

ABET
Self-Study Report
for the
Industrial Engineering Program
at
the University of Washington
Seattle, WA

June 2013

CONFIDENTIAL

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BACKGROUND INFORMATION

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B. Program History

History

The Bachelor of Science in Industrial Engineering (B.S.I.E.) received accreditation from ABET in 1986 while IE was a concentration in Mechanical Engineering. The Dean of Engineering granted Industrial Engineering “academic program” status in 1987 which established IE as a stand-alone unit in the College. The last ABET review was conducted in June 2007. There have been a number of positive changes since that time.

Program Changes

Department Status

On March 2, 2009, the UW Department of Industrial and Systems Engineering (ISE) was established by the Board of Regents.

Faculty Hires/Changes

Linda Ng Boyle joined the Department as an Associate Professor in the Fall 2009. This was an opportunistic joint hire with Civil and Environmental Engineering (she is 25% FTE in CEE). Prior to this appointment, she was an associate professor of Industrial Engineering at the University of Iowa and a senior researcher at the U.S. Department of Transportation - Volpe Center. Dr. Boyle's research centers on driving behavior, crash countermeasures, crash and safety analysis, and statistical modeling.

Associate Professor Christina Mastrangelo's position was increased to 75% in September 2008 and to 100% time in September 2010.

Assistant Professor Archis Ghate was promoted to Associate Professor with tenure in September 2012. He received the coveted NSF Career Award in 2011.

Art Chaovalitwongse, an Associate Professor of Industrial Engineering at Rutgers, was hired in September 2011 to fill a new position in Health Systems Engineering and has a joint appointment with the Department of Radiology (15%) at the UW Medical Center. His research focuses on optimization, machine learning and statistical learning techniques with application in neuroimaging/neurophysiology, computational biology, and logistics optimization. He is director of the “C14 Lab” under the Integrated Brain Imaging Center (IBIC) in the Department of Radiology.

Shan Liu was recruited to join ISE during the search for a newly created health systems engineering position. She is completing her PhD in Management Science & Engineering at Stanford University and will join ISE in September 2013. Her research areas are effectiveness of medical technologies and health interventions utilizing cost effectiveness analysis, dynamic systems modeling and optimization. She is an exceptionally talented young teacher and researcher who has already conducted highly impactful applied research focusing on optimizing screening for, monitoring, and treatment of chronic hepatitis C infection, a condition affecting more than 3 million in United States.

During the 2007 ABET review ISE’s faculty FTE was 6.5 tenure track faculty. With the hire of Shan Liu, ISE’s faculty FTE in September 2013 will be 9.1, an increase of 2.6.

Two faculty retirements will occur at the end of the 2013-2014 school year. Professor and Chair Richard Storch and Professor Kal Kapur will retire. Faculty searches are currently under way to fill both positions. The Chair position will likely be filled by an internal search among the senior faculty.

Dr. Joe Heim was hired as a research engineer in 2011 with a focus on health systems engineering working with UW Laboratory Medicine and Children’s Hospital. He has also served as an instructor for various courses including IND E 337 and IND E 424.

Research

The current research portfolio is about \$4.2 million funded by NSF, Microsoft, Toyota, Children’s Hospital, NHTSA and the Office of Naval Research just to name a few. ISE faculty have collaborative projects with the UW departments of Aeronautics & Astronautics, Civil & Environmental Engineering, Electrical Engineering, Radiology, Global Health, Environmental Health, the Business School, and Laboratory Medicine, as well as, Children’s Hospital, Harborview Medical Center, and Group Health. Research collaborations with other universities include Arizona State, Penn State, San Diego State, Drexel, Virginia Tech, University of Michigan, and Simon Fraser. Company collaborations include Boeing, Microsoft, and Toyota.

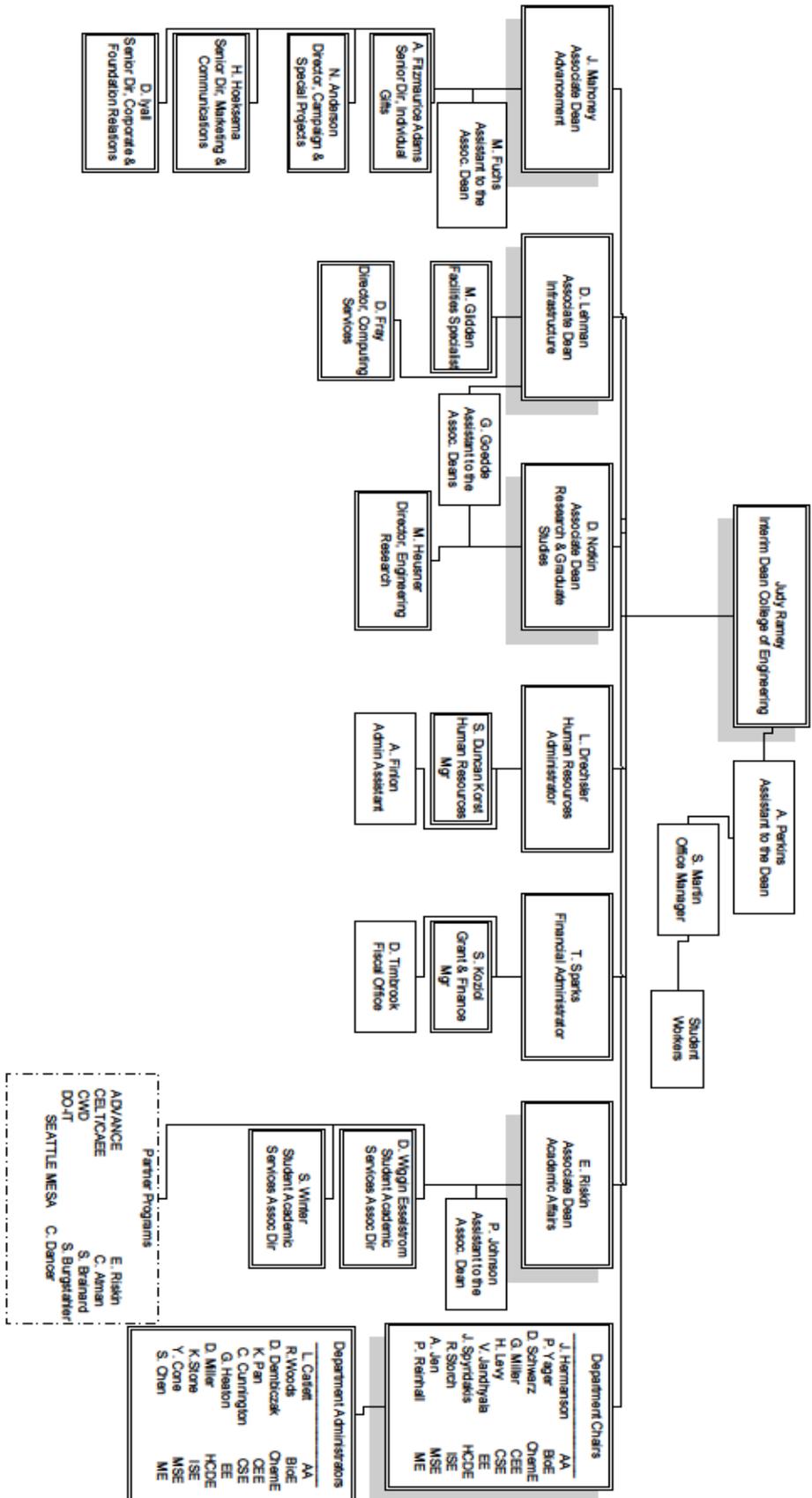
Professional Master's Degree

ISE has just received approval from the Board of Regents to offer a new Professional Master's Program for working professionals who want to pursue additional educational opportunities and learning. The Master of Industrial & Systems Engineering is for engineers, scientists, and mathematicians who already have professional jobs and who want to pursue a master's program without leaving their employment. The knowledge gained from this degree will enhance a student's technical skill set so they can work seamlessly across disciplines in their organization. Certificate programs in Global Integrated Systems Engineering and Engineering Leadership were established in 2008-2009 and have been quite successful. A certificate in Health Systems Engineering is in development.

C. Options

None.

D. Organizational Structure



E. Program Delivery Modes

Undergraduate courses are traditional on-campus lectures offered during the day.

F. Program Locations

University of Washington, Seattle campus.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

There were no shortcomings remaining in the program after the 2009 interim review.

CRITERION 1. STUDENTS

A. Student Admissions

Students must apply for admission to the Industrial Engineering (IE) program. The process is competitive and completion of the requirements does not guarantee admission. All students who meet the minimum admission requirements will be considered for admission.

Completion of the following prerequisite courses, or equivalent, with a GPA of 2.5 or higher is required. Typically the GPAs for those being offered admission are much higher than the minimum listed.

MATH 124 Calculus with Analytic Geometry I (5 credits)
MATH 125 Calculus with Analytic Geometry II (5 credits)
MATH 126 Calculus with Analytic Geometry III (5 credits)
CHEM 142 General Chemistry (5 credits)
CHEM 152 General Chemistry (5 credits)
PHYS 121 Mechanics (5 credits)
PHYS 122 Electromagnetism (5 credits)
PHYS 123 Waves (5 credits)
ENGL English Composition

There are three ways to be admitted to the IE program:

- **Upper Division Admission** - typically at the end of the sophomore year after completion of all the prerequisite courses listed above.
- **Early Admission** - for freshman completing their first year in college plus specific prerequisites (Math 124, 125, 126; English Composition; and 10 credits of the physical science prerequisites). Available Autumn Quarter only, for currently enrolled UW students who have completed at least 15 credits at UW.
- **Freshman Admission** - designed specifically for students applying to the UW as freshman. Students who indicate Industrial & Systems Engineering as their intended area of study on their UW application are considered for direct admission by the IE undergraduate admissions committee. Admission to the program at this early stage is extremely competitive.

IE has two admission cycles – Autumn Quarter and Spring Quarter. Currently enrolled UW students and transfer students can apply to the department once the College of Engineering application opens for the admission process, which is typically two weeks before the application deadlines of July 1 (for Autumn Quarter admission) and February 1 (for Spring Quarter admission).

B. Evaluating Student Performance

During a student's program of study, the staff advisor monitors each student's progress, including verifying that they satisfy the program's Undergraduate Continuation Policy (see attachment at the end of Criterion 1). This is done on a regular schedule at the end of each quarter when a student's most recent grades are available for review. Students are given copies of the continuation policy at orientation, and it is also available for reference via the Industrial Engineering web-page at

http://depts.washington.edu/ie/sites/default/files/file/Continuation_Policy--revised.pdf

and in hard copy at the advisor's office. The continuation policy sets a minimum requirement of 12 credits earned toward the degree per quarter, and satisfactory performance in grades, defined as maintaining a minimum quarterly grade point average of 2.0 in all departmental and professional program courses. Additionally, any individual grade in these courses must be 2.0 or higher, or the student can be placed on academic probation. Students may also independently access their degree audit at any time via the University's MyUW system. This system pulls the most recent data from the Registrar's office and organizes it based on the students' B.S.I.E. degree requirements.

The staff advisor reviews the students' performance and following consultation with the faculty undergraduate advisor, takes appropriate academic probationary actions in conjunction with the published program continuation policy. For instance, warning and probation letters are sent via regular mail and email, and advising meetings are scheduled.

C. Transfer Students and Transfer Courses

Transfer and current UW students apply to the program using the College of Engineering online application located at <https://www.engr.washington.edu/uapp/>.

The University allows a maximum of 90 lower-division credits to be applied to a particular degree, and a maximum of 135 total transfer credits (lower or upper division) to be applied to the 180 credits required for graduation. In general, it is University policy to accept credits earned from fully accredited institutions, provided that such credits have been earned through university-level courses. This policy applies to credits earned from institutions both inside and outside of the U.S. The IE program subscribes to this policy and works with transfer students individually to determine which credits will apply toward the B.S.I.E. degree.

Shortly after a student is admitted into the IE program, he or she meets with the academic advisor to review degree requirements and plan a course of study. The advisor reviews the transfer-credit evaluation performed by the UW Office of Admissions and determines how transfer credit is applied towards the B.S.I.E. degree. All transfer courses that are identified as UW equivalent courses, as determined by the UW Office of Admissions, are accepted by the IE

program. If a particular course from an accredited institution does not transfer as a UW equivalent but meets the IE criteria for a specific course within the department, the advisor works with the faculty and the UW Office of Admissions on a case-by-case basis to apply the course towards IE core or technical elective requirements. The Office of Admissions maintains a Transfer Equivalency Guide for all Washington state community and technical colleges on its website: <http://admit.washington.edu/EquivalencyGuide>.

Once admitted to the program, students are allowed to take additional coursework at other institutions following established University articulation policies. However, students must complete their final 45 credits as a matriculated student at the University. Students planning coursework at other institutions, especially as part of study abroad programs, are encouraged to discuss specific choices with the faculty undergraduate advisor and staff advisors before beginning these programs. The UW's International Programs and Exchanges office distributes a form that students complete prior to studying abroad. The student indicates proposed international courses and their UW equivalents on the form, and departments sign the agreement to accept any outside coursework prior to the student studying abroad.

D. Advising and Career Guidance

Once admitted to the IE program, students are invited to a new student orientation, and have access to both a faculty undergraduate advisor and a fulltime staff advisor. New student orientations are given early in fall and spring quarters. The new student orientation covers the following topics: course scheduling/long-term planning, curriculum, technical elective information, internship/job website/Co-Op program, continuation policy, add codes, computer accounts and undergraduate lab, graduation applications and exit interviews, staying in contact (non-full load, on-leave issues, special circumstances), scholarship opportunities, department events (holiday parties, ski trips, baseball games, etc.), Student activities—IIE, Alpha Pi Mu, Student Advisory Board, and tour facilities –computer room, student resource area, etc.

The staff advisor regularly reviews student files to ensure that students are taking the proper prerequisite courses to make them eligible for sequential or upper-division IE course requirements. During a typical advising session, the advisor prints a current degree audit for the student from the University maintained Degree Audit Reporting System (DARS). Based on this, the advisor completes a quarterly long-term plan of coursework with the student. This plan is copied for the student and the original is placed in the student file. Additionally, the advisor completes a manual audit of progress towards graduation.

Student files contain all application materials, letters of recommendation, scholarship information, email or postal mail correspondence with the student, internship and career information, and any notes regarding advising meetings or follow-up points of interest.

The staff advisor ensures that students in the program are informed of future course offerings and registration schedules. This is done by posting information on the department web-site (primarily on the *Course Schedules* page: <http://www.washington.edu/students/timeschd/>), producing a flyer which outlines courses offered for a particular quarter, and sending out the information to all students using a list-serve email account which all students are added to when they enter the program. Dissemination of this information is particularly important for students in planning their schedule as related to prerequisite coursework and course sequencing, as well as being aware of which technical elective courses will be offered during a particular quarter. Additionally, students may meet with the faculty advisor or staff advisor during the course of their program of study at any time. The staff advisor monitors completion of course requirements, including technical elective choices, and the faculty advisor approves any other required substitutions or changes. Courses taken to apply to these requirements must be taken for a numerical grade, and this mechanism permits review and evaluation of student progress toward the degree. For technical elective courses not already on the approved list, students may submit petitions for consideration of additional technical elective courses. The faculty undergraduate advisor reviews each request individually and approves or denies courses based on their applicability to IE. Approved courses must be advanced-level undergraduate courses. The required program of study is under continuous evaluation by the faculty to verify it achieves the student outcomes, as is described later.

Up to two quarters prior to a student's graduation date, the student meets with the advisor to complete the graduation application which is sent to the University Registrar. Both the advisor and student sign the graduation application, indicating an understanding of remaining course requirements. Finally, every student completes an exit interview (done by web survey) when they graduate.

The IE program developed a robust internship and job website specifically available for UW IE students. Students regularly visit the website for internship and job opportunities, and discuss career, salary negotiation, resume and interviewing tips with the staff advisor or faculty.

The director of the Co-Op office presents at the new student orientations and regularly emails the adviser with job and internship opportunities for students. In addition, students are notified of campus-wide and engineering-specific career fairs.

The UW student chapter of IIE regularly invites members of local industry to participate in resume workshops, mock interviews, industry panel nights, and other career and networking events for our students.

E. Work in Lieu of Courses

The IE program does not award credit for work in lieu of courses. Any Advanced Placement credit for coursework earned in high school is evaluated and awarded by the UW Office of Admissions.

F. Graduation Requirements

The Bachelor of Science in Industrial Engineering (B.S.I.E.) degree requirements are as follows:

Mathematics	24 credits
MATH 124 (or 127) Calculus with Analytic Geometry I	5 cr
MATH 125 (or 128) Calculus with Analytic Geometry II	5cr
MATH 126 (or 129) Calculus with Analytic Geometry III	5 cr
MATH 307 Intro to Differential Equations	3 cr
MATH 308 Linear Algebra with Applications	3 cr
IND E 315 Probability & Statistics for Engineers	3 cr
Physical Sciences	25 credits
CHEM 142 General Chemistry with lab	5 cr
CHEM 152 General Chemistry with lab	5 cr
PHYS 121 Mechanic with lab	5 cr
PHYS 122 Electro/Oscillatory with lab	5 cr
PHYS 123 Waves with lab	5 cr
Written and Oral Communications	12 credits
ENGL COMP University English Composition requirement	5 cr
HCDE 231 Intro to Technical Writing	3 cr
Additional writing credits, which can be earned in IND E 337.	4 cr
Visual, Literary & Performing Arts/Individuals & Society	30 cr
Minimum 10 credits in VLPA required	
Minimum 10 credits in I&S required	
General Engineering/Computing Courses	28 credits
CSE 142 Computer Programming for Engineers	4 cr
MSE 170 Fund of Material Science	4 cr
AA 210 Engineering Statics	4 cr
EE 215 Fundamentals of Electrical Engineering	4 cr

CEE 220 Intro to Mechanics of Material	4 cr
ME 230 Kinematics & Dynamics	4 cr
IND E 250 Fund. of Engineering Economy	4 cr
Industrial Engineering Required Core Courses	24 credits
IND E 316 Design of Experiments & Regression Analysis	4 cr
IND E 337 Intro to Manufacturing Systems	4 cr
IND E 410 Linear and Network Programming	4 cr
IND E 411 Stochastic Models and Decision Analysis	4 cr
IND E 494 Design in the Manufacturing Firm	4 cr
IND E 495 Industrial Engineering Design	4 cr
Technical Electives	min of 37 credits
Complete a minimum of 37 credits, including AT LEAST one course from EACH of the following 5 categories	
A. Operations Research: IND E 412 Integer and Dynamic Programming IND E 424 Simulation	4 cr
B. Statistics: IND E 321 Statistical Quality Control IND E 426 Reliability Engineering & System Safety	4 cr
C. Production/Operations: IND E 430 Manufacturing Scheduling & Inventory IND E 439 Plant Layout & Material Handling	4 cr
D. Design IND E 351 Human Factors in Design IND E 455 User Interface Design	4 cr
E. General Engineering AA 260 Thermodynamics CSE 143 Computer Programming for Engineers II	4 cr
Additional technical elective courses may also be chosen from the approved Undergraduate Technical Elective List. Refer any questions to the IE Advisor	
Total credits required for Graduation	180

G. Transcripts of Recent Graduates

The program will provide transcripts from some of the most recent graduates to the visiting team along with any needed explanation of how the transcripts are to be interpreted

Undergraduate Continuation Policy

While the University has general regulations governing scholastic eligibility for continuance, departments and programs in the College of Engineering have adopted additional requirements in order to make the best use of the limited facilities and resources available and to provide reasonable assurance of academic success. The following criteria and procedures will be applied to all undergraduate students.

