sustainable transformation in opportunities state-wide. Impact will be visible early in this program since much of the effort will address students who are already in secondary grades. However, key elements, especially those targeting underrepresented students, will also focus on middle school and earlier grades to expand the number and diversity of our future engineering and applied science degree graduates. The initial biennium request is for $4.56 million.

Strategy ▪ Build on proven successes ▪ Address critical pre-college gaps ▪ System-wide expansion of opportunities	4-8	9-12	Teachers
Extend national exemplar pre-engineering program to high schools and middle schools statewide(OIT is current OUS host university for one such program)	x	x	x
Expand access to computer science by building on collaboration created by Oregon Computer Science Teachers Association and the Software Association of Oregon	x	x	x
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 challenge programs which create exciting opportunities for advanced projects, mentoring, and scholarships	x	x	
Create summer internships for teachers and high potential students in industry and universities	x	x	
Focus state-wide communications/marketing to students, parents, teachers and counselors on STEM education and career paths	x	x	x

Figure 2: Summary of OPAS's proposed program to expand the number of Oregon students who prepare for, choose, and succeed in obtaining degrees in engineering and applied sciences.

References

[1]Cyberstates 2007, AeA, p. 85.
[2]NSF Science and Engineering Indicators 2008.
[3]College Board SAT State Reports, 1996-2007.
[4]New Oregon High School Graduation Requirements, ODE, January 22, 2007.
[5]College Board SAT State Reports, 1996-2007.
[6]CTE Enrollment by Program Area, ODE, 2007 Report.
[7]College Board AP State Reports, 2007.

Budget	EBL	POP	Total
In School Pre-engineering and Computer Science			
Pre-engineering: rigorous pre-professional curriculum			
▪ Leadership, administration, marketing and reporting	$ 34,474	$ 85,526	$ 120,000
▪ Pre-engineering high school clusters (25 schools)	$ 179,550	$ 445,450	$ 625,000
▪ Pre-engineering middle school clusters (10 schools)	$ 43,092	$ 106,908	$ 150,000
▪ Highly qualified pre-engineering teacher expansion	$ 57,456	$ 142,544	$ 200,000
▪ Under-represented students initiatives and support	$ 34,474	$ 85,526	$ 120,000
▪ Communication and community engagement	$ 7,182	$ 17,818	$ 25,000
▪ Evaluation	$ 17,237	$ 42,763	$ 60,000
▪ Subtotal	$ 373,465	$ 926,535	$ 1,300,000
Computer Science: capacity and infrastructure expansion			
▪ Leadership, administration, marketing and reporting	$ 14,364	$ 35,636	$ 50,000
▪ Geographic expansion (25 schools)	$ 107,730	$ 267,270	$ 375,000
▪ Regional centers of teaching excellence (4-6)	$ 35,910	$ 89,090	$ 125,000
▪ Under-represented student initiatives and support	$ 11,491	$ 28,509	$ 40,000
▪ Programming contest expansion	$ 5,746	$ 14,254	$ 20,000
▪ Marketing and communications	$ 4,309	$ 10,691	$ 15,000
▪ Evaluation	$ 14,364	$ 35,636	$ 50,000
▪ Subtotal	$ 193,914	$ 481,086	$ 675,000
In School Program Total	$ 567,379	$ 1,407,621	$ 1,975,000
Out of School Time Programs for Project Based Learning			
▪ Programs for grades 4 through 8			
▪ Leadership, administration, and reporting	$ 28,728	$ 71,272	$ 100,000
▪ Investments in programs focusing on engineering & tech	$ 350,482	$ 869,518	$ 1,220,000
▪ Evaluation	$ 22,982	$ 57,018	$ 80,000
▪ Subtotal	$ 402,193	$ 997,807	$ 1,400,000
▪ Programs for grades 9 through 12			
▪ Leadership, administration, marketing and reporting	$ 34,474	$ 85,526	$ 120,000
▪ Stipends to teacher/coaches	$ 71,820	$ 178,180	$ 250,000
▪ Materials and registration for teams	$ 43,092	$ 106,908	$ 150,000
▪ Training of teachers/coaches -- for all pre-engineering co	$ 14,364	$ 35,636	$ 50,000
▪ Grants specific to particular "leagues" for training and rel	$ 28,728	$ 71,272	$ 100,000
▪ Evaluation	$ 11,491	$ 28,509	$ 40,000
▪ Subtotal	$ 203,969	$ 506,031	$ 710,000
▪ Internships			
▪ Leadership, administration, and reporting	$ 2,873	$ 7,127	$ 10,000
▪ nternships for high school students with OUS faculty & i	$ 60,329	$ 149,671	$ 210,000
▪ Internships for teachers with faculty & industry	$ 12,928	$ 32,072	$ 45,000
▪ Evaluation	$ 2,873	$ 7,127	$ 10,000
▪ Subtotal	$ 79,002	$ 195,998	$ 275,000
Out-of-School-Time Program Total	$ 685,164	$ 1,699,836	$ 2,385,000
Communications and Marketing: Students, Parents, Teachers, Counselors			
▪ Leadership, administration, and reporting	$ 5,746	$ 14,254	$ 20,000
▪ Web presence	$ 12,928	$ 32,072	$ 45,000
▪ Print materials & distribution	$ 15,800	$ 39,200	$ 55,000
▪ Speakers Bureau	$ 14,364	$ 35,636	$ 50,000
▪ Other	$ 8,618	$ 21,382	$ 30,000
Communication & Marketing Program Total	$ 57,456	$ 142,544	$ 200,000
Planning & Oversight	$ 28,728	$ 71,272	$ 100,000
Total	$ 1,310,000	$ 3,250,000	$ 4,560,000

Forecast of Student Participation (EBL only)

	Projected			
	AY10	**AY11**	**AY13**	**AY15**
Number of students				
Pre-high school Outside School Time	715	1,072	1,429	1,786
High School Outside of School Time	108	162	310	455
High School In Class	919	2,758	6,436	9,194
High School Internships	29	29	36	43
Total	1,770	4,020	8,210	11,478
Student contact hours				
Pre-high school Outside School Time	40,665	60,998	81,330	101,663
High School Outside of School Time	8,977	13,466	25,810	37,873
High School In Class	55,163	165,488	386,138	551,625
High School Internships	9,194	9,194	11,492	13,791
Total	113,999	249,145	504,770	704,952
Average contact hours per student				
Pre-high school Outside School Time	57	57	57	57
High School Outside of School Time	83	83	83	83
High School In Class	60	60	60	60
High School Internships	320	320	320	320
Total	64	62	61	61

Forecast of Student Participation (EBL + POP)

	Projected			
	AY10	**AY11**	**AY13**	**AY15**
Number of students				
Pre-high school Outside School Time	2,487	3,731	4,974	6,217
High School Outside of School Time	375	563	1,078	1,582
High School In Class	3,200	9,600	22,400	32,000
High School Internships	100	100	125	150
Total	6,162	13,994	28,577	39,949
Student contact hours				
Pre-high school Outside School Time	141,540	212,310	283,080	353,850
High School Outside of School Time	31,247	46,870	89,835	131,823
High School In Class	192,000	576,000	1,344,000	1,920,000
High School Internships	32,000	32,000	40,000	48,000
Total	396,787	867,180	1,756,915	2,453,673
Average contact hours per student				
Pre-high school Outside School Time	57	57	57	57
High School Outside of School Time	83	83	83	83
High School In Class	60	60	60	60
High School Internships	320	320	320	320
Total	64	62	61	61