

**Engineering and Technology Industry Council
Campus Investment Proposal
Biennium from July 1, 2007 to June 30, 2009**

Campus: Oregon State University

Contact Name: Ron Adams, Dean

Date of Revised Submission: July 20, 2007

Summary of Proposal:

Education is a leading indicator of future innovation competitiveness and America is lagging the rest of the world from grade school to graduate school. Oregon does a good job delivering engineering baccalaureates and science doctoral graduates and research but we deliver half the national average in two key innovation drivers: engineering PhDs and engineering research. OSU's College of Engineering has demonstrated that with additional investment it can bridge this gap by delivering graduates and research impacts at the level of the nation's best engineering schools. And this investment will both make Oregon more competitive and ensure future prosperity through innovation.

Vision Statement

To best serve the people of Oregon, Oregon State University (OSU) has embarked on a journey to transform its College of Engineering from a great program into one of the nation's top schools. A top engineering college located in Oregon will help the state, the Pacific Northwest, and the nation remain globally competitive by delivering top engineering talent, from BS through PhD, and by spinning out new ideas from internationally competitive research programs.

Aspirational Peers

In chronological order, the College of Engineering expects to achieve metrics similar to those found at:

- 2010 Rensselaer Polytechnic Institute – RPI conducts approximately \$39 million in research annually; graduates 78 Ph.D. and 585 baccalaureates.
- 2015 University of California - Davis – UC-Davis conducts about \$60 million in research, graduates 72 Ph.D. and 600 baccalaureates.
- 2020 Cornell University – the average of the top-25 engineering schools in the United States annually awards approximately 120 PhD and 600 baccalaureates degrees, does \$120 million in research, receives 10 patents and spin outs between 5 and 10 companies.

Long-term Goals

The OSU College of Engineering will be a catalyst for Oregon prosperity through innovation. It will deliver the engineering talent and new ideas needed to spawn innovation allowing existing

companies to grow and new companies to form. New ideas will come from world-class faculty engaged in research with the best Ph.D. students, research that links every sector of the economy to innovation. The resulting companies will provide family wage jobs for Oregonians and lead to prosperity.

The benefits of an investment in the College of Engineering will extend beyond what is traditionally viewed as the high tech sector to medicine, agriculture, and forest products. By extending the reach of innovation to many sectors, Oregon's competitiveness will be broad as well as deep, further strengthening our role in the global economy.

OSU will continue to educate the best of Oregon's high school graduates, preparing them to contribute to Oregon's economy whether they graduate with a baccalaureate or doctoral degree. Our faculty will attract some of the best international students and whether they leave the College of Engineering with a BS or PhD, all our students will understand the power of combining invention and entrepreneurship.

The OSU College of Engineering will measure itself against the best engineering schools in the nation and the world. Building on the solid base of the 22nd largest undergraduate program with a reputation for developing the best work ready engineers, we will focus our attention on two key measures of innovation capacity and therefore have even greater impact on the prosperity of Oregon; engineering PhDs graduated and total dollars of competitive research per year. The College of Engineering will have 1,100 graduate students and graduate 350 M.S. and 120 Ph.D. students in 2020. Two hundred twenty faculty will conduct interdisciplinary, industry-connected research totaling \$120 million per year. When we achieve these metrics, we will measure up to nation's top-25 engineering schools.

As a further measure of our success in serving the State, the top high school graduates in Oregon and around the nation will see our College as one of their top choices of places that develop work ready engineering talent. We will graduate 650 baccalaureate students in 2020.

The OSU College of Engineering has demonstrated that we can be among the nation's best. We have reached this position through the creation of a culture of collaboration and accountability and through the passion to both create opportunity for young people all across Oregon and to translate research results into real impact on innovation right here in Oregon. And that culture and passion show in the impressive results of recent investments. From 1999-2005, investments of \$40 million in state funds from Oregon's Engineering and Technology Industry Council (ETIC), leveraged \$80 million in private contributions, and produced the following dividends for Oregon:

- *Constructed the new 153,000-square-foot Kelley Engineering Center.* Built as a home for innovation, this facility is one of the best engineering buildings in the country.
- *Recruited and retained professors who out produce their peers across the nation by 30 – 40 percent.* OSU's leadership in key research clusters attracts top young faculty from the best programs.
- *Doubled engineering research funding to \$24 million.* OSU is nationally competitive in multiple areas including the research clusters listed below.