Basic Criteria

1. Full-time students are expected to complete 12 or more credit hours per academic quarter applicable toward the B.S.I.E. degree (*an average of 15 hours per quarter is required to complete graduation requirements in the conventional 12 quarters.*)
2. Part-time attendance may be allowed. Written permission must be obtained from the IE Undergraduate Faculty Advisor. An application for part-time status must be made prior to the first day of each quarter. Students who have received permission to attend part-time must complete a minimum of six credits each quarter applicable towards the B.S.I.E. degree.
3. A student who withdraws from the University without prior written approval or is dropped for nonpayment of fees must obtain written approval from the IE Undergraduate Faculty Advisor before registering or maintaining pre-registration for the following academic quarter. In such cases the department registration may be disallowed or canceled if the student's academic record is inferior to the level of admission prevailing at the time.
4. All undergraduate students who have exceeded the graduation requirements of the B.S.I.E. degree program by more than 10 credits will be transferred to the College of Arts and Sciences.
5. Students must maintain a quarterly grade point average of 2.0 in all departmental and professional program courses. The grade point average is computed by considering all engineering college departmental courses of 300 level or higher, including repeated courses, but excluding Visual, Literary, and Performing Arts (VLPA) and Individuals & Society (I&S) distribution requirements. **If the quarterly grade point average in these courses falls below 2.0, or if any single grade is below 2.0, the student will be placed on departmental probation and must achieve a quarterly average grade point higher than 2.0 the following quarter or be dropped from the department and transferred to the College of Arts and Sciences.**
6. To graduate, a student must earn a total of 180 credits with a minimum cumulative GPA of 2.00 in all engineering courses, with no grade below 1.0 in any of these courses. Students may *not* double-count courses towards any two requirements in the B.S.I.E.. In addition, courses counting towards the B.S.I.E. degree may not be taken on a satisfactory/ not-satisfactory basis.

Review and Notification Procedure

The progress of each student will be reviewed each quarter. If a student's performance fails to meet the standards outlined above, the student will be placed on probation the following quarter. The students will be notified in writing of the reason for probation and will be told what must be done for removal from probation. If the student does not show progress toward removing the deficiencies in the following quarter, the student will be notified in writing, dropped from the department and transferred to the College of Arts & Sciences.

Appeals Procedure

The College of Engineering recognizes that inequities can result from any continuation policy. Therefore, a student who has been placed on probation or has been dismissed and believes that some facts in the record have been overlooked or misinterpreted, may request reconsideration of the probation dismissal by writing a letter to the Program Director. Included in the letter should be any additional information in support of the student or any other information that the student believes is relevant. The letter and supporting material will be transmitted to a department faculty committee, which will review carefully all the available information and then decide whether or not academic probation should be considered for another quarter. The appeal must be made within 30 days of the notification of placement on probation or dismissal. The committee will make a response to the appeal within 30 days.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

University of Washington:

*The primary mission of the University of Washington is the preservation, advancement, and dissemination of **knowledge**. The University preserves knowledge through its libraries and collections, its courses, and the scholarship of its faculty. It advances new knowledge through many forms of research, inquiry, and discussion; and disseminates it through the classroom and the laboratory, scholarly exchanges, creative practice, international education, and public service. As one of the nation's outstanding teaching and research institutions, the University is committed to maintaining an environment for objectivity and imaginative inquiry and for the original scholarship and research that ensure the **production of new knowledge** in the free exchange of diverse facts, theories, and ideas.*

*To promote their capacity to make **humane and informed decisions**, the University fosters an environment in which its students can develop mature and independent judgment and an appreciation of the range and diversity of human achievement. The University cultivates in its students both **critical thinking** and the effective articulation of that thinking.*

As an integral part of a large and diverse community, the University seeks broad representation of and encourages sustained participation in that community by its students, its faculty, and its staff. It serves both non-traditional and traditional students. Through its three-campus system and through educational outreach, evening degree and distance learning programs, it extends educational opportunities to many who would not otherwise have access to them.

B. Program Educational Objectives

The Industrial Engineering Program Educational Objectives can be found at <http://depts.washington.edu/ie/academics/accreditation-ABET> and are as follows:

Careers

Our graduates are employed in productive careers utilizing industrial engineering skills in industry and/or academia.

Engineering Expertise

Our graduates apply engineering design methods and tools to represent, integrate and solve important problems, and their work reflects an appreciation of the non-deterministic nature of engineering systems and devices.

Professionalism

Our graduates are ethical leaders who are socially responsible, work collaboratively with others, and have an appreciation for other disciplines.

Lifelong Learning

Our graduates remain at the leading edge of the industrial engineering discipline and respond to challenges of an ever-changing environment with the most current knowledge and technology.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

The bolded headings below are key components of the **University Mission** followed by a description of how the IE Educational Objectives form the underpinning of this mission:

Knowledge: In their careers, our graduates use design methods and tools that represent the state-of-the-art in industrial engineering.

Production of new knowledge: Our graduates know the value of inquiry and of integrating and solving important problems.

Humane and informed decisions: Professionalism compels our graduates to be socially responsible leaders who work collaboratively with others.

Critical thinking: Through an appreciation of lifelong learning, our graduates remain at the leading edge of the industrial engineering discipline in order to respond to the needs of an ever changing environment.

D. Program Constituencies

The program constituents are:

- Employers of IE graduates
- Alumni of IE program
- Faculty of the ISE department

The information below describes how the program educational objectives meet the needs of our program constituents.

- *Careers:* The educational objective for career meets the needs of the employers by providing top quality industrial engineering graduates to work in their companies. It meets the needs of alumni by preparing them for jobs in industry and/or academia. It meets the needs of faculty by ensuring that our curriculum continues to produce graduates that are in demand by industry and academia.
- *Engineering Expertise:* The educational objective for engineering expertise meets the needs of employers by providing graduates with the skills, tools, and expertise to represent,

integrate and solve important problems. It meets the needs of the alumni by providing them with the skills, tools, and expertise to be successful in the field. And it meets the needs of faculty because our students get jobs at good companies and go on to pursue additional degrees at high quality universities.

- *Professionalism*: The educational objective for professionalism meets the needs of employers by providing graduates who are ethical, work collaboratively, and have an appreciation for other disciplines thereby enhancing the business environment. It meets the needs of the alumni by teaching them to be successful, socially responsible leaders who work collaboratively with others in a diverse, global society which will make them more successful in their work lives. And it meets the needs of faculty because the students we are graduating have a sense of ethics, and work collaboratively with others so they can be successful in their careers.
- *Lifelong Learning*: The educational objective for lifelong learning meets the needs of employers by producing employees who strive to remain at the cutting edge of knowledge and technology therefore placing companies at a competitive advantage. It meets the needs of the alumni by instilling an appreciation and desire to seek out new knowledge and technology which keeps them relevant in a constantly changing world. And it meets the needs of faculty because it is impossible to transmit all of the relevant knowledge students will need throughout their professional lives. This goal satisfies faculty needs by ensuring our graduates will know how to stay current and relevant and will know how to find new information they need to remain successful.

E. Process for Review of the Program Educational Objectives

Before the recent ABET changes to Criterion 2, the educational objectives, their relationship to learning outcomes and the curriculum, and how well students achieved them were reviewed annually at the Fall faculty retreat and the Spring Visiting Committee meeting. The data collected from employer and alumni surveys and the student attainment data discussed in Criteria 4 & 5 were reviewed and discussed.

The faculty began discussing the changes to Criterion 2 and the focus in the educational objectives moving from attainment to relevancy in December 2012. Based on this change, the faculty realigned the educational objectives in February 2013. In addition, the changes to the educational objectives and the requirements in this Criterion were discussed at the Spring 2013 Visiting Committee Meeting. In the future, the educational objectives will continue to be reviewed annually by program constituencies in the following ways to ensure that they continue to be relevant and are meeting constituent needs:

- *Employers*: These constituencies provide feedback through the Visiting Committee and through other interactions with the department. These other interactions include events that are sponsored by the student chapter of IIE, such as mock interviews, recruiting events, the senior design poster session and professional society presentations.

- *Alumni:* Alumni participate in review of the relevancy of program educational objectives through the Visiting Committee (industry board), surveys, alumni events, and the alumni email list.
- *Faculty:* Faculty members are actively involved with the undergraduate program through regular reviews of assessment data, program objectives and outcomes, and the curriculum. Each faculty member teaches undergraduate courses and many conduct research projects with undergraduate students.

Minutes of faculty meetings, faculty retreats, and visiting committee meetings will be available during the visit.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The following are IE program's student outcomes.

- a. An ability to apply knowledge of mathematics, science and engineering appropriate to the discipline
- b. An ability to design and conduct experiments, analyze and interpret data
- c. An ability to design a system, component, or process to meet desired needs
- d. An ability to function on multi-disciplinary teams
- e. An ability to identify, formulate, and solve engineering problems
- f. An understanding of professional and ethical responsibility
- g. An ability to communicate effectively
- h. The broad education necessary to understand the impact of engineering solutions in a societal context
- i. A recognition of the need for, and an ability to engage in life-long learning
- j. A knowledge of contemporary issues
- k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- l. An understanding of the integrated, inter-disciplinary nature of the discipline

The educational objectives and learning outcomes are documented on the ISE webpage at:

<http://depts.washington.edu/ie/academics/accreditation-ABET>

B. Relationship of Student Outcomes to Program Educational Objectives

The student outcomes map into the IE Educational Objectives in the following ways:

Educational Objectives	Student Outcomes
<i>Careers</i> Our graduates are employed in productive careers utilizing industrial engineering skills in industry and/or academia.	a,b,c,e,g,k,l
<i>Engineering Expertise</i> Our graduates apply engineering design methods and tools to represent, integrate and solve important problems, and their work reflects an appreciation of the non-deterministic	a,b,c,e,g,k,l

nature of engineering systems and devices.	
<p><i>Professionalism</i></p> <p>Our graduates are ethical leaders who are socially responsible, work collaboratively with others, and have an appreciation for other disciplines</p>	d,f,h
<p><i>Lifelong Learning</i></p> <p>Our graduates remain at the leading edge of the industrial engineering discipline and respond to challenges of an ever-changing environment with the most current knowledge and technology</p>	i,j

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

The current UW Industrial Engineering ABET student outcomes are listed in Criterion 3. Criterion 5 shows how the curriculum and its associated prerequisite structure support the attainment of the student outcomes.

Assessment Process and Frequency of Assessment

The Industrial Engineering program regularly assesses and evaluates the extent which student outcomes are attained using several tools. The specific measurements and where in the curriculum they are obtained are summarized in Table 4-1. Note that the assessment measures are only from required courses. Every year, the instructor that taught the required course provides the data to the departmental administrator, who compiles the data in an assessment information database. The faculty ABET coordinator takes the data that has been collected from the preceding academic years, analyzes and presents it to the faculty at the annual faculty retreat, held in September of each year prior to the beginning of the Autumn Quarter (the start of the new academic year). The faculty discuss the results and identify if any action is to be pursued to improve the attainment of the student outcomes.

The assessment tools to measure students' performance are:

- Course assignment/exam grades (for designated classes, annually, throughout the academic year, starting in 2008.)
- Senior Design Rubrics administered in IND E 495 (annually)

The assessment tools to measure students' perceptions are:

- ABET Senior Surveys regarding confidence and opportunities (annually [end of Spring quarter], on-line)

It is noted that outcome *l* was added by this Industrial Engineering program and has been an outcome included in the past three ABET reviews. This outcome is directly related to the Industrial Engineering Program Criteria, which address design and integration of systems. It still remains an important component of our program and is therefore, assessed on an annual basis along with outcomes *a* to *k*.

Table 4-1. Assessment tools mapped to each student outcome.

Student Outcome	Course Assignments/Exam Grades					IND E 495 Senior Design Rubrics	ABET Senior Survey
	IND E 316	IND E 337	IND E 410	IND E 411	IND E 494		
a	Exam 2		Midterm			Q2	Q1, Q2, Q3, Q4
b	Last HW	Time & Motion HW				Q2	Q5, Q6
c					Senior Design Proposal	Q2, Q3, Q5	Q7
d					Peer Assessment, Peer Obs		Q8, Q9
e			Final	Final		Q1	Q10
f					Ethics HW	Q3	Q12, Q13
g		Tech Writing on 6 HW			Presentation	Q6	Q14, Q15, Q16
h		Global Issues HW				Q3	Q18
i		Library Research HW					Q20
j		Contemporary Issues HW					Q19
k	Exam 1			HW 1			Q11
l					Senior Design Proposal	Q4	

Expected Level of Attainment

Course Assignment Grades

As of 2008, the department identified assignments from selected courses across the curriculum to address achievement of each outcome. Assignments and/or exams from the following required classes are collected and reviewed:

1. IND E 316: Design of Experiments
2. IND E 337: Introduction to Manufacturing Systems
3. IND E 410: Linear and Network Programming
4. IND E 411: Stochastic Models and Decision Analysis
5. IND E 494: Design in the Manufacturing Firm

The expected level of attainment for specific course assignments and exam grades is 70 % (or the equivalent of a C grade, which is a 2.0 in the UW grading system).

IND E 495 Senior Design Rubrics

The senior design rubrics are administered annually, each spring quarter, in IND E 495 (Industrial Engineering Design). They have been in use for over a decade. The data reported here is from 2007 to the present. There are two rubrics employed. The first is used at the annual senior design poster session (Fig 4-1). The raters (or evaluators) are all volunteers and include practicing IE's, IE managers from local industry, and IE faculty. This rubric is used to rate the work of the teams in two categories: (1) problem definition, which maps into outcome *e* and (2) analysis, which maps into outcomes *a*, *b*, and *c*. The second rubric is the project report rubric (Fig 4-2). This rubric is used to grade the project reports and is done by the instructor. The work performed by the senior design teams is rated in six categories, which map to 9 of the 12 student outcomes. All rubric ratings are on a scale of 1 [unacceptable] to 4 [exemplary/exceeds expectations]. Additionally, the course instructor grades other student work during the two-quarter senior design sequence. The six categories are:

1. Problem definition: problem definition/assessment, customer needs/constraints, gather data. *Maps onto outcome e.* (Average of the results of the poster session rubric and the project report rubric)
2. Analysis: identify skills, make assumptions, and perform analysis. *Map onto outcome a, b, and c.* (Average of the results of the poster session rubric and the project report rubric)
3. Consideration: environmental, society, legal, ethical, geopolitical. *Maps onto outcome c, f, and h.*
4. Integration of IE skills: manufacturing systems, operations research, quality engineering, human factors. *Maps onto outcome l.*
5. Decision-Making: consider alternatives, and justify choice. *Maps onto outcome c.*
6. Written Communications: communicate effectively with clients via written reports. *Maps onto outcome g.*

The composite scores for each question are the average of all the scores for all the teams from all the evaluators for a given year. The senior design rubric has an expected level of attainment for each of the student outcomes of 3.0 (which is equivalent to Good/Meets Expectations).

**Senior Design Poster Evaluation
2013**

Project: _____

Score: _____

Objective	4 Exemplary	3 Proficient	2 Apprentice	1 Novice
Poster Mechanics	The poster is very attractive in terms of design, layout, and neatness. Graphics are easily viewed and are related to the topic, making the material easier to understand. No grammatical mistakes.	The poster is suitably attractive. Most graphics are easily viewed and relate to the topic. There is a grammatical mistake on the poster.	The poster is a bit messy. Many graphics are not clear or are too small. There are a couple of grammatical mistakes.	The poster is distractingly messy or very poorly designed. It is not attractive. Graphics do not relate to the topic. There are several grammatical mistakes on the poster.
Technical & Analysis Details	High level of relevant detail is presented to allow the audience to make judgments about the content. Complete & correct analysis and consistent with assumptions.	Sufficient technical detail is included to enable the audience to understand the nature of the project work. Analysis is sufficiently complete and correct, but contains minor errors.	In places, the information was too detailed or was lacking. Analysis is satisfactory, but better tools exist. Analysis contains conceptual or procedural errors.	Significant amounts of technical detail are lacking or inadequate so audience cannot appreciate the design. Analysis has major conceptual or procedural errors & uses inappropriate tools.
Design	The problem is stated clearly and is well-motivated. Data needs are clearly understood & utilized. Includes thorough description of the proposed design or prototype including expected results. Conclusions are stated clearly and supported.	The problem is clearly stated, but the significance is not conveyed. Data needs are well-identified and mostly complete. The presentation includes sufficient information to assess the value of the design. Conclusions are stated, but not supported.	The problem and scope are ill-defined. Data needs are partially addressed and incomplete. Presentation does not include enough information to assess design. Conclusions are vague.	It is not clear why the project was undertaken. Data needs are not sufficiently addressed. Design seems disorganized and not well-conceived. No conclusions are given.
Systems Thinking	Clear evidence of systematic consideration and evaluation of all relevant problem parameters and system components. Solution is responsive to and integrated with entire system.	Solution is practical i.e. system design and concept of operations. Rationale and evidence for most major decisions are provided. Solution follows evidence..	Provides rationale for some design decisions. Draws unwarranted conclusions. Some major system parameters are not included or discussed.	Systems thinking is not evident. Fails to identify relevant components and parameters. Provides incomplete rationale for decisions. Solution and claims not backed by sufficient evidence.
Presentation	Presenters demonstrate full knowledge of the material, can explain and elaborate on questions, and engage the audience	Presenters have sufficient knowledge of the material to answer questions and maintain the audience's attention.	Presenters have difficulty answering questions beyond a rudimentary level. The audience's attention is weak.	Presenters cannot answer questions. The audience is not paying attention.

Comments:

Evaluator: _____

Figure 4-1. Rubric for annual senior design poster session.

Industrial Engineering Senior Design Project Report

Group Members: _____ Year: _____ Project: _____
 IE graduates will be able to design IE processes or systems which meet specified project requirements by:

Objective	4 Exemplary	3 Proficient	2 Apprentice	1 Novice	Score
Problem Definition: problem definition; customer needs & constraints; gather data	Total variable identification; customer needs/multiple realistic constraints evaluated to focus data needs; data needs prioritized to address problem; data gathering complete	Substantial variable identification; customer needs/ multiple realistic constraints considered; data needs well identified; data gathering substantially complete	Partial variable identification; customer needs/ multiple realistic constraints identified; data needs partially addressed; data gathering incomplete	Poor variable identification; customer needs/ multiple realistic constraints not explicitly considered; data needs not sufficiently addressed	
Analysis: identify skills; make assumptions; correct analysis	Analysis is complete, correct and consistent with assumptions. Assumptions are clearly stated and methods selected for analysis are appropriate.	Analysis is sufficiently complete and correct, but contains 1 or 2 minor errors. Some minor assumptions are omitted or violated	Analysis is satisfactory, but other, more appropriate analytical tools exist for this problem. Analysis contains 1 or more conceptual and/or procedural errors but computations are correct. One or more major assumptions are omitted or violated.	Analysis contains major conceptual and/or procedural errors and incorrect computations. Many assumptions are omitted and violated. Analytical tools applied are inappropriate and/or do not apply all relevant IE knowledge.	
Considerations: environmental; social; legal; ethical; geopolitical (E, S, L, E, G)	Identifies a number of important E, S, L, E, G considerations; evaluates strengths & weaknesses of each category, including present and future ramifications.	Identifies a number of important E, S, L, E, G considerations; includes limited discussion of the strengths & weaknesses of each category.	Identifies only a few of the obvious E, S, L, E, G considerations with shallow discussion of the ramifications.	Lists E, S, L, E, G considerations which have already been discussed in class, with no discussion of the ramifications.	
Integration of IE Skills: Manufacturing Systems; Operations Research; Quality Engineering; Human Factors	Integrates 2 or more areas of IE in an appropriate manner. The application of these skills presents a complete treatment of the design project.	Integrates 2 areas of IE skills (e.g., manufacturing systems & quality engineering) in an appropriate manner. Several specific IE skills in an area are used. This may include minor errors, but is conceptually sound.	Includes one area of IE skills, but uses several specific skills within an area. The application of these skills may have several errors, and the opportunity to use other skills may have been overlooked.	Does not clearly reflect any integration of IE skills; only one identifiable IE skill is used in the project. Concept of applying the skills may be faulty. Several opportunities to draw from other skills may have been overlooked.	
Decision-Making: consider alternatives; justify choice	2 or more alternatives considered; all evaluated correctly based on clearly pre-defined criteria that adequately address the problem	2 or more alternatives considered; each is evaluated correctly based somewhat on imprecisely defined criteria that partially addresses the problem; alternatives address meaningfully different objectives	2 alternative solutions are considered; evaluation criteria contains some minor errors; evaluation criteria are imprecisely defined and do not address the problem well; alternatives are not meaningfully differentiated	Only one solution is presented and evaluated; no evaluation criteria are presented	
Written Communications: communicates effectively with clients via written report	Written report is virtually error-free, logically presents design project, is well organized and easy to read, and contains high quality graphics.	Presents design project logically, well organized, easy to read, contains high quality graphics, and few minor grammatical &/or rhetorical errors.	Generally well written but contains some grammatical, rhetorical and/or organizational errors; design project is not well explained and not fully discussed.	Does not present design project clearly, is poorly organized and/or contains major grammatical and/or rhetorical errors.	

Evaluator: _____

Date: _____

Figure 4-2. Rubric for senior design project report.

Senior Surveys

Senior surveys are administered in the senior design course. The surveys are administered on-line using the password-protected catalyst web tool available through the University of Washington (See Fig 4-3 as an example). Students are asked to rate their confidence in the outcome areas, and also their opportunity to learn the outcome areas. In order to more accurately assess potential curricula needs, these questions were designed to specifically address components of student outcomes.

Question 5.			
YOUR CONFIDENCE IN YOUR KNOWLEDGE AND SKILLS			
For the following knowledge and skill areas, please indicate your level of confidence. For example, if you have little confidence in your ability to use mathematics to solve engineering problems, then mark fair. If you are extremely confident in your ability, mark very good.			
Required.			
	Fair	Good	Very Good
1. Using my knowledge of mathematics to solve relevant engineering problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
2. Using my knowledge of chemistry to solve relevant engineering problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
3. Using my knowledge of physics to solve relevant engineering problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
4. Using my knowledge of engineering to solve relevant engineering problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
5. Designing and conducting an experiment to obtain measurements or gain additional knowledge about a process.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
6. Analyzing and interpreting data to find an underlying theme.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
7. Designing a device or process to satisfy a given set of specifications.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fair	Good	Very Good
8. Functioning as a technically contributing member of an engineering team.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 4-3. Clipping of the on-line catalyst survey assessing student's level of confidence.

There are two parts of the senior survey with 20 questions total; 10 assessing confidence and 10 assessing opportunities in various knowledge and skills areas. As noted in Table 4-2, four questions address outcome *a*, individually addressing mathematics, chemistry, physics and engineering. Two questions address outcome *b*, separately considering designing experiments and analyzing data. One question addresses outcome *c* and two

questions address outcome *d*. Two questions each address outcomes *e* and *f*. Four questions are used to assess outcome *g*. One question each is used to address outcomes *h*, *i*, *j*, and *k*.

Table 4-2. Mapping of student outcomes to ABET Senior Survey

ABET Senior Survey (Both confidence & opportunities)	Student outcomes											
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	<i>k</i>	<i>l</i>
Q1 Knowledge of mathematics to solve engr problems	X											
Q2 Knowledge of chemistry to solve engr problems	X											
Q3 Knowledge of physics to solve engr problems	X											
Q4 Knowledge of engineering to solve engr problems	X											
Q5 Designing & conducting experiments to gain knowledge		X										
Q6 Analyzing & interpreting data to find meaning		X										
Q7 Designing a device or process to satisfy specifications			X									
Q8 Functioning as a technically contributing member of a team				X								
Q9 Functioning as an accounting member of a team				X								
Q10 Formulating unstructured engineering problems					X							
Q11 Using appropriate techniques for problem solving											X	
Q12 Understanding professional responsibilities						X						
Q13 Understanding ethical responsibilities						X						
Q14 Writing effectively							X					
Q15 Making professional presentations							X					
Q16 Effectively expressing engr-related ideas							X					
Q17 Listening & impartially interpreting different viewpoints												
Q18 Understanding potential risks & impacts an engr soln may have to the public								X				
Q19 Applying knowledge about current issues to engr problems										X		
Q20 Recognizing limitations & knowing when to see additional information									X			

For the senior surveys, there are two categories of information: Opportunities and Confidence. For Opportunities, the expected attainment is 70% for “Often” and “Very Often”, and for Confidence, the expected attainment is 70% for “Good” and “Very Good”.

Summaries of the Results of the Evaluation Process & Analysis

The following is a summary of the results from each assessment tool for 2008 to 2012. The data for the 2012-2013 academic year are still being collected and compiled. Summaries will be complete and reviewed during the IE faculty retreat. It will be available at the time of the ABET program evaluator visit. Note that the year represents the second half of the academic year. For example, 2008 includes data from the 2007-2008 academic year.

Outcome a: An ability to apply knowledge of mathematics, science and engineering.

- *IND E 316: Design of Experiments: Exam 2*
*A discussion during the Sept 2012 retreat showed that the specific exam used for assessing this outcome may differ slightly given the instructor. However, outcome *a* is always assessed in the 2nd exam and this could be midterm 2 or the final, depending on the instructor.
- *IND E 410: Linear and Network Programming: Midterm*
- *IND E 495: IE Design: Senior design rubric: Q2-Analysis.*
- *Senior Survey, Q1: Knowledge of Mathematics*
- *Senior Survey, Q2: Knowledge of Chemistry*
- *Senior Survey, Q3: Knowledge of Physics*
- *Senior Survey, Q4: Knowledge of Engineering*

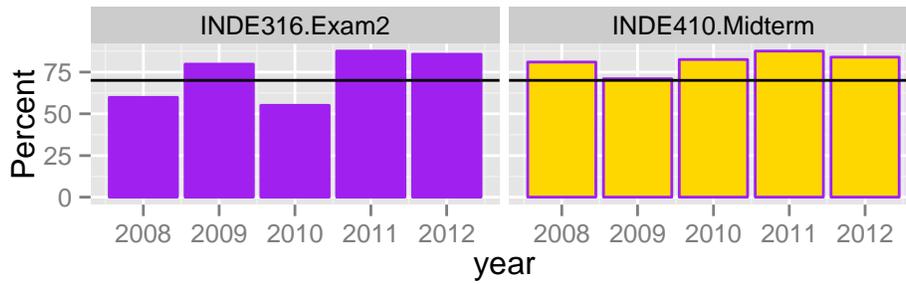


Figure 4-4. Course assessments for outcome *a*.

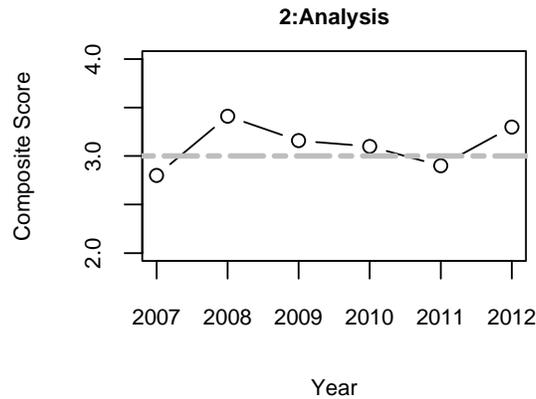


Figure 4-5. Senior design rubric, Q2-Analysis.

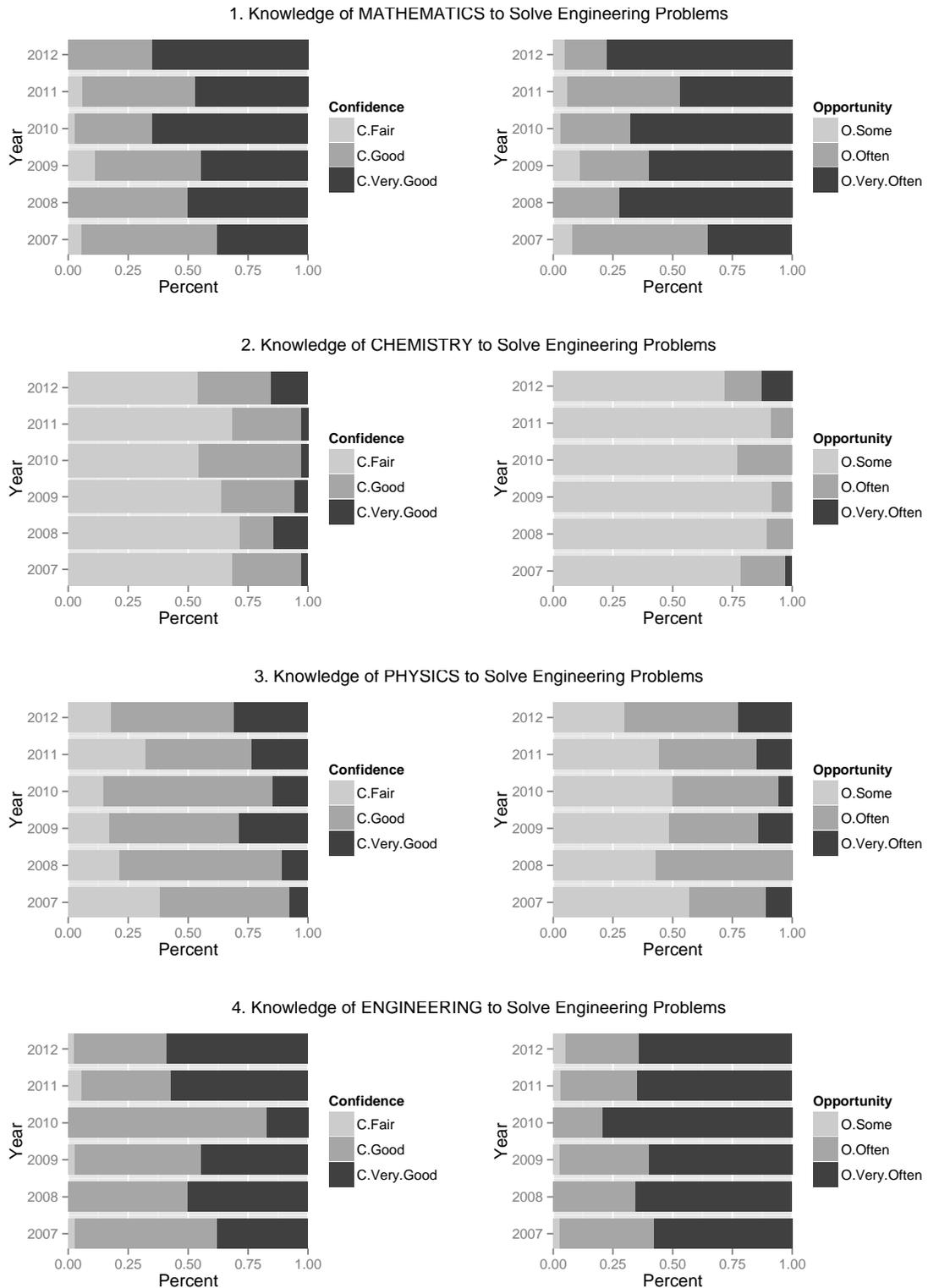


Figure 4-6. ABET Senior survey questions (#1 to #4)

The senior design rubrics Q2 had a median score of 3.13 with values ranging from 2.8 to 3.41. In general, the scores have been fairly consistent over the past six year and this is

to be expected as our students get a great deal of exposure to data analysis skills from a mathematical and engineering perspective (see Appendix A for IE Course Syllabi).

The senior surveys showed that students rated their confidence and opportunity in mathematics and engineering high, while basic sciences (especially chemistry) rated much lower (see questions 1- 4 below). The faculty have discussed the low confidence level and lack of opportunity to solve chemistry and physics issue. The IE program is more heavily slanted toward use and dependence of mathematics and fundamental engineering skills that is inherent within our curriculum.

In summary, our students perform very well in math and science classes. Despite this, the students show a lack of confidence in and opportunities to solve basic science issues. Many IE courses require students to combine engineering skills to solve problems and complete projects. No changes were made to the curriculum with respect to these findings.

Outcome b: An ability to design and conduct experiments, as well as, analyze and interpret data.

- *IND E 316: Design of Experiments: Last HW assignment*
*A discussion during the Sept 2012 retreat showed that the specific homework assignment made may differ slightly given the instructor. However, the faculty consensus was that outcome *b* is assessed during the last or next to last HW assignment.
- *IND E 337: Introduction to Manufacturing Systems: Time and Motion Study Assignment*
- *IND E 495: IE Design: Senior design rubrics: Q2-Analysis* (shown in Outcome a)
- *Senior Survey, Q5: Designing & Conducting Experiments*
- *Senior Survey, Q6: Analyzing & Interpreting Data*

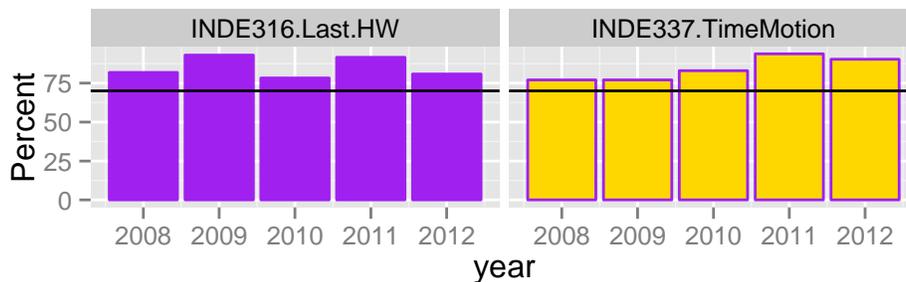


Figure 4-7. Course assessments for outcome *b*.

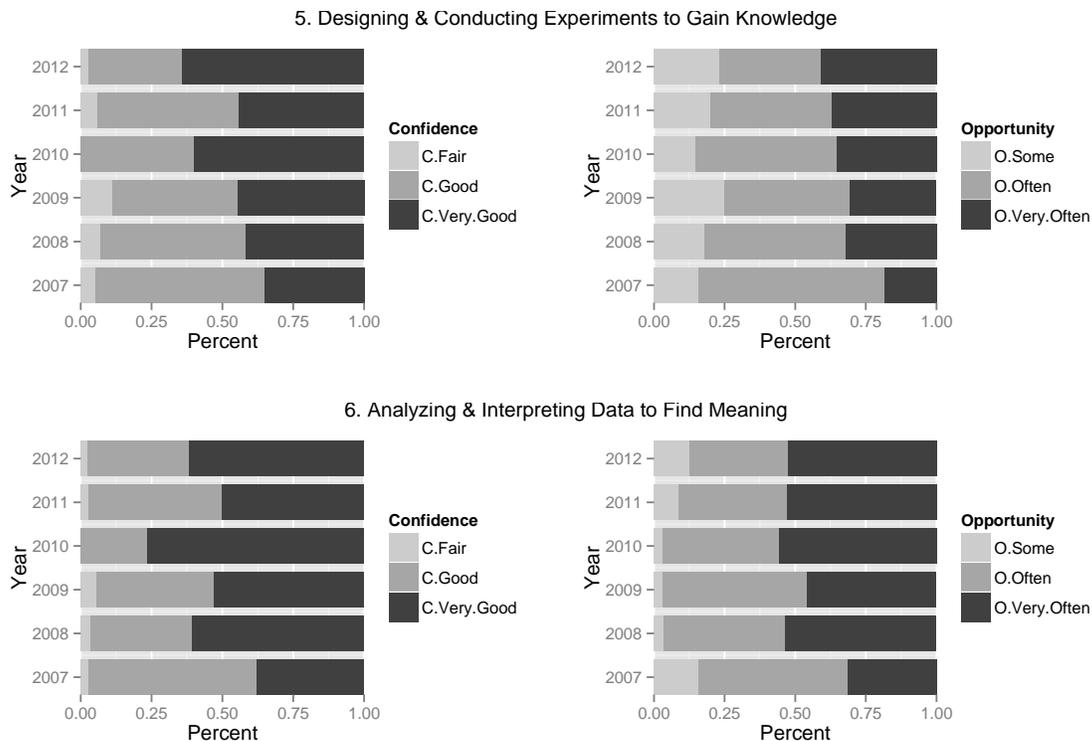


Figure 4-8. ABET Senior survey questions (#5, #6)

The coursework show a good understanding of designing and conducting experiments (grades obtained for the past five years have consistently been above 70%). Over 70% of the students ranked their confidence to design and conduct experiments, and analyze and interpret data as “Good” or “Very Good”. The opportunities associated with this skill set was also consistently rated as “Often” and “Very Often”.

In summary, a critical part of IE is experimental design and data analysis. Many classes offered in the IE program are statistically based and students use these abilities in our design courses, including senior design.