- *Spun out 8 research ideas that are either new companies or under consideration for new companies or products.* Musicstrands is up and running and discussions or R&D partnerships are underway in seven additional areas.
- *Grew into the 22nd largest undergraduate program in the U.S. with 3,100 students.* Along the way, OSU nearly doubled the number of new freshmen capable of entering any engineering school in the US.
- *Increased PhD enrollment by more than 40 percent to 220 students.* This increase in PhD enrollment is the direct result of the high caliber faculty.
- *Created internationally renowned educational innovations like TekBots[®] and expanded internships, including MECOP.* TekBots has been adopted by top US engineering programs as well as a Japanese engineering program.
- *Co-founded the Oregon Nanoscience and Microtechnologies Institute (ONAMI) with UO, PSU, and PNNL.* OSU's partnership with PNNL in the Microproducts Breakthrough Institute is a key component of this powerful collaboration.

Investment Description

Goal

OSU will ensure Oregon's competitiveness in the global economy by delivering the impact of the nation's top 25 engineering schools. Specifically, OSU will deliver to Oregon industry the nation's best work ready graduates and in engage collaborative research that spins out market competitive technologies as indicated by the following metrics in 2020:

- Work ready graduates
 - Grow BS degrees from 540/yr to 650/yr
 - Grow MS degrees from 180/yr to 350/yr
 - Grow PhD degrees from 24/yr to 120/yr
- Collaborative research
 - Grow research funding from \$24M/yr to \$120M/yr
 - Increase spin outs (through R&D partnerships, potential technology license agreements, and new company formation) from 5/yr to 20/yr

Strategy

Work Ready Graduates:

To ensure that its engineering graduates are globally competitive, OSU will continue to innovate educational programs across all disciplines. Examples of innovations currently in progress include:

- New programs to attract young Oregonians to computer science and engineering: e.g. to address the nationally occurring trend toward major reduction in Computer Science enrollments OSU established a major outreach effort to kids in K-12 to generate interest in Computer Science.
- International global design projects utilizing virtual global teams. Initial discussions are underway with BerufsAkademie Ravensburg in Germany and Beihang University in China.
- Platform for Learning (R) for Computer Science students that follow the model of Tekbots(R). Seed funding has been provided by Google as part of the Open Source collaboration.

- International internships: discussions are underway with Freightliner/Daimler-Chrysler and Boeing China.

Collaborative Research:

OSU's engineering research program is organized by collaborative research clusters. These collaborations engage OSU engineering faculty with faculty in other disciplines, other universities including those within Oregon and across the US and world, and with industry partners. Our long-term plan calls for doubling the number of faculty over the next three biennia. Our research clusters, their current competitive positions, and goals and strategy for impact in 2020 are summarized below.

Energy Systems Research Cluster

The goal of this research cluster is to develop innovative, alternative energy systems capable of providing electric power or transportation fuels using centralized or distributed energy sources, while creating new industries and family-wage jobs in the State of Oregon. Currently OSU researchers are leading the nation in developing the technology that will harness ocean wave energy and creating passively safe nuclear power. In collaboration with other research clusters, advanced bio-diesel fuels and bacteria generated hydrogen are actively being explored for use as transportation fuels. Having generated over \$20M in energy related research over the past 10 years, OSU is Oregon's only institution developing, constructing and testing energy systems currently being considered by US utilities for near-term deployment. The new investment will add 10 top energy researchers to the cluster to advance progress on existing concepts and to develop new energy systems. It will provide for the renovation of valuable laboratory space for collaborative research supporting 110 graduate students and providing expanded research of \$10M/year.