Outcome c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

- *IND E 494: Design in the Mfg Firm: Senior Design Proposal*
*Based on discussion at a faculty meeting, it was noted that outcome C can be assessed using the senior design proposal. Hence, the data for this assessment tool will be collected on an annual basis beginning with the 2012-2013 academic year.
- *IND E 495: IE Design: Senior Design Rubrics: Q2-Analysis (shown in Outcome a)*
- *IND E 495: IE Design: Senior Design Rubrics: Q3-Consideration*
- *IND E 495: IE Design: Senior Design Rubrics: Q5-Decision Making*
- *Senior Survey, Q7: Designing a Device or Process*

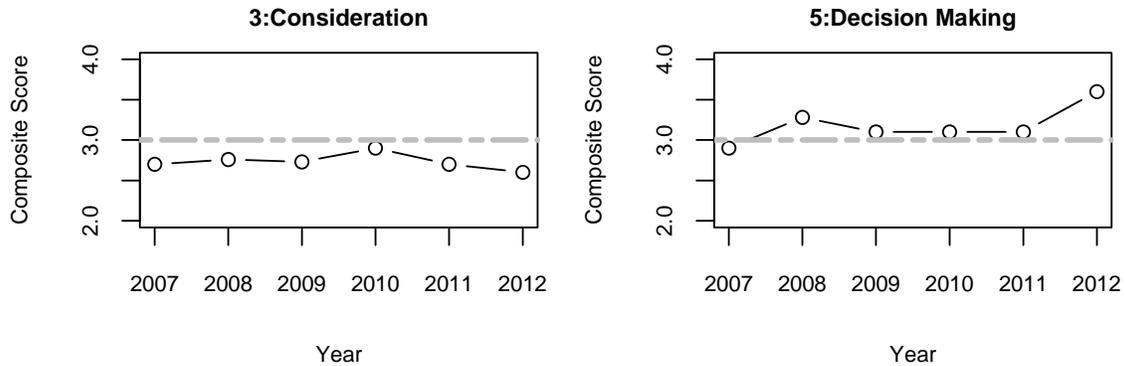


Figure 4-9. Senior design rubric, Q3-Considerations, and Q5-Decision Making

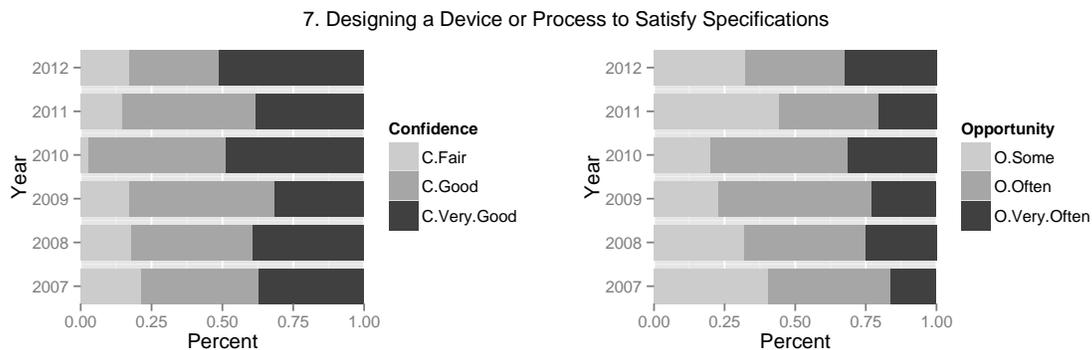


Figure 4-10. Senior survey question 7

The senior rubric Q3 had a median score of 2.7 with values ranging from 2.6 to 2.9. The findings associated with this category are below what is desirable. The faculty have made recommendations for improvement and are described in greater detail in Section B: Continuous Improvement. Senior rubric Q5 (Decision making) has a median score of 3.1 with values ranging from 2.9 (in 2007) to 3.6, which has been consistently above the threshold for the past six years. The senior survey shows that students have good confidence in their ability and ample opportunities to design a device or process to satisfy specifications.

In summary, students learn to apply the design process throughout the IE curriculum. The senior design project is a real world problem, with real world constraints and provides students an understanding of the issues from an economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability perspective.

Outcome d: An ability to function on multi-disciplinary teams

- *IND E 494: Design in the Mfg Firm: Peer Assessment & Team Process Observation.*
*To better address the ability of our students to function in a multi-disciplinary team, we have included a revised peer assessment and team process observation, which allow students to evaluate each other as well as assess the team process in general.

In 2008, 2009, and 2010, this peer assessment was conducted in IND E 495 (IE Design). However, because the team process actually begins in IND E 494 (Design in the Manufacturing Firm), the faculty decided that an assessment of the peer process would be better evaluated in both this earlier class and in IND E 495 and as of 2011, the peer assessment was changed to include assessment in both courses.

- Senior Survey, Q8: Functioning as a technically contributing member
- Senior Survey, Q9: Functioning as an accountable member

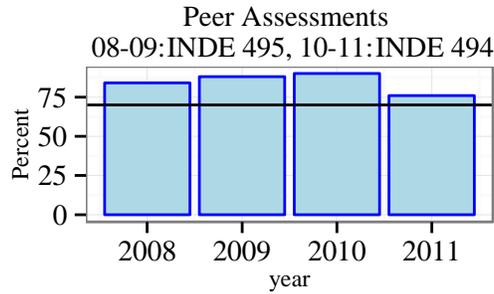


Figure 4-11 Course assessments for outcome *d*

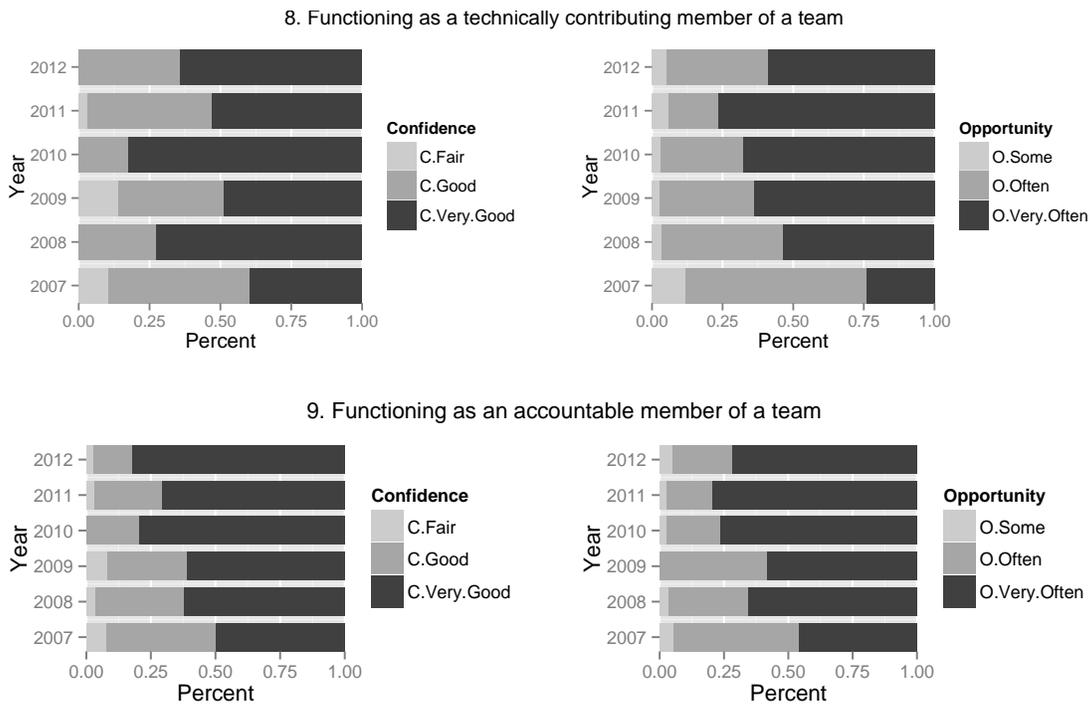


Figure 4-12 Senior survey questions 8 and 9

The peer assessments are available for four years (2008 to 2011). In 2012, due to changes in the instructor for the IND E 494/495 series, the data was inadvertently not collected. However, this data is collected for this past academic year (2012-2013) and will be available for the ABET visit. The data that does exist for 2008 to 2011 indicate that

students do well in the team process (with the mean scores consistently above 70%). The senior survey questions also demonstrate that students have very good confidence in their ability to function as an accountable team member and contribute to the technical aspects.

Outcome e: An ability to identify, formulate, and solve engineering problems

- *IND E 410: Linear and Network Programming: Final Exam*
- *IND E 411: Stochastic Models and Decision Analysis: Final Exam*
- *IND E 495: IE Design: Senior Design Rubrics: Q1-Problem Definition*
- *Senior Survey, Q10: Formulating unstructured engineering problems*

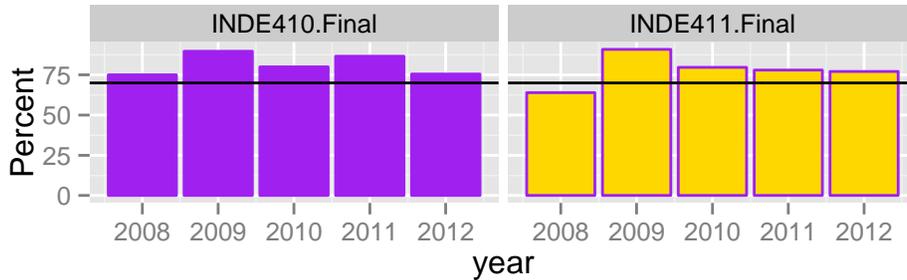


Figure 4-13. Course assessments for outcome e.

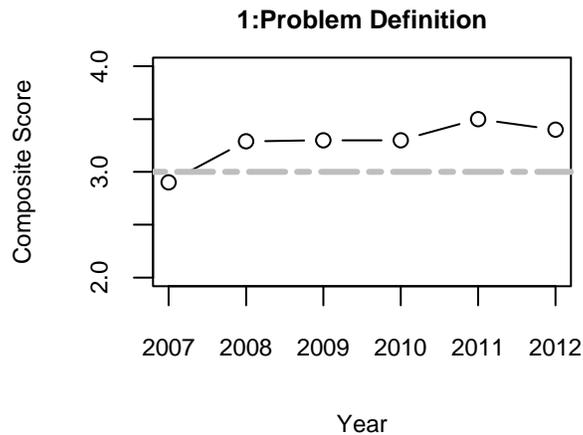


Figure 4-14. Senior design rubric, Q1: Problem Definition.

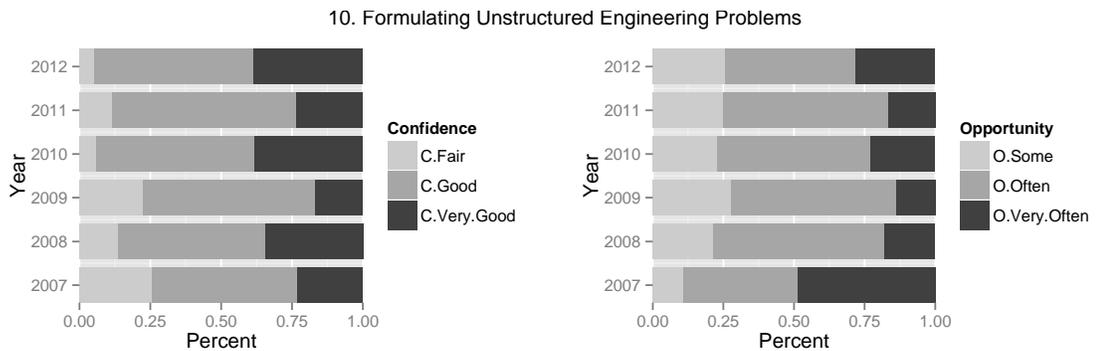


Figure 4-15. Senior survey question 10

The final exam scores for IND E 410 (Linear and Network Programming) and 411 (Stochastic Models and Decision Analysis) indicate that they have a good ability to identify, formulate and solve engineering problems. In 2008, the mean exam score for the final was below 70%, but have shown improvement over following years. There are two instructors for these two courses (Profs. Zabinsky and Ghate) and these two instructors continually discuss course material, exams, and content in an effort to ensure continuous improvements in this area. This is described further in Section B Continuous Improvement.

The median score for the senior design rubrics Q1 is 3.3 (out of 4 possible) with values ranging from 2.9 to 3.5. This category ranks the highest with the mean ratings consistently above expectations (it was only slight below at 2.9 in 2007). This is expected given that all IE classes consist of understanding how to identify, formulate, and solve engineering problems.

Outcome f: An understanding of professional and ethical responsibility

- *IND E 494: Design in the Mfg Firm: Ethics Assignment*
- *IND E 495:IE Design: Senior Design Rubrics, Q3-Consideration(shown in Outcome c)*
- *Senior Survey, Q12: Understanding professional responsibilities*
- *Senior Survey, Q13: Understanding ethical responsibilities*

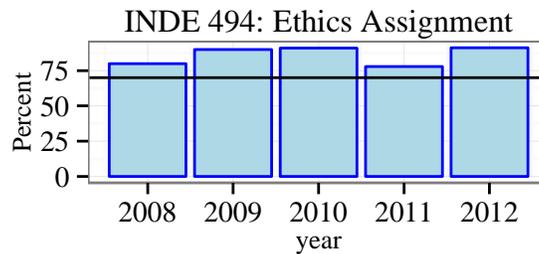


Figure 4-16. Course assessments for outcome f

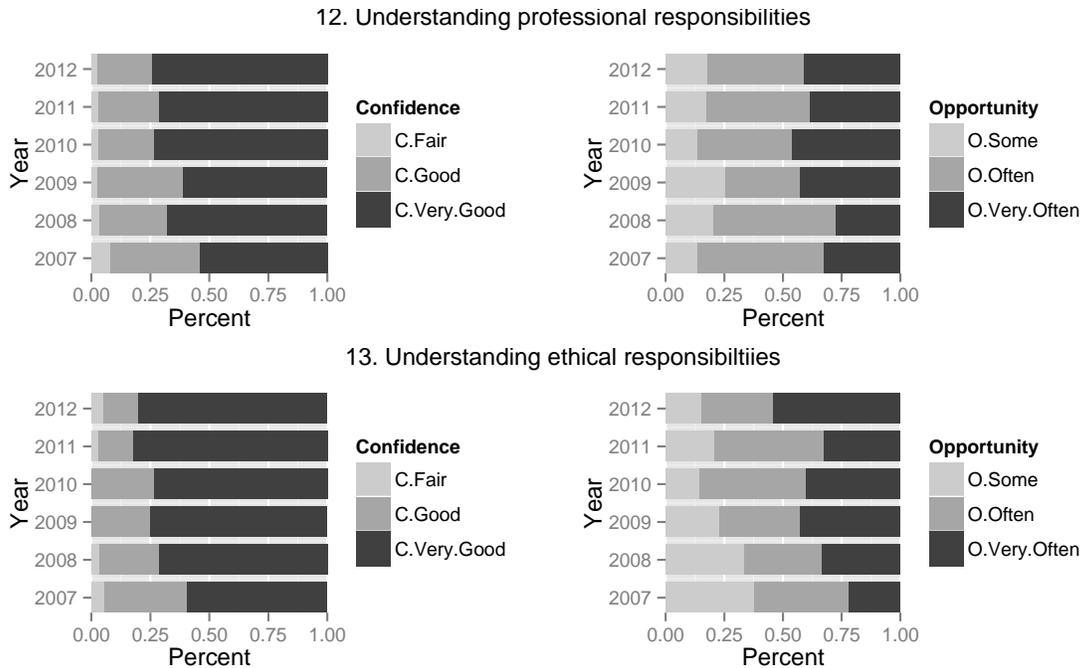


Figure 4-17. Senior survey questions 12 and 13

The senior design rubric and senior survey show that students feel confident in their professional and ethical responsibilities. The mean grades over the past five years for the ethics assignment in IND E 494 have consistently exceeded 70% (Fig 4-16). In terms of understanding professional and ethical responsibilities, over 80% have rated their confidence as “Very good” or “Good” each year (Fig 17). The opportunities to understand professional responsibilities have been relatively consistent from 2007 to 2012 (with combined ratings of “Often and “Very often” being over 75%). The opportunities to understand ethical responsibilities have increased from 2007 to 2012 although some improvements were still considered worthwhile and are discussed in Section B Continuous Improvement.

Outcome g: An ability to communicate effectively

- *IND E 337: Introduction to Manufacturing Systems: Technical writing grades on six assignments*
- *IND E 494: Design in the Mfg Firm: Presentation*
- *IND E 495: IE Design Senior Design Rubrics: Q6-Written Communication*
- *Senior Survey, Q14: Writing Effectively*
- *Senior Survey, Q15: Making professional presentations*
- *Senior Survey, Q16: Effectively expressing engineering-related ideas*

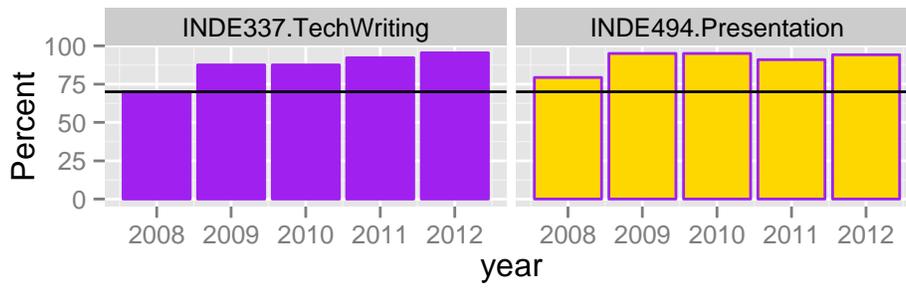


Figure 4-18. Course assessments for outcome g.

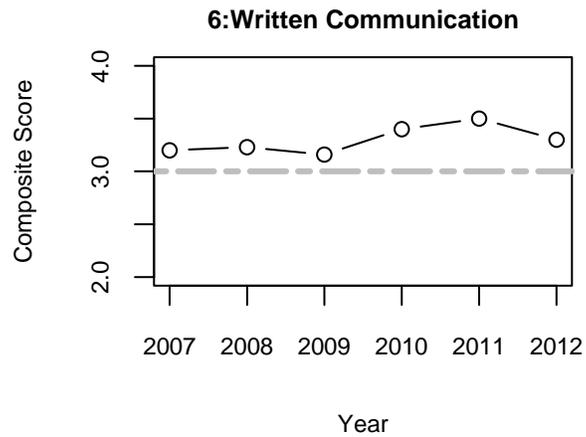


Figure 4-19. Senior design rubric, Q6-Written Communication.

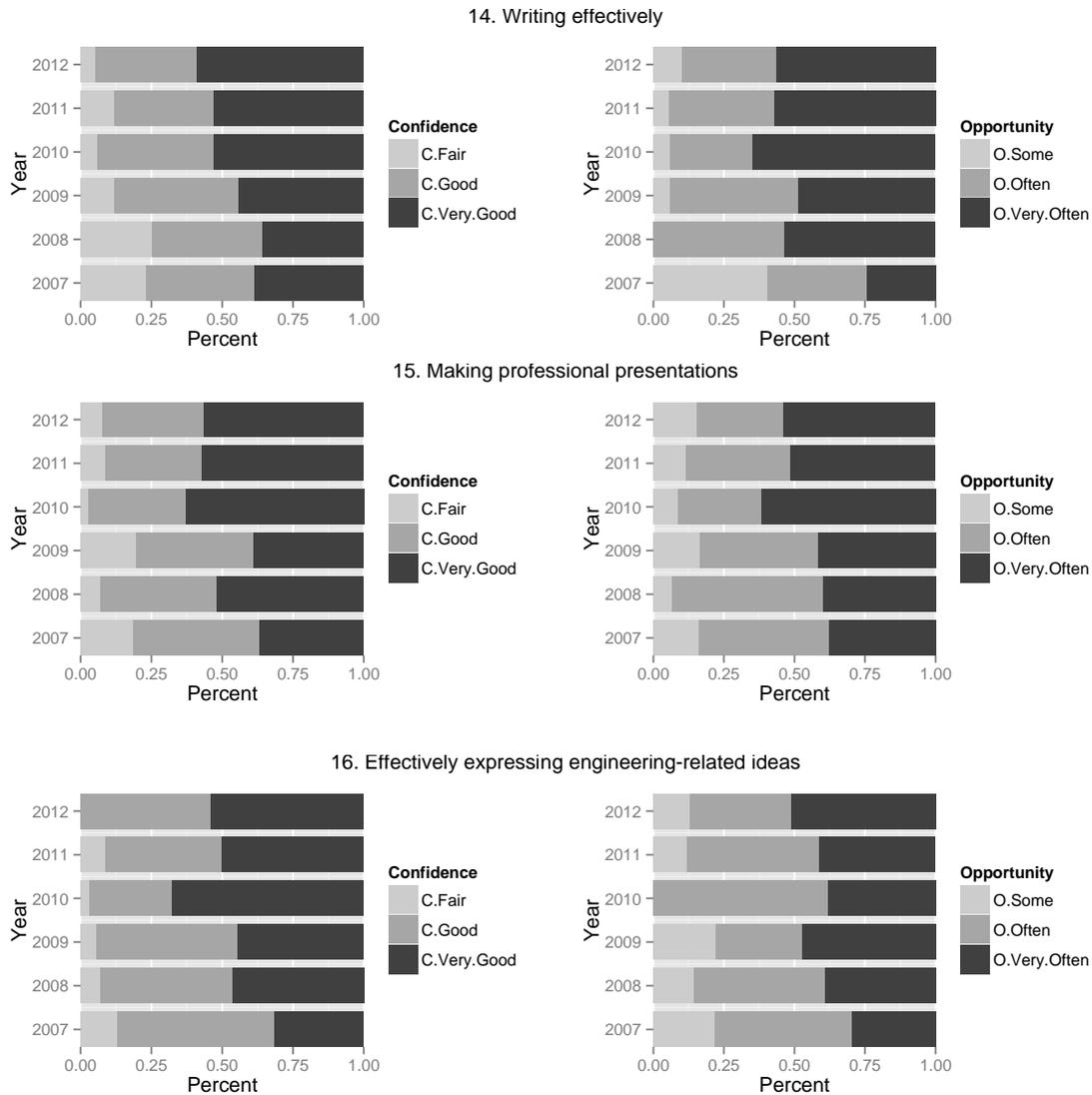


Figure 4-20. ABET Senior survey questions (#14 to #16)

Students write and speak in public in a number of IE courses throughout our curriculum. They also take Writing (W) courses (a UW designation) that cover both writing and speaking. For the senior design course (IND E 494/IND E 495), students are also required to complete a presentation and written report.

The mean scores from the technical writing assignments in IND E 337 and the presentation skills in IND E 494 have steadily increased (Fig 4-18). The senior design rubrics Q6 (Written communication) has a median score of 3.265 with values ranging from 3.16 to 3.375 (Fig 4-19). This has consistently been above the threshold for this category. Students report that they have reasonable confidence and ample opportunities for communicating ideas in writing, orally, and technically (Fig 4-20). The quality of writing in the senior design project reports is quite strong, but it is noted that there is only one report per team and specific aspects of the writing cannot be attributed to any one student.

Outcome h: The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

- *IND E 337: Introduction to Manufacturing Systems: Global Issues HW*
- *IND E 495: IE Design: Senior design rubric: Q3-Consideration (Shown in outcome c)*
- *Senior Survey, Q18: Understanding the potential risks & impacts an engr solution may have to the public*

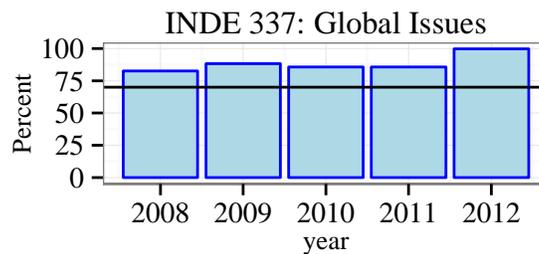


Figure 4-21. Course assessment for outcome *h*

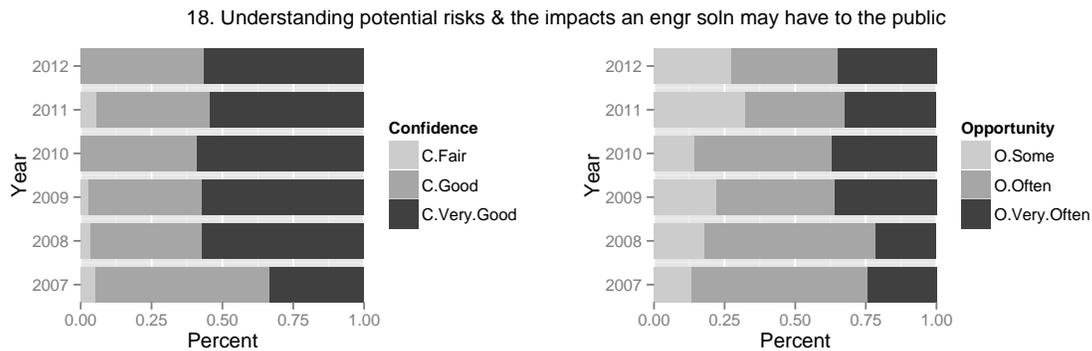


Figure 4-22. ABET Senior Survey question (#18)

Over the past few years, there have been opportunities to recognize and understand global issues, and students appear very confident in their ability to understand potential risks and impacts of engineering solutions to the public. Scores on the Global Issues assignment in IND E 337 (Introduction to Manufacturing Systems) have been consistently above 70% and have shown some improvement. Similarly, the results of question 18 of the senior survey are also well above the threshold.

Outcome i: A recognition of the need for, and an ability to engage in life-long learning.

- *IND E 337: Introduction to Manufacturing Systems: Library Research Assignment*
- *Senior Survey, Q20: Recognizing limitations & knowing when to seek additional information*

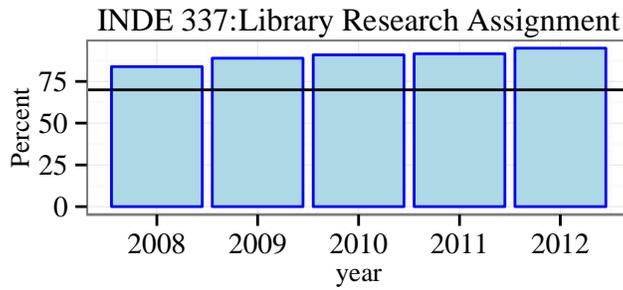


Figure 4-23. Course assessment for outcome *i*.

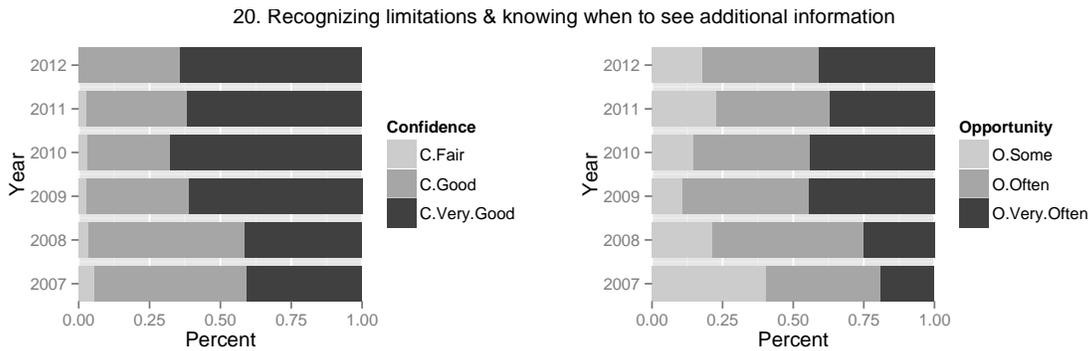


Figure 4-24. ABET Senior Survey question #20

Both assessment tools for this outcome have shown consistently strong achievement. Faculty have been specifically mentioning this outcome in a number of courses and achievement levels have been increasing over time.

Outcome *j*: A knowledge of contemporary issues

- *IND E 337: Introduction to Manufacturing Systems: Contemporary Issues Assignment*
- *Senior Survey, Q19: Applying knowledge about current issues to engineering problems*

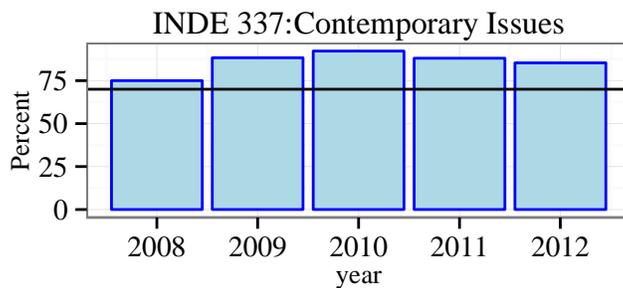


Figure 4-25. Course assessment for outcome *j*.

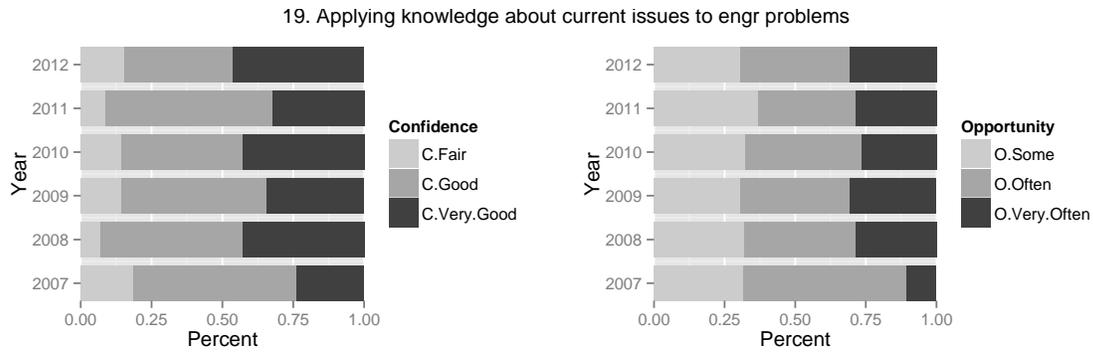


Figure 4-26. ABET Senior Survey question (#19)

While results in both assessment tools for outcome j have been above the threshold, both the contemporary issues assignment and the results of the senior survey show there is a possibility for improvement of achievement of this outcome. Section B describes recent actions taken to try to improve these results.

Outcome k : An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

- *IND E 316: Design of Experiments: Exam 1*
- *IND E 411: Stochastic Models and Decision Analysis: HW 1*
- *Senior Survey, Q11: Using appropriate techniques for problem solving*

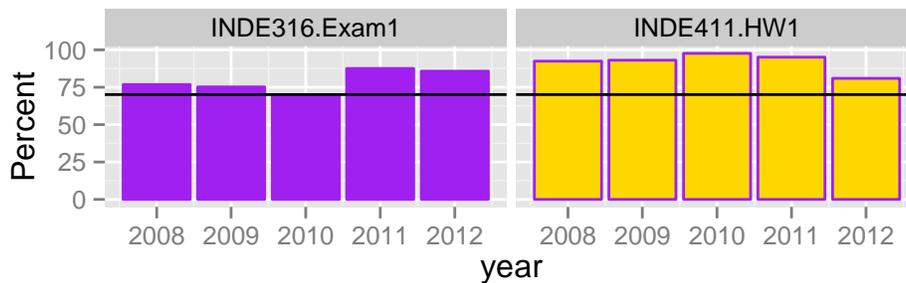


Figure 4-27. Course assessments for outcome k .

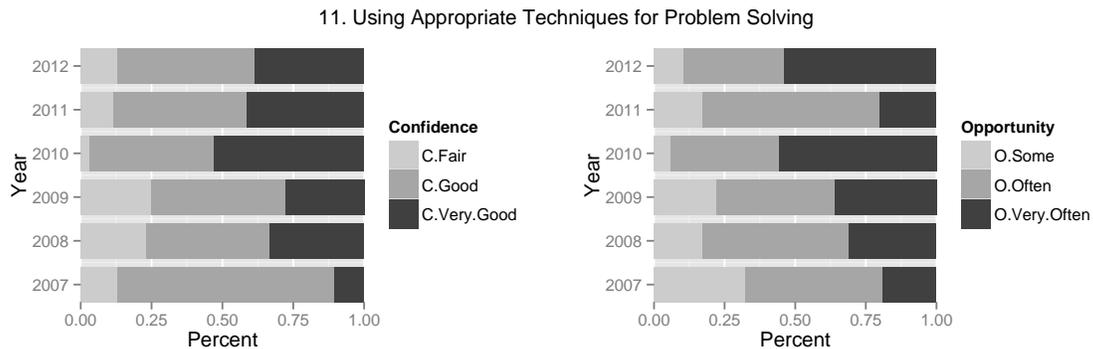


Figure 4-28. ABET Senior Survey question (#11)

The mean grades from IND E 316 (Design of Experiments) Exam 1 and IND E 411 (Stochastic Models and Decision Analysis) HW1 show that the students are meeting expectations for using techniques, skills, and modern engineering tools for practice (Fig 4-27). The students ratings from the ABET senior survey question #11 show that they have reasonable confidence and opportunities to achieve this outcome (Fig 4-28). Results from the senior design rubric and project evaluation provide evidence of strong achievement of this outcome.

Outcome I: An understanding of the integrated, inter-disciplinary nature of the discipline.

- *IND E 494: Design in the Mfg Firm: Senior Design Proposal (for 2012-2013 academic year)*
- *IND E 495: IE Design: Senior Design Rubrics: Q4-Integration of IE skills*

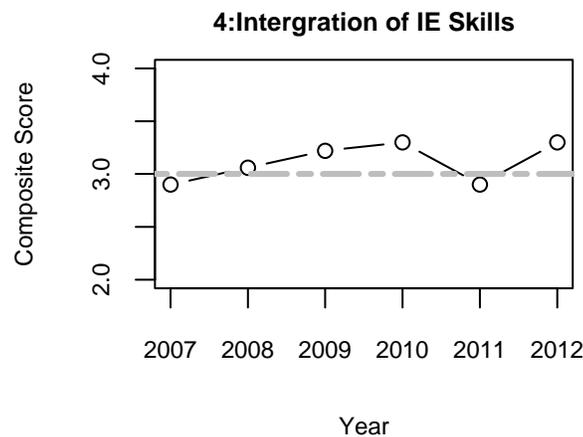


Figure 4-29. Senior design rubric, Q4-Integraton of IE Skills.

The senior design rubric Q4 has a median score of 3.14 with values ranging from 2.9 to 3.3. We have been consistently above the threshold in this area (mean ratings score was 2.9 for 2007 and 2011 only). This is expected as our senior design class encompasses concepts from all the IE classes into a real-world project.

Documentation and maintenance of results

- Each year, faculty retreat: faculty are assigned to courses from which assessment data is collected
- At that time, they are reminded of the assessment data that is to be collected
- Following completion of each assessment course, the instructor collects data and provides it to department administrator
- The department administrator inputs it in to the assessment information database.
- At the end of the academic year, the updated database is given to the faculty ABET coordinator, who prepares the graphical information for presentation at the next faculty retreat.

B. Continuous Improvement

The results from our assessment tools (senior design rubric, course assignment and exam grades, and senior survey) are reviewed annually as part of our continuous improvement process. Each year, and prior to the beginning of the Autumn Quarter, the faculty have an all day retreat where we set aside the necessary time to review and discuss the data from the assessment tools. In general, the discussion centers on the following:

- Review of each assessment tool (as presented in section A of criterion 4).
- Do our curriculum goals appear to be met?
- Do the metrics/assessment tools continue to provide insights on the student outcome identified or whether a change needs to be made (given addition of new faculty member, changes in class instructor, and changes in curricula). If not, what changes can we make?
- What actions should be considered based on this discussion? Are potential improvements required in the curriculum and/or in individual courses?

Discussions have concluded that the curriculum is currently performing well, and major curricula changes are not required. However, some course related improvements were considered and some potential improvements to the assessment tools were also considered.

One issue that has arisen is associated with *student outcomes c and h*. As noted earlier in the data from the senior design rubric, category 4 (consideration) is consistently rated below 3.0 (meets expectation). During this ABET cycle, a number of things were tried to produce improved results for this outcome. On an annual basis (up to 2011), an external expert was brought in to give a presentation on “lean/green” and showcase analytical tools that can be used to address being efficient while also being sustainable. The lecture showed the students how to use lean tools used to improve productivity (taught initially in IND E 337) to address environmental problems in industry. A new lecture on these other considerations was also added in 2009. Although there was a slight improvement in 2010, this improvement was not sustained. This issue was discussed at the faculty retreat in September 2011. Based on that discussion, in the 2012 offering of senior design, the instructor added grading of these other considerations as a part of the project proposal, which is submitted at the end of winter quarter (IND E 494). In 2013, the instructor of this course again updated the lecture that focuses on other considerations. This updated lecture was moved to early in the course (2nd week of January), with the goal of having students begin to include this in their work earlier. This updated lecture includes considerations of risk. The goal is to tie the idea of the other considerations to the risk of the success of the design being developed. Assessment of the result of this new lecture will occur in June 2013 and be considered at the faculty retreat in September 2013.

Also associated with the data from the senior design rubric and the senior survey questions about the opportunities in the curriculum to understand ethical issues, it was decided to take actions to improve this area (outcome *f*). To address this issue, we have added modules/assignments in the Senior Design Class to enhance opportunities to learn

about ethics, including an ethics assignment and presentation. It seemed that the students had been missing key aspects of the ethics issue in their work. Consequently, a new grading rubric for the ethics assignment in senior design was developed and used in 2013. The goal is for the rubric to help students better frame the problem. However, we also recognized that this class is at the end of their IE program. Hence, to further enhance the need to consider other societal and ethical considerations, students who take IND E 351 (Human Factors) also undergo Internal Review Board certification to conduct studies on humans as part of the class requirements. This class is a technical elective as part of the Design category.

To further address outcomes *c*, *h* and *j*, additional and augmented lectures in IND E 337 were used in the last two years. A new lecture discussing globalization was added. The National Academies Press publication “Making Things: 21st Century Manufacturing and Design” was presented and discussed. Other readings and class discussions were based on “OECD Science, Technology and Industry Outlook, 2012” and “OECD Sustainable Manufacturing Toolkit.” These additions to the course were started in 2012. Since much of the assessment of these 3 outcomes occurs associated with senior design, the results of 2013 assessment data will be used to determine the impact of these additions.