ONAMI

The Oregon Nanoscience and Microtechnology Institute is one of the signature research clusters for Oregon and involves key collaborations between OSU, U of O, PSU, Pacific Northwest National Labs, HP, Intel, Xerox as well as numerous small companies. Oregon has been recognized nationally as being a leader in micro and nanotechnology, and ONAMI is focused on commercializing key basic research advances into products that bring economic vitality to Oregon as well as national visibility for research excellence. Initial research breakthroughs through ONAMI efforts include micro-scale bio-diesel reactors and portable kidney-dialysis units. ONAMI conducts \$4M/year in research at OSU and involves more than 40 graduate students. In order to leverage the growth potential in ONAMI, OSU proposes to increase the number of faculty by 17, the number of graduate students to 130 and grow research to \$15M per year.

Biological and Environmental Systems Cluster

Biological and environmental engineering is focused upon a variety of biotechnology and environmental systems; about \$1.7M/yr of research is done in areas related to bioprocessing, biomaterials and environmental remediation. This funding comes from a variety of federal agencies including EPA, NIH, NIEH, NSF, DOE, DoD and Pacific Northwest National Lab. The cluster faculty collaborate with a variety of companies such as Bend Research, AVI, SIGA, Amgen, and Hemcon and state agencies such as ODEQ, ODOT, and ODWR. The Cluster has

about 20 graduate students in chemical engineering, environmental engineering, and bioengineering. The investments in 13 additional faculty will expand capacity to allow nationally and internationally competitiveness and will increase the national stature of the program (the Environmental Engineering program is currently ranked 34th in the US). The proposed investment would result in: an increase in graduate student enrollments to 110 coupled with an increase in research activity to a level of \$8M annually; an expanded capacity to provide research to serve Oregon's environmental services industry and its growing biotechnology industrial sector; creation of a graduate educational and research program in air pollution control to serve the environmental service industry, several state agencies, and a variety of companies; expansion of research on water reuse and treatment to support industrial and municipal growth in the state.

Kiewit Center for Transportation and Infrastructure

Infrastructure engineering creates and maintains the "built environment," which includes industrial sectors of construction, engineering services, and the public works portion of local, state, and federal agencies. Building and maintaining Oregon's infrastructure is nearly 10% of the state's economy. OSU's Kiewit Center for Transportation and Infrastructure conducts about \$5.4 M/year in research in collaboration with agencies, companies, and universities such as ODOT, AGC, Hoffman Construction, CH2M-Hill, David Evans and Associates, PSU, and UO to provide new technologies for cost effective applications. The Center has about 80 graduate students in structural, geotechnical, construction, water resources, and transportation engineering. The investments in 23 additional faculty will expand the program to 200 graduate students and \$30M/year in research expenditures. The impact of this investment will be to expand capacity making Oregon's companies more nationally and internationally competitive and ensuring the quality of the state's infrastructure. The strategy will build on our current successes in developing nationally recognized research programs such as the Highway Bridge Testing and Evaluation Program (ODOT funding), the National Center for Accessible Transportation (Dept. of Education funding), NEES Tsunami Research Center (NSF funding), and the Groundwater Remediation Program (DOE funding).

Mixed-Signal Integrated Systems

RF/analog circuitry called *mixed-signal integrated systems* provides the interface between "real world signals" such as voice or temperature measurements and transforms them into digital information for processing. Oregon's leading mixed-signal concentration includes efforts at Intel, Tektronix, Maxim, Mentor Graphics, Planar, Pixelworks, Triquint, and many others.

OSU's mixed-signal group research expenditures over the last four year was \$10M through strong industry collaborations and currently the faculty advise more than 50 graduate students. In order for Oregon and the nation to remain globally competitive in mixed-signal technologies, and area China has recently targeted as one of its top 15 engineering thrusts, OSU proposes to double the faculty to 10, increase the number of graduate students to 130. Two recent million dollar sensor networks and animal tracking research programs have developed collaborations with Forestry and Agriculture that will be a catapult to developing an engineering research center on environmental sensing and monitoring. Through this effort will grow the research to \$8M/year, enhance collaborations with PSU and OHSU and increase the impact on regional and national industry.