Discussions among the faculty also concerned outcome *d*. Students work on teams in the senior design class over two consecutive quarters. Despite positive results from senior survey questions 8 and 9, there was some uncertainty among the faculty about the adequacy of the survey as an assessment tool. Given how important the ability to function on a team is to the success of our graduates, a variety of actions were undertaken to potentially improve the attainment of this outcome. In 2011, a new team based project was added to IND E 337. This was to provide an additional team activity earlier in the curriculum. Additionally, in 2013, enhancements to the teaming aspect of senior design were introduced. Dr. Jim Borgford-Parnell, from the Center for Engineering Learning and Teaching, presented a lecture on the cognitive benefits of team based learning. Then, as part of the team based activities in senior design, the teams are required to develop a peer assessment tool. Four times during the two quarter sequence, the teams use the assessment tool to evaluate the team’s performance as well as the performance of individuals on the team. The benefits of these changes will be evaluated following review of the assessment data for 2013. This new assessment tool will replace the previous tool, which was a single team peer review at the end of the senior design project.

If there are two or more instructors that regularly teach a specific class, the instructor of those courses meet on a periodic basis to compare syllabi, course assignments, and discuss any student issues that may arise.

For example, the IND E 410, 411, and 412 Operations Research series are taught by Professors Zabinsky and Ghate. In particular, IND E 410 and 411 are used to help this IE program assess outcomes *a*, *e*, and *k*. As noted earlier in the results summary, the average exam grades are generally well over 70% except for two noted exceptions: IND E 410 Midterm for 2009 [slightly over 70% and IND E 411: Final for 2008 [64%]. Although these grades are reasonable, the two instructors still have frequent discussions regarding

the course material to continually enhance the course material. Recently, it has become evident that students have trouble accessing the courses due to the limited size of the classroom for the computer lab session. To allow more students to take this sequence, the lab sessions will be dropped starting next year, and the course will be held 3 times a week for 80 minutes each session. The course material will be revised to integrate exercises throughout the course, instead of concentrating them during the computer lab sessions. Since most students bring laptops to class now, this change should not adversely impact the students, and the course scheduling will be easier to allow better access for students interested in the OR sequence.

Another course that is taught by several instructors is IND E 315 (Probability & Statistics for Engineers). This is an introductory statistics class that serves the needs of the entire College of Engineering and is therefore, fairly large (over 100 students per quarter). Although this class is not used as an assessment tool, it is a required class that forms the basis of knowledge for outcomes *a*, *b*, *e*, *i*, *j*, *k*, and *l*. In the past six years, this course has been taught by Profs. Kapur, Mastrangelo, and Boyle. They meet periodically to discuss opportunities to enhance student learning, engagement, and interest. The instructors have discussed in-class projects, supplemental data sets, and the extent that a statistical software package should be used to supplement student learning.

A review of the results of the ABET Senior Surveys shows that there is consistency, with little change over the past six years. Further, we recognize that there are many things that can impact the ratings for the senior design rubrics (including changes in evaluators from year to year, the number of projects, the quality of the project definitions, and the external support from companies), but these outcomes are useful for addressing enhancements in our curricula. The ratings of this senior rubric in combination with the other performance and perception metrics collected provide insights for our continuous improvement process.

C. Additional Information

The following will be available for review during the ABET visit:

- Copies of the Senior Design Rubric
- Copies of the Senior Survey
- Copies of course assignments and exams used for assessment
- Faculty retreat meeting minutes or other faculty meeting in which ABET was discussed

CRITERION 5. CURRICULUM

A. Program Curriculum

1. ABET Self Study Table 5-1

The University of Washington is on a quarter system and the Industrial Engineering curriculum and course offerings are shown in Table 5-1 (per the format provided in the ABET self study). Table 5-1 describes the plan of study for students in the UW IE program including information on course offerings in the required curriculum in the form of a recommended schedule by year and term along with maximum section enrollments for all courses in the program over the last two terms the course was offered.

2. The IE program curriculum and its alignment with the program educational objectives.

Our curriculum provides various opportunities for our students to be introduced to real world problems in Industrial Engineering, and gain the tools to become experts in the engineering field. Several IE courses (required non-IE, required IE, selected electives, and electives) also offer an opportunity to work on group projects, and in multidisciplinary groups. As noted by Tables 5-2 to 5-5, our students are provided industrial engineering skills, while also receiving breath and depth in math, science, problem solving abilities, and the broad general education required to become responsible citizens. The classes in the first two years of the program introduces students to the fundamental math and science skills, while the last two years offer more in-depth knowledge with practice. Our senior design classes (IND E 494 and IND E 495) demonstrate the learning in real world settings.

Table 5-2. Required non-IE curriculum's alignment with four program educational objectives

Required non-IE Courses		Program Educational Objectives			
Course No.	Title	Career	Engineering Expertise	Professionalism	Lifelong Learning
Math 124	Calculus w/Anal Geom		I		
Math 125	Calculus w/Anal Geom II		I		
Math 126	Calculus w/Anal Geom III		I		
Math 307	Intro to Diff Equations		I		
Math 308	Linear Algebra w/Applications		I		
Chem 142	General Chemistry w/LAB		I		
Chem 152	General Chemistry w/LAB		I		
Phys 121	Mechanics w/LAB		I		
Phys 122	Electro/Oscillatory w/LAB		I		
Phys 123	Waves		I		
Eng Comp	English Composition	I			
HCDE 231	Intro to Tech Writing	I			
CSE 142	Computer Prog for Eng				
MSE 170	Fund of Material Science		I		
AA 210	Engr Statics		I		
EE 215	Fund of Electrical Engineering		I		
CEE 220	Intro to Mechanics of Materials		I		
ME 230	Kinematics & Dynamics		I		

I=Introduced, P=Practiced, D=Demonstrated

Table 5-3. IE required course alignment with four program educational objectives

IE Required Courses		Program Educational Objectives			
Course No.	Title	Career	Engineering Expertise	Professionalism	Lifelong Learning
IND E 250	Fundamentals of Engineering Economics	P	I		
IND E 315	Prob/Stats for Engineers	P	I		
IND E 316	Design of Experiments & Reg Analysis	P	P		
IND E 337	Intro Manufacturing Systems	P	P	P	P
IND E 410	Linear and Network Programming	P	P		
IND E 411	Stochastic Models & Decision Analysis	P	P		
IND E 494	Design in the Mfg Firm	D	D	D	D
IND E 495	Industrial Engineering Design	D	D	D	D

I=Introduced, P=Practiced, D=Demonstrated

Table 5-4. Selected electives alignment with four program educational objectives

Selected Electives		Program Educational Objectives			
Course No.	Title	Career	Engineering Expertise	Professionalism	Lifelong Learning
<i>A. Operations Research</i>					
IND E 412	Integer & Dynamic Programming	P	P		
IND E 424	Simulation	P	P		
<i>B. Statistics</i>					
IND E 321	Statistical Quality Control	P	P		
IND E 426	Reliability Engr & System Safety	P	P		
<i>C. Production/Operations</i>					
IND E 430	Mfg Scheduling & Inventory	P	P		
INDE 439	Plant Layout & Material Handling	P	P		
<i>D. Design</i>					
IND E 351	Human Factors in Design	P	P	P	P
IND E 455	User Interface Design	P	P	P	P
<i>E. General Engineering</i>					
AA 260	Thermodynamics		I		
CSE 143	Computer Programming for Engr II		I		

I=Introduced, P=Practiced, D=Demonstrated

Table 5-5. Technical electives alignment with four program educational objectives

Technical Electives		Program Educational Objectives			
Course No.	Title	Career	Engineering Expertise	Professionalism	Lifelong Learning
IND E 101	Introduction to Industrial Engineering	I	I		
IND E 470	Systems Engineering	P	P		
IND E 496	Technology-Based Entrepreneurship	D	D	D	

I=Introduced, P=Practiced, D=Demonstrated

3. The IE program curriculum and its associated prerequisite structure.
 Tables 5-6 to 5-9 (required non-IE course, required IE courses, selected electives and technical electives, respectively) show how our program curriculum and associated prerequisite structure maps to the attainment of student outcomes.

Table 5-6. Required non-IE courses in support of the student outcomes

Required Courses (non-IE)		Student Outcomes											
Course No.	Title	a	b	c	d	e	f	g	h	i	j	k	l
Math 124	Calculus w/Anal Geom	X										X	
Math 125	Calculus w/Anal Geom II	X										X	
Math 126	Calculus w/Anal Geom III	X										X	
Math 307	Intro to Diff Equations	X										X	
Math 308	Linear Algebra w/Applications	X										X	
Chem 142	General Chemistry w/LAB	X										X	
Chem 152	General Chemistry w/LAB	X										X	
Phys 121	Mechanics w/LAB	X										X	
Phys 122	Electro/Oscillatory w/LAB	X										X	
Phys 123	Waves	X										X	
Eng Comp	English Composition							X					
HCDE 231	Intro to Tech Writing				X			X				X	
CSE 142	Computer Prog for Eng	X				X						X	
MSE 170	Fund of Material Science	X	X		X	X						X	X
AA 210	Engr Statics	X				X						X	
EE 215	Fund of Electrical Engineering	X	X	X	X	X							
CEE 220	Intro to Mechanics of Materials	X	X			X						X	
ME 230	Kinematics & Dynamics	X	X										
Total		16	4	2	3	5	0	2	0	0	0	15	1

Table 5-7. IE required courses that support the student outcomes

IE Required Courses		Student Outcomes											
Course No.	Title	a	b	c	d	e	f	g	h	i	j	k	l
IND E 250	Fund. of Engineering Economics	X				X			X		X	X	X
IND E 315	Prob/Stats for Engrs	X	X			X				X	X	X	X
IND E 316	Design of Experiments & Reg Analysis	X	X	X		X						X	X
IND E 337	Intro Manuf Systems	X				X		X	X	X	X	X	X
IND E 410	Linear and Network Programming	X	X	X		X				X	X	X	X
IND E 411	Stochastic Models & Decision Analysis	X	X	X		X				X	X	X	X
IND E 494	Design in the Mfg Firm	X	X	X	X	X	X	X	X	X	X	X	X
IND E 495	Industrial Engr Design	X	X	X	X	X	X	X	X	X	X	X	X
Total		8	6	5	2	8	2	3	4	6	7	8	8

Table 5-8. Selected electives that support the student outcomes

Selected Electives		Student Outcomes											
Course No.	Title	a	b	c	d	e	f	g	h	i	j	k	l
<i>A. Operations Research</i>													
IND E 412	Integer & Dynamic Programming	X	X	X		X				X	X	X	X
IND E 424	Simulation	X	X	X		X		X				X	
<i>B. Statistics</i>													
IND E 321	Statistical Quality Control	X	X	X		X			X	X	X	X	
IND E 426	Reliability Engr & System Safety	X		X		X	X		X	X	X	X	X
<i>C. Production/Operations</i>													
IND E 430	Mfg Scheduling & Inventory	X		X		X		X	X		X	X	X
IND E 439	Plant Layout & Material Handling	X		X		X		X	X		X		X
<i>D. Design</i>													
IND E 351	Human Factors in Design			X		X	X	X	X		X		X
IND E 455	User Interface Design	X	X	X	X	X	X	X	X			X	X
<i>E. General Engineering</i>													
AA 260	Thermodynamics	X				X						X	
CSE 143	Computer Programming for Engr II	X				X						X	
Total		7	4	8	2	8	2	5	6	4	5	6	5

Table 5-9. Technical electives that support the student outcomes

Technical Electives		Student Outcomes											
Course No.	Title	a	b	c	d	e	f	g	h	i	j	k	l
IND E 101	Introduction to Industrial Engineering	X	X	X									X
IND E 470	Systems Engineering	X		X		X		X	X	X		X	
IND E 496	Technology-Based Entrepreneurship	X		X		X	X	X	X		X		X
	Total	3	1	3	0	2	1	2	2	1	1	1	2

4. Worksheet that illustrates the prerequisite structure of the program’s required courses.

Please see the B.S.I.E. graduation requirements and Sample Quarterly Schedule located at the end of this Criterion.

5. Description of how our IE program meets the requirements in terms of hours and depth of study for each subject area (Math & Basic Sciences, Engineering Topics, and General Education) specifically addressed by either the general criteria or the program criteria.

We refer you again to our B.S.I.E. graduation requirements located at the end of this section.

The Math & Basic Science requirements are covered by courses required for graduation. This includes one year of calculus (15 credits), plus 3 additional required Math courses, MATH 307: Intro to Differential Equations, MATH 308: Linear Algebra with Applications, and IND E 315: Probability and Statistics for Engineers (3 credits each for a total of 9 credits). Because Industrial Engineering as a discipline has a heavy reliance on mathematics, two years of mathematics courses are required. The courses in the second year are important foundational material for IE courses in the third and fourth years.

Basic Sciences requirements are met by the requirement for 2 courses in General Chemistry with Lab (10 credits) and 3 courses in Physics with Lab (15 credits). This is equivalent to one and 2/3 years of basic science. Physics and Chemistry are foundational material to the basic engineering science courses.

The B.S.I.E. degree also requires a minimum of 28 specified credits in basic engineering. This includes CSE 142: Basic Computing, MSE 170: Fundamentals of Materials Science, AA 210: Statics, EE 215: Fundamentals of Electrical Engineering, CEE 220: Introduction to Mechanics of Materials, ME 230: Kinematics and Dynamics, and IND E 250: Fundamentals of Engineering Economy. Additionally, the B.S.I.E. requires one of two

additional general engineering courses, either AA 260: Thermodynamics or CSE 143: Computer Programming for Engineers II (both 4 credits each).

The B.S.I.E. requires 12 credits of Written and Oral Communication. This includes 5 credits of English Composition, which satisfies the University requirement and can be achieved by taking University specified courses that have been placed in this category. The second required course in this category is HCDE 231: Intro to Technical Writing (3 credits) and an additional University approved W course. A required B.S.I.E. course, INDE 337 is a University approved W course and thus is almost always used to complete this 12 credit requirement.

The final general education requirement for the B.S.I.E. is a minimum of 30 credits of courses taken from the University approved categories of Visual, Literary and Performing Arts, and Individuals and Society. Students must choose and take at least 10 credits in each of these two categories. The general education component provides students with a breadth of knowledge that enables them to work collaboratively with others and have an appreciation for other disciplines. It enhances their understanding of the culturally diverse nature of the local, national and international society. Furthermore, it helps them become socially responsible leaders, capable of making humane and informed decisions.

The final categories are the required INDE courses (24 credits), selective technical INDE elective courses (one course from each of 4 categories) for a minimum of 16 credits and additional technical electives taken from a list of approved technical electives or approved individually by the faculty undergraduate advisor.

The total B.S.I.E. requirement is a minimum of 180 credits.

6. Major design experience that prepares students for engineering practice.

The IE program has a required, two consecutive quarter course sequence (IND E 494 and IND E 495) which is the senior design course. The two courses include instruction in IE design and systems engineering methodology. There is additional coverage of topics related to other considerations in design, including economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. There is also instruction and an assignment in professional ethics. However, the most substantial effort on the part of the students is work on a design problem from a local industrial partner. The problems are solicited from companies represented on the ISE Visiting Committee, from industrial research partners and from other sources. Often, alumni working in local industry identify suitable problems and offer them to the IE program for potential senior design projects. The course instructor typically meets with potential senior design project sponsors during the summer or early Autumn Quarter to discuss and finalize the projects. These projects are normally presented in a one or two paragraph statement. They are designed to be open-ended, thus requiring the student teams to delve deeply into the issue to decide what data is needed, what the underlying problem is, and what methodologies are appropriate to apply as analysis tools.

Students take the senior design course near the end of their program. They must have senior standing in order to take the sequence. That is, they will have completed enough of their coursework so they can apply previous learning in this senior design course. Since these are real problems and for real companies, students must identify and consider real world design constraints in developing alternative solutions. They must also develop a means for choosing among alternatives and provide recommendations to the company at the conclusion of the project. Naturally, the real world constraints associated with recommended solutions to the company must be a part of the work.

Students are introduced to the problems at the beginning of the first course in the sequence (IND E 494). Representatives of the sponsoring companies are present to discuss the problem with the class. Students then provide the instructor with a priority list of problems they are interested in working through. Using that information, plus other inputs, the course instructor assigns teams to each project. The teams are formed with consideration to the students' interest, as well as gender, culture, and student academic performance to provide the teams with diversity and opportunities to work with different viewpoints and ideas. The students then work on the problem as a team.

The outputs of the senior design work include a final written report, an oral presentation (both in class and to the sponsoring company), and a poster presentation at a final event in which teams of volunteers (practicing Industrial Engineers, company managers and faculty) evaluate the work. There are two grading rubrics that are presented to the students at the beginning of the first quarter of the course that are also used for evaluation of the work. One is for the written project report. The second is for evaluation of the posters at the poster presentation session.

This current academic year (2012-2013) has seen a typical group of senior design projects. There were projects for Boeing, Crowley Maritime, Oak Harbor Freight Lines, Genie (Terex) Industries, 2 projects for Seattle Children's Hospital and a newly establish brew pub. The number and diversity of projects is a function of the size of the senior class (typical team size is 4-6 students) and the project availability. The mix of manufacturing, logistics, health care and other companies displayed this year is typical of the mix annually.

7. The IE program does not use cooperative education to satisfy curricular requirements.
8. Materials that will be available for review during the visit to demonstrate achievement related to this criterion

We will have the following material available for the program evaluator at the time of the scheduled visit.

- Course syllabi
- Textbooks
- Sample student work for all INDE classes
- Senior Design Project Reports and Posters

B. Course Syllabi

See Appendix A.

Table 5-1 Curriculum
Industrial Engineering Program

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE. ¹	Subject Area (Credit Hours)			Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered ²
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (✓)	General Education		
1st Year/1st Qtr: MATH 124, Calculus w/Anal Geometry	R	5			Win, Spr 2013	120
CHEM 142, General Chemistry w/lab	R	5			Win, Spr 2013	331
ENGL Composition*	R			5 (W)	Win, Spr 2013	22
1st Year/2nd Qtr: MATH 125, Calculus w/ Analytic Geometry II	R	5			Win, Spr 2013	120
CHEM 152, General Chemistry w/lab	R	5			Win, Spr 2013	401
VLPA/I&S	E			5	Win, Spr 2013	N/A
1st Year/3rd Qtr: MATH 126, Calculus w/ Analytic Geometry III	R	5			Win, Spr 2013	150
PHYS 121 Mechanics w/lab	R	5			Win, Spr 2013	220
CSE 142, Computer Programming for Eng	R		4		Win, Spr 2013	436, 357
2nd Year/1st Qtr: MATH 307, Intro to Differential Equations	R	3			Win, Spr 2013	50
PHYS 122, Electro/Oscillatory w/ lab	R	5			Win, Spr 2013	183
AA 210, Engineering Statics	R		4		Aut 2012, Win 2013	195, 191
HCDE 231, Intro to Technical Writing*	R			3 (W)	Win, Spr 2013	30
2nd Year/2nd Qtr: MATH 308, Linear Algebra with Applications	R	3			Win, Spr 2013	50
PHYS 123, Waves w/ lab	R	5			Win, Spr 2013	156
CEE 220, Intro to Mechanics of Materials	R		4		Win, Spr 2013	160, 183
IND E 315, Probability/Statistics for Engrs.	R	3			Win, Spr 2013	129, 140

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE. ¹	Subject Area (Credit Hours)			Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered ²
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education		
2nd Year/3rd Qtr: IND E 250, Engineering Economics	R		4		Win 2012, Win 2013	63, 65
MSE 170, Fund of Material Science	R		4		Win, Spr 2013	68, 90
ME 230, Kinematics & Dynamics	R		4		Win, Spr 2013	160, 178
VLPA/I&S	E			3		
3rd Year/1st Qtr: IND E 337, Intro Manufacturing Systems*	R		4 (W)		Aut 2011, Aut 2012	43, 55
IND E 410, Linear Programming	R		4		Aut 2011, Aut 2012	41, 45
IE Area E Technical Elective	SE		4			
VLPA/I&S	E			4		
3rd Year/2nd Qtr: IND E 316, Design of Experiments	R		4√		Win 2012, Win 2013	45
IND E 411, Nonlinear Programming	R		4		Win 2012, Win 2013	43, 47
IE Area B Technical Elective	SE		4√			
VLPA/I&S	E			4		
3rd Year/3rd Qtr: IE Approved Technical Elective	SE		3			
IE Approved Technical Elective	SE		4			
EE 215, Fund of Electrical Engineering	R		4		Win, Spr 2013	134, 135
IE Area D Technical Elective	SE		4√			
4th Year/1st Qtr: IE Area A Technical Elective	SE		4			

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE. ¹	Subject Area (Credit Hours)			Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered ²
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education		
IE Area C Technical Elective	SE		4			
IE Approved Technical Elective	SE		3			
VLPA/I&S	E			4		
4th Year/2nd Qtr: IE Approved Technical Elective	SE		4			
VLPA/I&S	E			5		
IND E 494, Design in the Manufacturing Firm	R		4√		Win 2012, Win 2013	50, 35
4th Year/3rd Qtr: IE Approved Technical Elective	SE		3			
VLPA/I&S	E			5		
Free elective				4		
IND E 495, IE Design	R		4√		Spr 2012, Spr 2013	49, 35
<i>Add rows as needed to show all courses in the curriculum.</i>						
TOTALS-ABET BASIC-LEVEL REQUIREMENTS			49	89	42	
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM: 180						
PERCENT OF TOTAL			27.20%	49.40%	23.30%	
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours		32 Hours	48 Hours		
	Minimum Percentage		25%	37.50%		

*Fulfills College Writing Requirement

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Bachelor of Science in Industrial Engineering Graduation Requirements

Mathematics.....[24 credits]

- ◆ MATH 124 (or 127)* [5cr] Calculus with Analytic Geometry I
 - ◆ MATH 125 (or 128)* [5cr] Calculus with Analytic Geometry II
 - ◆ MATH 126 (or 129)* [5cr] Calculus with Analytic Geometry III
 - MATH 307 [3cr] Intro to Differential Equations [pr: MATH 125]
 - MATH 308 [3cr] Linear Algebra with Applications [pr: MATH 128]
 - IND E 315 [3cr] Prob. & Statistics for Engineers [pr: MATH 307]
- *The sequence of MATH 127, 128, 129 may be taken in lieu of 124, 125, 126.

Industrial Engineering Required Core Courses.....[24 credits]

- IND E 316 [4cr] Design of Experiments & Regression Analysis [pr: IND E 315]
- IND E 337 [4cr] Intro to Manufacturing Systems
- IND E 410 [4cr] Linear & Network Programming [pr: either MATH 136 or MATH 308; CSE 142]
- IND E 411 [4cr] Stochastic Models & Decision Analysis [pr: IND E 315; IND E 410]
- IND E 494 [4cr] Design in the Manufacturing Firm [pr: IND E 337; senior standing]
- IND E 495 [4cr] Industrial Engineering Design [pr: IND E 494]

Physical Sciences.....[25 credits]

- ◆ CHEM 142 [5cr] General Chemistry with lab
 - ◆ CHEM 152 [5cr] General Chemistry with lab [pr: CHEM 142]
 - ◆ PHYS 121* [5cr] Mechanics with lab [pr: MATH 124]
 - ◆ PHYS 122* [5cr] Electro/Oscillatory with lab [pr: MATH 125]
 - ◆ PHYS 123* [5cr] Waves with lab [pr: MATH 126]
- *The accompanying lab sections to PHYS 121, 122, 123 must be completed

Technical Electives.....[minimum 37 credits]

Complete a minimum of 37 credits, including **AT LEAST** one course from **EACH** of the following 5 categories.

- A. Operations Research:
 - IND E 412 [4cr] Integer and Dynamic Programming [pr: IND E 411]
 - IND E 424 [4cr] Simulation [pr: IND E 337 & 411; 411 may be taken concurrently]
- B. Statistics:
 - IND E 321 [4cr] Statistical Quality Control [pr: IND E 315]
 - IND E 426 [4cr] Reliability Engineering & System Safety [pr: IND E 315]
- C. Production/Operators:
 - IND E 430 [4cr] Manufacturing Scheduling & Inventory [pr: IND E 337 & 410; both of which may be taken concurrently]
 - IND E 439 [4cr] Plant Layout & Material Handling [pr: IND E 410; which may be taken concurrently]
- D. Design:
 - IND E 351 [4cr] Human Factors in Design
 - IND E 455 [4cr] User Interface Design
- E. General Engineering:
 - AA 260 [4cr] Thermodynamics [pr: CHEM 142; MATH 126; PHYS 121]
 - CSE 143 [5cr] Computer Programming for Engineers II [pr: CSE 142]

Visual, Literary & Performing Arts/Individuals & Society

[V/LP/A/I&S].....[30 credits]

Minimum 10 credits in V/LP/A required.
Minimum 10 credits in I&S required.

General Engineering/Computing Courses.....[28 credits]

- CSE 142 [4cr] Computer Programming for Engineers
- MSE 170 [4cr] Fund of Material Science [pr: CHEM 152]
- AA 210 [4cr] Engineering Statics [pr: MATH 126; PHYS 121]
- EE 215 [4cr] Fund. of Electrical Engineering [pr: PHYS 122; MATH 126]
- CEE 220 [4cr] Intro to Mechanics of Material [pr: AA 210]
- ME 230 [4cr] Kinematics & Dynamics [pr: AA 210]
- IND E 250 [4cr] Fund. of Engineering Economy

Total credits required for Graduation.....180 credits

Early Admission Requirements:

- AUTUMN quarter only
- Must be enrolled at UW w/ at least 15cr earned at UW
- Must complete: MATH 124, 125, 126 or equiv; 10 cr of Physical Science requirements; 5 cr ENGL COMP

Industrial Engineering Sample Quarterly Schedule

FRESHMAN-AUTUMN QUARTER		FRESHMAN-WINTER QUARTER		FRESHMAN-SPRING QUARTER	
MATH 124 or 127 -Calculus 1	5	MATH 125 or 128 -Calculus 2	5	MATH 126 or 129 -Calculus 3	5
CHEM 142-Chem & lab 1	5	CHEM 152-Chem & lab 2	5	PHYS 121-Mechan & lab	5
ENGL COMP	5	VLP/PAI&S	5	CSE 142-Computer Prog	4
QUARTER TOTAL	15	QUARTER TOTAL	15	QUARTER TOTAL	14
SOPHOMORE-AUTUMN QUARTER		SOPHOMORE-WINTER QUARTER		SOPHOMORE-SPRING QUARTER	
MATH 307-Diff Equations	3	MATH 308-Linear Algebra	3	IND E 315 -Prob & Stats Engr.	3
PHYS 122-Electro & lab	5	PHYS 123-Waves & lab	5	MSE 170-Mats Science	4
AA 210-Statics	4	CEE 220-Mech of Materials	4	ME 230-Dynamics	4
HCDE 231-Tech Writing	3	VLP/PAI&S	3	IND E 250	4
QUARTER TOTAL	15	QUARTER TOTAL	15	QUARTER TOTAL	16
JUNIOR-AUTUMN QUARTER		JUNIOR-WINTER QUARTER		JUNIOR-SPRING QUARTER	
IND E 337 - Intro to Manufact Syst	4	IND E 316 - Design of Experiments	4	Area A - D TECH ELECTIVE	4
IND E 410-Appl Linear Programming	4	IND E 411-Nonlin & Stoch Mdl	4	TECH ELECTIVE	4
Area A - D TECH ELECTIVE	4	Area A - D TECH ELECTIVE	4	EE 215- Fundamentals of EE	4
VLP/PAI&S	3	VLP/PAI&S	4	TECH ELECTIVE	3
QUARTER TOTAL	15	QUARTER TOTAL	16	QUARTER TOTAL	15
SENIOR-AUTUMN QUARTER		SENIOR-WINTER QUARTER		SENIOR-SPRING QUARTER	
Area E TECH ELECTIVE	4	IND E 494-Design /Manufact. Firm	4	IND E 495-Senior Design	4
Area A - D TECH ELECTIVE	4	TECH ELECTIVE	4	TECH ELECTIVE	3
TECH ELECTIVE	3	VLP/PAI&S	5	VLP/PAI&S	5
VLP/PAI&S	5				
QUARTER TOTAL	16	QUARTER TOTAL	13	QUARTER TOTAL	12

CRITERION 6. FACULTY

A. Faculty Qualifications

The ISE faculty excel in teaching, research and service. Many are internationally renowned and conduct cutting edge research. ISE faculty are passionate teachers and researchers.

Teaching

All of the faculty in ISE hold PhD degrees and have government or industry experience. The faculty teach across numerous specialty areas, including engineering design, health systems engineering, human factors, virtual reality, large-scale assembly, manufacturing, optimization, quality and reliability, supply chain management, and system integration. Adjunct professors from Civil & Environmental Engineering, College of Forest Resources, Environmental Health, Global Health and Health Sciences, Management Science, Mechanical Engineering, Radiology, along with national and international visiting scholars, enhance the departments teaching and research efforts.

Research

As stated previously, the current research portfolio is about \$4.2 million funded by NSF, Microsoft, Toyota, Children's Hospital, NHTSA and the Office of Naval Research just to name a few. ISE faculty have collaborative projects with the UW departments of Aeronautics & Astronautics, Civil & Environmental Engineering, Electrical Engineering, Radiology, Global Health, Environmental Health, the Business School, and Laboratory Medicine, as well as, Children's Hospital, Harborview Medical Center, and Group Health. Research collaborations with other universities include Arizona State, Penn State, San Diego State, Drexel, Virginia Tech, U. of Michigan, and Simon Fraser. Company collaborations include Boeing, Microsoft, and Toyota. There is a strong output of journal and symposium papers by faculty and students.

Professional Service

Most faculty are involved in professional societies such as INFORMS, ASEE, IIE, IFIP, SME, ASME, HFES, ASQ, IEEE, MOSI, ASA, INCOSE, and WEPAN as outlined below.

Faculty Qualifications

The primary focus of Professor **Benita Beamon**'s research program is to use quantitative methods (discrete-event simulation, mathematical modeling, and statistics) to develop management policies for supply chains, production systems, and humanitarian relief chains. Professor Beamon's ongoing work in supply chain management focuses on sustainability. In

particular, she is interested in performance measurement and environmentally conscious production system and food supply chain analysis and design. Her research work has been supported by the National Science Foundation, University of Washington's Innovation Fund, The Fritz Institute, The Boeing Company, Flow International Corporation, LensCrafters, Pierre Foods, and Medtronic Physio-Control. Professor Beamon's research activities have been honored by two best paper journal awards, and her work has also been featured in *The Institute* (IEEE quarterly publication), the Institute of Industrial Engineers (IIE) Online, and the *Advanced Manufacturing Technology Newsletter*. Her other current and recent professional affiliations include: Adjunct Associate Professor of Global Health, University of Washington (2010 – Present), Faculty Fellow of the joint Department of Global Health and College of the Environment focus on Climate change and Global Health: Adaptive Solutions for Human Health and the Environment, University of Washington, 2010 – Present, and Research Fellow, Sightline, Inc., Seattle, WA (2008-2011).

Professor Beamon is the Faculty Advisor for the University of Washington chapter of Alpha Pi Mu (the Industrial Engineering Honor Society). She has published in numerous professional journals, served as an Associate Editor for the *International Journal of Modelling and Simulation* from 2000-2010, and is currently an advisory board member for the *Journal of Humanitarian Logistics and Supply Chain Management* (2010 – present). Professor Beamon also won the 2008 National CIEADH/IIE Innovations in Curriculum Award for her class "Humanitarian Logistics". Professor Beamon received her PhD in Industrial and Systems Engineering from the Georgia Institute of Technology, her MS in Operations Research and Industrial Engineering from Cornell University, and her BS in Industrial Engineering from Northwestern University.

Professor **Linda Ng Boyle's** research centers on human factors and statistical modeling. Her expertise centers on quantifying operator behavior, transportation safety, and the analysis and design of safety systems. She is the associate director of research for PacTrans, the region's university transportation center, and director of the Human Factors and Statistical Modeling Laboratory. Prof. Boyle and her students have conducted extensive research on adaptive automation for private and commercial vehicles, which has immense implications for the car of the future. She has led several independent evaluations of new technology (adaptive cruise control, combination forward collision/lane keeping systems), and has extensive experience with designing studies in controlled and naturalistic environments. Her work has been of great interest to students as demonstrated by the number of requests for presentations in high schools, and the number of students at the undergraduate and graduate level working in her lab.

Her research has been funded by the National Academy of Sciences – Transportation Research Board (TRB), US DOT, NSF, NIH, CDC, and Toyota. Over the course of her research, Dr. Boyle has authored almost 100 scientific articles, book chapters, and technical reports. Prior to her appointment at the UW, she was on the faculty at the University of Iowa and a senior researcher in the Office of Safety and Security at the U.S. DOT - Volpe Center.

She is a member of the Human Factors and Ergonomics Society (HFES), the American Statistical Association (ASA), and the Institute of Industrial Engineers (IIE). She is the recipient of the NSF Career Award, an associate editor for the highest impact journal in safety (Accident, Analysis and Prevention), and chair of the TRB Committee on Statistical Methods. She received her PhD in Civil and Environmental Engineering and MS in Inter-Engineering (now called

Industrial Engineering), both from the University of Washington. Her BS is in Industrial Engineering from the State University of New York at Buffalo.

Professor **Wanpracha “Art” Chaovalitwongse**’s research interests focus on developing a new decision-making paradigm for complex data and engineering systems. He has dedicated his career to drive transformative technological advances and employ them at the frontiers of national challenges – including complex systems for health care, genetics, transportation, and information security. He has studied several cross-disciplinary research problems and developed novel computational approaches to frame, model and optimize complex systems based on observable massive data and knowledge of system’s fundamental structures. Specifically, Professor Chaovalitwongse’s technical research focuses on developing new computational techniques/tools to optimally extract spatial and temporal characteristics of multidimensional time series data. His application research is targeted at analyzing data from brain activity to study brain diseases, cognitive functions, and human performance. Since he joined UW two years ago, he has extended his research to study multiple modalities of brain signal processing, from neurophysiological to neuroimaging data. His expertise in signal processing and brain network (connectivity) modeling has been proven beneficial and innovative in the neuroimaging field. Professor Chaovalitwongse is a member of Institute for Operations Research and Management Sciences (INFORMS).

His work in health care was awarded for Excellence in Research from the University of Florida, and he also holds several patents of novel optimization techniques adopted in the development of seizure prediction system. He is a two-time winner (2004 & 2008) of the William Pierskalla best paper for research excellence in Operations Research and Health Care applications by INFORMS. He has articles published in leading journals and conferences such as *Operations Research*, *Mathematical Programming*, *INFORMS Journal on Computing*, *Transportation Science*, *Computer Networks*, *IEEE transactions on Bio-medical Engineering*, *IEEE SMC*, *Epilepsy Research*, *Journal of Clinical and Neurophysiology*, *Epilepsia*, *SIGKDD*, *CSB*, and *ISMB*. He is currently an Area Editor in the healthcare and medical diagnosis area for the *Annals of Operations Research*, and an Associate Editor for the *IEEE Transactions on Human-Machine Systems*, *Journal of Combinatorial Optimization*, *Journal of Global Optimization*, and *Optimization Letters*. He joined the department of Industrial & Systems Engineering in Fall 2012 as an Associate Professor after serving as an Associate Professor at Rutgers University and Visiting Associate Professor at Princeton University. Professor Chaovalitwongse received his MS and PhD in Industrial & Systems Engineering from the University of Florida in 2000 and 2003, respectively.

Professor **Tom Furness** is a pioneer in the development of interfaces between humans and complex machines. He has been a crusader for the past 45 years for building aircraft cockpits which take into account the perceptual organization of the human. Most of his work has centered on the concept of virtual interface technologies that provide a circumambience of three dimensional spatial information to the human using the visual, auditory and tactile sensory modalities. His current research involves the comprehensive development of affordable virtual interface technologies for industry and consumers with applications in medical imaging, virtual prototyping, prostheses for the handicapped, virtual classrooms and televirtuality. Prior to joining the University of Washington in 1989, Professor Furness served for 23 years as the Chief of the Visual Display Systems Branch, Human Engineering Division of the Armstrong Aerospace

Medical Research Laboratory (USAF), Wright-Patterson AFB, OH. While in this position, he developed and evaluated visually-coupled systems and virtual interface concepts to improve the communication of information and control functions with the pilot and in 1986 he organized the Super Cockpit program for the Air Force and served as the program director until leaving for the UW. In this regard he is credited as being one of the original inventors of virtual reality.

Professor Furness is the founder of the Human Interface Technology Laboratory (HIT Lab) at UW and founder and international director of the HIT Lab NZ at the University of Canterbury, Christchurch, New Zealand and the HIT Lab Australia at the University of Tasmania, Launceston, Tasmania. He is also an Erskine Fellow and Adjunct Professor at the University of Canterbury and an Adjunct Professor at the University of Tasmania. Professor Furness lectures widely and has appeared in many national and international network and syndicated television science and technology documentaries and news programs. He is the inventor of the personal eyewear display, the virtual retinal display, the HALO display, spectrum pattern matching systems and holds 16 patents in advanced sensor, display and interface technologies. With his colleagues Dr. Furness has started 26 companies, two of which are traded on NASDAQ at a market capitalization of > \$ 10 B (USD). In 1998 he received the Discover Award for his invention of the virtual retinal display and more recently in 2013 the SPIE Prism Award for photonics innovation. He teaches courses in user interface design, virtual reality and technology entrepreneurship at the University of Washington, University of Canterbury and the University of Tasmania.