Intelligent Information Systems

This research cluster consists of the Northwest Alliance of Computational Science and Engineering (NACSE) led by Cherri Pancake, the Artificial Intelligence/Machine Learning research group led by Tom Dietterich and the End User Software Research group led by Margaret Burnett. NACSE recently collaborated with Civil Engineering to create full internet control of the world's largest wave basin housed at Oregon State University. With this remote control capability, researchers from all over the world can use this facility to study tsunamis. With recent new faculty hires from Purdue and Carnegie Mellon in the AI/Machine Learning group, this group has emerged as one of the top 10 in the nation. The End User Software research thrust is a collaborative effort with several universities including Carnegie Mellon, Penn State, Drexel and others that started with a multi-million dollar grant from NSF. By adding 14 faculty to this cluster, research expenditures will increase to \$13M/year and graduate students will increase from 50 to 120.

Graphics and Visualization for Display Systems

Oregon has a well recognized industry cluster in the display technologies and Oregon State University faculty have partnered with this consortium of companies. Four faculty in the computer graphics and visualization hired in the last four years have initiated an NSF collaborative industry/university research center to further build these relationships. Several other universities including UC Davis will be part of this consortium. The research cluster includes 20 graduate students. The research cluster will add 4 faculty increasing the number of graduate students to 60 and research expenditures of \$2M/year.

Autonomous Systems

Autonomous Systems represents a new research cluster at OSU that is focused on how to automate systems--from vehicles to networked sensors--for applications ranging from homeland defense to monitoring of infrastructure. Autonomous air vehicles can be used for monitoring our coast for tsunamis, as well as for search and rescue as was done after Hurricane Katrina. Autonomous monitoring of bridges through acoustic sensing can distinguish damage requiring rebuilding as opposed to aging bridges that are still safe. Oregon is home to several companies that provide key sensing and control capabilities for autonomous systems such as CloudCap, Hood Technologies and Garmin. The Insitu Group is a key Oregon employer with Oregonians in the Hood River community employed in its autonomous vehicle R&D facility. OSU proposes to increase the number of faculty in this strategic area by 9 and the number of graduate students to 100. Research expenditures across the college approach \$1.5M in this area and can grow to \$8M with this addition of faculty.

The impacts of doubling OSU engineering faculty over the next three biennia are captured in the table below. By 2020 our strategies for growth in and impact of collaborative research clusters will allow us to achieve metrics similar to those of the top engineering schools in the nation.

OSU Research Cluster	Hires	Oregon Industry Collaborations	Measurable Results			
			Research \$M/year		Enrolled Graduate Students	
			Current	2020	Current	2020
Energy Systems Establish Energy Independence	10	PGE, Oregon DOE, EPRI, Westinghouse, BPA	2	10	25	110
ONAMI Ensuring Oregon's Leadership in the Small Technology Industry	17	HP, Intel, Xerox, Ultman-Browning, LSI Logic	4	15	40	130
Biological & Environmental Ensuring a clean, health environment	13	Bend Research, AVI, SIGA, Amgen, ODEQ, ODOT, ODWR	1.7	8	20	110
Infrastructure & Transportation Ensuring a viable infrastructure to support economy growth	23	ODOT, AGC, Hoffman Construction, CH2M-Hill, David Evans & Associates	5.4	30	80	200
Mixed Signal - Integrated Systems Securing Oregon's leadership in the face of world competition	5	Intel, Tektronix, Maxim, Mentor Graphics, Texas Instruments, Pixelworks, Triquint, Marvell	2.5	8	50	130
Intelligent Information Systems Creating Innovative Solutions	14	Intel, IBM, Microsoft, HP	3.5	13	50	120
Computer Graphics and Visualization Helping Innovate Display Systems	4	Summit, Planar, Pixelworks, In Focus	0.5	2	20	60
Autonomous Systems Creating mobile observational systems	9	Garmin, Hood Technologies, Cloudcap, ODOT, Mentor Graphics	1.5	8	40	100
Emerging Areas including Open Source (collaborative with PSU & UO)	19		2.9	26	195	140
Totals	114		24	120	520	1100

Organizational structure:

To fully unlock its collaborative capacity, OSU is organizing its degree programs and faculty around five schools. One of those schools, Electrical Engineering and Computer Science is already formed and the others are in process. This organizational change will enhance OSU’s ability to assimilate new faculty and achieve the desired growth impacts. The table below summarizes this new structure:

School	Degree Programs
Chemical Biological and Environmental Engineering	Chemical Engineering Bioengineering Environmental Engineering
Civil and Construction Engineering	Civil Engineering Construction Engineering Management
Electrical Engineering and Computer Science	Electrical and Computer Engineering Computer Science
Mechanical Industrial and Manufacturing Engineering Systems	Mechanical Engineering Materials Science Industrial Engineering Manufacturing Engineering
Nuclear Science and Engineering	Nuclear Engineering Radiation Health Physics Medical Physics (new collaboration with OHSU)

The combination of schools and clusters creates a community to assimilate the added faculty and staff. The table below shows how the schools and research clusters are linked to create this network.

Schools	Collaborative Research Clusters								
	Energy Systems	ONAMI	Bio & Environmental Systems	Infrastructure/ Transportation	Mixed Signal Integration Systems	Intelligent Information Systems	End User SW/Computer Graphics & Visualization	Autonomous Systems	Emerging
Chem-Bio-Environmental									
Civil-Construction									
Electrical and Computer Science									
Mechanical Industrial and Manufacturing									
Nuclear Science and Engineering									

The Investment Components

Existing Program:

With the **\$9.2M** investment in the last biennium, the OSU College of Engineering saw excellent production of work ready engineers with good, high impact graduate experience. Breakthroughs described above were the results of this investment. However, since OSU engineering faculty are individually out producing their peers across the nation by 30-40 percent, substantial gains in total impact as summarized under **Goals** are out of reach without additional investment.

2007-2009 Biennium:

The general fund investment of **\$19.5M** and Certificates of Participation of **\$9.46M** will permit execution of the first phase of our strategy and hence deliver the goals described above. The former is focused on people and the latter on infrastructure to support those people. We will hire approximately 16 faculty over the FY07-09 biennium in the College and with intent to promote collaboration with the Colleges of Agriculture and Forestry. We will also seek faculty hires that enhance collaboration with OHSU, UO, and PSU. These new faculty, will be supported by additional administrative staff positions and start up funding.

These new hires will require an investment of \$2.4 million in start up commitments. In addition, existing faculty will be supported through a significant investment in laboratory and equipment infrastructure to assist their continued success. Equipment investments totaling about \$4.0 million are planned. Laboratory upgrades and construction of new facilities will be completed.

Looking to the future, this investment will need to be replaced with a source of recurring public funds. The following is a summary of the operating investment needed during startup as OSU adds faculty over the next three biennia and reaches steady state under this proposal. These estimates include inflation:

- FY 2007-FY 2009: \$28.5 million
- FY 2009-FY 2011: \$44.0 million
- FY 2011-FY 2013: \$65.0 million

Total Private Investment:

OSU will raise a private investment of **\$27.2M** or a one-to-one match of the combined public investment during AY2007 through AY2009. This fund raising will be accomplished through the momentum created by OSU's drive to build a top 25 engineering college and the impetus of the campus wide capital campaign. Fund raising during the current biennium is expected to exceed \$25M in private gifts to the college, a substantial increase over the past biennium. This private support will be a key enabler in our ability to support top students, recruit and retain top faculty and provide the infrastructure for growth.

Results and Benefits

2007-2009 Biennium:

The addition of 16 faculty, 8 each year, \$27.2 million in new private investment, and upgrades of laboratory facilities and equipment will:

- Deliver 550 work ready BS level engineers per year.
- Increase PhD enrollment by 28%
- Grow research expenditures to \$33 million per year.
- Result in a three-fold increase in invention disclosures and spin out up to six new companies. In addition, research results are expected to ultimately result in at least two new product lines for existing companies.
 - Currently, 8 ideas are under consideration for transfer to existing companies or license to new companies yet to be formed.
 - Example: Two year old MusicStrands has grown to 54 employees with significant growth projected this year.
 - Example: Smart Desktop will license their Task Tracer technology. It will be one the first licenses where OSU will hold equity.
 - Example: A new company is currently being formed called Oregon Software Solutions based a license of an algorithm that tracks spread sheet errors. Oregon State will have an equity share in this company.

Long Term Benefits and Return on Investment:

Oregon will benefit from impacts of a top 25 engineering college including:

- Delivery of talent ready to contribute to Oregon's innovation economy at the highest level
- Delivery of new ideas from internationally competitive research programs that will spawn new products, new companies, and new industries
- Presence of a world class partner for collaboration with Oregon's industry
- A magnet for top talent at all levels, from new high school graduates to PhD students to professors and the leadership of innovative companies looking at Oregon as a location for their operations.

Proposed Investment and Private Support Forecast (\$M)

2007-2009 Biennium	OSU POP	OSU EBL	OSU Total
Proposed Investment (\$M)			
State Investment (\$M)	11.48	8.00	19.48
Certificates of Participation (\$M)	9.46		9.46
Expected private support (\$M) (3)	19.22	8.00	27.22
Total (\$M)	40.16	16.00	56.16
Personnel supported (FTE) (4)			
Existing faculty (1)	5.00	33.00	38.00
New faculty (5)	12.00	0.00	12.00
Existing graduate assistants (5)	0.00	8.00	8.00
New graduate assistants (5, 6)	15.00	0.00	15.00
Existing staff (1)	0.00	9.00	9.00
New staff (5, 7)	4.00	0.00	4.00
Total	36.00	50.00	86.00
Uses of proposed investment (\$M)			
New facilities, professorships, fellowships	19.22	6.87	26.09
Improvements to facilities	5.46		5.46
Laboratory equipment	2.00		2.00
Other equipment	2.00		2.00
Other one-time expense	2.40		2.40
Existing faculty salaries & benefits (1)	1.00	6.84	7.84
New faculty salaries & benefits (5)	3.09		3.09
Existing graduate assistants (1)		0.49	0.49
New graduate assistants (5)	1.17		1.17
Existing staff salaries & benefits (1)		1.80	1.80
New staff salaries & benefits (5)	0.72		0.72
Services & supplies	1.38		1.38
Debt Service	1.72		1.72
Total	40.16	16.00	56.16

Notes

- (1) Hired through June 2007.
- (2) Continuing expenses associated with ETIC investments made or faculty hired through June 2007.
- (3) Consistent with ETIC Private Support Policy dated 1-23-02.
- (4) FTE expressed as percent of full time over 2 years of biennium.
- (5) To be hired with ETIC funds during 2007-2009 biennium.

Metrics forecast (for programs/departments receiving ETIC funding):

	Baseline	Projected (2)			
	AY 99 (1)	AY09	AY11	AY13	AY20
Undergraduate student credit hours	52,690	61,600	62,700	63,800	73,000
Graduate student credit hours	12,870	19,200	20,000	20,800	37,000
Bachelor's degrees granted	390	560	570	580	650
Master's degrees granted	123	150	175	200	350
PhD degrees granted	27	40	45	55	120
Externally-funded research expenditures, \$M (3)	12	33	42	48	120
Invention disclosures (4)	22	45	55	75	200
License/options (5)	0	2	2	3	10
License income received, thousands (6)	16	35	50	75	1000
Startup Companies (7)	0	2-4	2-4	2-4	5-10
National ranking of programs (8)					
Civil Engineering	35-45	35	35	35	30
Electrical Engineering	65-75	60	60	60	20
Mechanical Engineering	45-55	50	50	50	40
Nuclear Engineering	15-20	8	7	7	5
Ranking of College of Engineering (8)	83	80	70	60	13
Notes					
(1) Actuals from 12 months ending June 30, 1999.					
(2) Forecast for the 12-month periods shown.					
(3) Total external dollars spent by ETIC-related departments towards research during academic year.					
(4) AUTM definition					
(5) Number of license or option agreements executed during the year. AUTM definitions.					
(6) Calendar year totals					
(7) New companies that were dependent on the licensing of your program's technology for their					
(8) Rankings equivalent to US News & World Report rankings based on two measures most impactful to the Oregon economy; PhD graduated and Research dollars					