Professor Furness earned the BS in Electrical Engineering from Duke University in 1966 and the PhD in Engineering and Applied Science from the University of Southampton, England in 1981.

Professor **Archis Ghate's** research focuses on stochastic and dynamic optimization. He often uses dynamic programming, optimal control, mathematical programming, applied probability, statistics, and game theory to model and solve these problems. He is interested in applying these methods to medical treatment planning and service operations management. His work has appeared in journals such as Operations Research, Manufacturing and Service Operations Management, Operations Research Letters, Networks, Advances in Applied Probability, and European Journal of Operational Research. His research is funded by the National Science Foundation.

Professor Ghate received a CAREER award from the National Science Foundation in 2011 and an award for Excellence in Teaching Operations Research from the Institute of Industrial Engineers in 2012. Professor Ghate was voted Outstanding Professor by the Industrial and Systems Engineering students last four years in a row and his classes have appeared several times on the list of highest rated courses in the College of Engineering at the University of Washington. Professor Ghate was the President of the Pacific Northwest Professional Chapter of INFORMS a few years ago. He is a member of INFORMS and of IIE. He has reviewed journal articles for several journals including Operations Research, Manufacturing and Service Operations Management, Networks, Computers and Operations Research, and European Journal of Operational Research. He is an Associate Editor for IIE Transactions. He joined the Industrial and Systems Engineering department at the University of Washington in Fall 2006 as an Assistant Professor after completing his PhD in Industrial and Operations Engineering at the University of Michigan, Ann Arbor in August 2006, and an MS in Management Science and Engineering from Stanford University in June 2003. He completed his undergraduate education

in Chemical Engineering at the Indian Institute of Technology, Bombay in 2001. He was promoted to Associate Professor with tenure starting September 2013.

Research engineer and instructor, **Joe Heim**, works to improve the performance of health care and manufacturing systems through application of fundamental industrial engineering design and analysis principles, such as mathematical modeling and simulation methods as well as the Toyota/Lean Production System. His research explores the development of domain specific simulation modeling languages and their roles in strategic and operations planning for complex organizations such as hospitals, academic medical centers and medical product manufacturers. The subjects Joe teaches include introductory production systems, graduate supply chain management, discrete event simulation, production operations and production systems design. His objective is to integrate lessons learned from industry and business management with the engineering science and practice of industrial and systems engineering. Dr. Heim received his PhD in Industrial Engineering from Purdue University.

Professor **Kailash (Kal) C. Kapur's** research focuses on customer centered approach for quality and reliability engineering; system design, control and optimization; prognostics and system health management, and integrated quality management system (IQMS), which also includes all the elements of six sigma. As a leader in the field of reliability, he is working to extend the area to include multi-state network reliability, as well as, applying these new principles to the evaluation of supply chain networks. In the area of six sigma implementation, he is focusing on the application of these principles to homeland security and health systems. His research in six sigma has also addressed optimization and modeling strategies for design for six sigma. He has done extensive consulting in reliability design and management, quality engineering, including Taguchi Methods and design of experiments, statistical process control and total quality management.

Professor Kapur has co-authored the book *Reliability in Engineering Design*, John Wiley & Sons. He has co-authored a book on reliability in Chinese last year and is currently working on another textbook on fundamentals of reliability. He has written chapters on reliability and quality engineering for several handbooks such as *Industrial Engineering*, *Mechanical Design*, *Operations Research and Engineering Statistics*. He has published over seventy papers in technical, professional, and research journals and has recently given keynote addresses at international conferences on reliability and safety. He is a member of the Institute for Operations Research and Management Science (INFORMS), the Institute of Industrial Engineers (IIE), the American Society for Quality (ASQ), and the Institute of Electrical and Electronics Engineering (IEEE). Professor Kapur has received funding from NSF, the US Army, and companies such as General Motors and Ford. Professor Kapur received The Allan Chop Technical Advancement Award from the Reliability Division and The Craig Award from the Automotive Division of ASQ. He was elected a Fellow of ASQ and IIE. He received his PhD in Industrial Engineering from the University of California, Berkeley.

Professor **Christina Mastrangelo's** primary research field is systems engineering, quality engineering and empirical stochastic modeling. Her research interests include the areas of operational modeling for semiconductor manufacturing, system-level modeling for infectious disease control, multivariate quality control, statistical monitoring methods for continuous and batch processing and multi-response modeling.

Dr. Mastrangelo has several years of industrial experience at AlliedSignal Aerospace, Honeywell IACD and Ion Implant Services. She has published over 30 papers in the area of empirical stochastic modeling and statistical process monitoring. One of the papers received the Ellis R. Ott Award for significant contribution to the field of quality engineering. She is a member of ASA, ASEE, ASQ, INCOSE, INFORMS, WEPAN, and a senior member of IIE.

Professor **Richard Storch** is a leading researcher in productivity improvement as applied to shipbuilding. His work involves a variety of topics including dimensional quality control, work organization, lean implementation and system design, mass customization and design for production. Large assembly industries such as shipbuilding face challenges in adapting and implementing modern manufacturing approaches. Professor Storch's major on-going research has involved the definition and adaptation of group technology and mass customization for shipbuilding. The principles of group technology applied to the manufacturing and assembly operations, and mass customization applied to design, are critical to moving away from one-of-a-kind or custom production. Professor Storch's recent work has focused on a new definition of the design process, which allows for rational decision-making in choosing the proper stage at which to employ mass customization while still satisfying customer requirements for the end product. His other on-going work has involved the definition of lean principles for shipyards including flow, visual controls, quality and dimensional control, work station design, and material management. Prof. Storch has also applied the principles of lean thinking to health care improvement. This work has been done collaboratively with the UW Department of Global Health, the Department of Radiology and Harborview Medical Center.

Professor Storch is the lead author of the text *Ship Production* and publishes frequently in the *Journal of Ship Production and Design* and *Production Planning and Control*. He also commonly presents his research findings at the Ship Production Symposium and the International Conference on Computer Applications in Shipbuilding. He is a member of the Ship Production Committee, a fellow of the Society of Naval Architects and Marine Engineers (SNAME), and a member of the International Federation of Information Processing (IFIP) Working Group 5.7, Institute of Industrial Engineers (IIE), and American Society of Naval Engineers (ASNE), and serves on the editorial boards of the *Journal of Ship Production and Design* and the *Journal of Marine Science and Technology*. He received his PhD in Mechanical Engineering from the University of Washington.

Professor **Zelda Zabinsky**'s research in global optimization is internationally recognized. Her book, titled *Stochastic Adaptive Search in Global Optimization*, presents theory on algorithms for large-scale non-convex optimization that has led to innovative methods that are computationally efficient. She is a keynote speaker at the World Congress on Global Optimization, held in China. One of her methodologies has been applied to the optimal design of stiffened composite panels with manufacturing constraints. This research has led to a design tool in use by Boeing engineers for the design of large composite structures (e.g. composite fuselage). Providing engineering with the capability to optimally design cost-effective composite structures will increase the competitiveness of US-based industries including the aerospace industry, and other industries (e.g. design of composite engine hoods or body panels). Professor Zabinsky is also developing efficient optimization methodologies to address uncertainty within a complex system. She led a team that worked closely with Boeing and the FAA to apply optimization to the management of air traffic flow under stochastic weather conditions to reduce airline delay.

She also developed optimization models including uncertainty for preparedness and response in emergency response situations, funded by the Department of Homeland Security. Similar issues arise in supply chain optimization and logistics where the production and distribution decisions are affected by randomness in demand, transportation time, and other unplanned disruptions. She has also applied optimization under uncertainty to the supplier selection problem (the start of any supply chain), and to reverse logistics (where sustainability is a criterion).

Professor Zabinsky's two current research interests are rule-based optimization and Operations Research models in health care. She has NSF funding for both research efforts, and just received funding from Microsoft to transition the rule-based optimization methodology to enterprise planning and resource application. Her work in health care is in collaboration with Group Health Research Institute. Professor Zabinsky has published in *Mathematical Programming, Operations Research, Journal of Global Optimization* and many other journals. She is a Fellow of the Institute of Industrial Engineers (IIE), and an active member of the Institute for Operations Research and Management Science (INFORMS) and the Mathematical Optimization Society (MOS). She received her PhD in Industrial and Operations Engineering from the University of Michigan.

B. Faculty Workload

See Tables 6.1 and 6.2 below.

C. Faculty Size

Faculty Size

Since the last ABET review, the current faculty has been successfully delivering courses for the undergraduate and graduate degrees over the past seven years. The IE curriculum includes two courses that are required for our students and are also service courses for the College of Engineering (IND E 250, Fundamentals of Engineering Economy and IND E 315, Probability and Statistics for Engineers). Of these, IND E 250 has been taught one quarter per year and IND E 315 has been taught 3 quarters per year. This year, a second offering of IND E 250 has been added. There are 6 required IE courses that are offered once per year. Additionally, there are 10 IE elective courses that are offered at least once every other year. Thus, 16 undergraduate course sections must be offered each year. There are on average, 3 graduate IE courses offered by ISE faculty per quarter for a total of 9 per year. Thus, a total of 25 courses are offered per year by 9 faculty (the faculty size will increase to 10 in the coming year). This is less than an average of 3 courses per faculty member. The nominal teaching load is 4 courses per year. Thus, there is adequate coverage of courses by current faculty, with substantial extra teaching capability that can account for sabbatical leave, research buyout and other reduced teaching load needs. In addition to the 9 ISE faculty members, there is one full time research engineer and a number of adjunct faculty. One of the adjuncts (Prof. Peter Johnson, whose primary appointment is in the Department of Environmental and Occupational Health Sciences and who has a PhD in ergonomics) has been teaching one section of IND E 315 each year. He has also taught one of our electives,

IND E 351, Human Factors. The full time research engineer, Dr. Joseph Heim, who has a PhD in Industrial Engineering and many years of industrial experience, has been teaching IND E 337, Introduction to Manufacturing Systems. Thus, there are additional faculty resources available to augment the regular faculty in teaching the IE curriculum.

There have been a number of position changes in faculty size since the 2007 review.

- Linda Ng Boyle joined the Department as an Associate Professor in the Fall 2009.
- Associate Professor Christina Mastrangelo's position was increased to 100% time in September 2010.
- Art Chaovalitwongse, an Associate Professor at Rutgers, was hired in September 2011 to fill a new position in Health Systems Engineering.
- Assistant Professor Archis Ghate was promoted to Associate Professor with tenure in September 2012.
- Shan Liu was recruited to join ISE during the search for a newly created health systems engineering position. She is completing her PhD in Management Science & Engineering at Stanford University and will join ISE in September 2013.
- During the 2007 ABET review ISE's faculty FTE was 6.5 tenure track faculty. With the hire of Shan Liu, ISE's faculty FTE in September 2013 will be 9.1, an increase of 2.6.

Two faculty retirements will occur at the end of the 2013-2014 academic year. Professor and Chair Richard Storch and Professor Kal Kapur will retire. Faculty searches are currently under way to fill both positions. The Chair position will likely be filled by an internal search among the senior faculty. Both Professors Kapur and Storch have elected to accept the 40% rehire option. As such, they will be available to teach up to 2 courses per year for a maximum of five years. This will further increase the ability to provide adequate teaching resources for the undergraduate and graduate programs.

Student Interactions

ISE is known for its friendly, congenial atmosphere and the accessibility of our faculty. Although our staff advisor assists students with the nuts and bolts of getting a degree, the faculty mentor students in career and professional development. There are a myriad of departmental events every year in which faculty initiate and participate. Career enhancing events include mock interviews and panel discussions with industry representatives, sessions on attending graduate school, and fostering internship opportunities.

Many faculty are also involved in supervising undergraduate students doing research. This is in addition to the regular teaching load. These projects may be associated with funded

research or may be specific areas of interest for students and faculty. Depending on the work involved, students may receive credit for the work as a technical elective. Many work in teams with local industry and other University units including the School of Medicine. ISE currently has 9 undergraduate researchers being funded by grants.

Faculty serve as advisors for the student chapter of the Institute of Industrial Engineers and Alpha Pi Mu.

One of the regular faculty members is the Undergraduate Advisor (currently Prof. Linda Boyle). The duties of the Undergraduate Advisor include conducting the new student orientation, meeting with students to discuss curriculum and career planning, reviewing and approving courses for technical electives (if the course is not on the approved technical elective list) and reviewing and approving courses for transfer credit/substitution. Additionally, all faculty commonly meet with undergraduates to discuss career planning, potential graduate school choices, etc. This year the student chapter of IIE sponsored an event to provide information to students considering graduate school. Presentations were made by Prof. Ghate, the graduate advisor and Prof. Storch. Additionally, a panel of graduate students discussed their reasons for attending graduate school and provided advice about the application process.

College and University Service

Faculty actively participate in the governance of the College and University through various committees. Each academic year, the ISE faculty decide on service assignments for the coming year. This includes representation on University and College of Engineering councils.

The ISE faculty assignments for College and University service for 2012-2013:

COE Executive Committee: ISE Chair (Richard Storch/Zelda Zabinsky)

College Council: Benita Beamon/Linda Boyle

Council on Educational Policy: Tom Furness/Christina Mastrangelo

Excom: Zelda Zabinsky (Autumn, Winter), Richard Storch (Spring)

Promotion and Tenure: Kal Kapur

ABET Continuous Improvement: Linda Boyle

UW Faculty Senate: Linda Boyle

Industry Collaborations/Connections

The faculty are regularly involved in interactions with local industry and a variety of Professional Societies. Each year, senior design projects are solicited from and developed with local industry. Some recent examples include Boeing, Starbucks, UPS, Genie Industries, Philips Medical, Fluke Manufacturing, Crowley Maritime, Oak Harbor Freight Lines, University of Washington Hospital, Children's Hospital, and Group Health. In recent years,

research projects have been done with Boeing, Microsoft, Philips Medical, Expedia, and ThyssenKrupp Aerospace. The ISE faculty are members of IIE, INFORMS, ASQC, SNAME, etc. IE graduates are in high demand from local, state, national and international sources. Our graduates work for Boeing, UPS, Starbucks, Microsoft, Philips Medical and Amazon, as well as companies, consulting firms and academic institutions in the US and around the world.

Professor **Beamon**'s current research work focuses on humanitarian relief and food supply chain sustainability. As such, "industry", as it applies to her ongoing research pertains to NGOs in humanitarian relief and organizations involved in food supply. In humanitarian relief, her primary collaborator has been with WorldVision, which has provided her with critical data to support the development of quantitative relief models. In food supply sustainability, she has primarily collaborated with the Edible Economy Project, a group of food supply chain actors in central Illinois who have been working together to create a regional food hub network. This collaboration has provided her with direct and indirect access to farmers, food distributors, and consumers. As in humanitarian relief, this group has provided her with critical qualitative and quantitative data in support of her quantitative food supply models.

Professor **Boyle** works with many companies in the automotive industry and is currently working with Toyota on quantifying the tasks and temporal nature of driver behavior. As the associate director of research for PacTrans (this region's university transportation center), Professor Boyle facilitates information exchanges and coordinates funding allocation between the state transportation agencies and the universities within the Pacific Northwest.

Professor **Furness** is a co-founder and board chair for ARToolworks, the developer of the ARToolkit and other related augmented reality technologies. He is founder and president of the RATLab, an engineering services company with a focus on photonics and electro-optics who clients include Visualant, Bell Helicopter, HeartRate Games, and Microvision. He is a consultant for Sonosite which develops and distribute advanced portable diagnostic ultrasound systems. He is the chief scientist and chair of the advisory board for Visualant which develops and distributes photonics products for security and authentication. And finally, he is a found and consultant for Microvision which develops and distributes retinal scanning technology and laser picoprojectors.

Professor **Ghate** has ongoing collaborations with physicists, doctors, and health economists at the University of Washington Medical Center. These collaborations focus on medical treatment planning and healthcare operations management problems.

Research engineer and instructor, **Joe Heim**, interacts with industry in three ways. The first is applying results of research and current best practices to development efforts at companies and organizations in the Puget Sound region. This includes longer-term projects involving graduate and undergraduate research students as well as projects lasting 1-2 quarters, which are intended to support application of new materials introduced in the classroom (e.g., IND E 337 and IND E 535). Starbucks, Seattle Children's Hospital Ambulatory Clinics and Laboratories, Terex Corp and Boeing are a few of the companies with whom he works in this

capacity and who have hired graduates from our program, often following completion of sponsored projects. Secondly, he is an independent consultant working with a variety of industry clients in the areas of product development, production system design, software development, performance improvement, supply chain management and lean practices training. In many instances, consulting engagements are used as case studies in the courses he teaches. And finally, for several years he has been a member of the Board of Directors for Impact Washington, the Washington State MEP (NIST Manufacturing Extension Partnership). In this capacity he works with senior business leaders and government agencies to improve the performance of current Washington manufacturers and increase opportunities for growth and expansion of the industrial base of the state.

Professor **Mastrangelo** has had interactions with many companies in the semi-conductor manufacturing industry. Her research work has included interaction with Intel, associated with multi-variate quality control and systems modeling. She was a Boeing Welliver Fellow, during which time she visited Boeing facilities around the country and had the chance to interact with Boeing Industrial Engineers in a wide range of job positions.

Professor **Storch** works with many shipbuilding companies. In the past few years, he has worked with Vigor Industries and Alaska Shipbuilding and Drydock. He is part of the technical advisory team of the Center for Naval Shipbuilding Technology. He is also a reviewer of industry research proposals for the National Shipbuilding Research Program, administered by the South Carolina Research Association. He has also had funded research projects with Boeing, Philips Medical and Expedia in the past few years.

Professor **Zabinsky** has worked with several industrial practitioners, including Atigeo LLC, on optimization of complex systems utilizing large data sets; and ClearSight Systems, Inc., on optimization applied to enterprise systems. ClearSight hired several of her PhD students. She is currently co-PI on a contract from Microsoft, and Microsoft has also hired her PhD students. She has worked with Boeing over the years on several areas of research, including optimal design of composite structures and air traffic flow management. Her PhD students have been hired by T-Mobile, Terex/Genie, and Boeing. She has also had projects with the Port of Tacoma, Hunt-Wesson, Genie, Solectron and Majiq on optimization for scheduling, supply chain and inventory.

D. Professional Development

The professional development activities available to UW faculty are outlined extensively in Criteria 8E of the self study. Here is a brief synopsis of ISE faculty participation in these activities.

Faculty Fellows. All of ISE's recent faculty hires have participated in the Faculty Fellows Program that orients new faculty the University campus community

Royalty Research Fund. The following faculty have received grants from this UW based funding source for junior faculty:

Jan 2009: Ghate, Archis V. (Industrial Engineering)
Modeling financial contagion: A 'complex networks' approach
\$28,597

Jan 2007: Beamon, Benita M. (Industrial Engineering)
Inventory policies for pre-positioned response in humanitarian relief
\$31,344

Center for Engineering Learning and Teaching (CELT). ISE faculty have used CELT advisors for improving assignments, mid-course evaluations, and help with team establishment and projects.

ADVANCE. Professors Beamon and Mastrangelo were each awarded buyout money for one quarter to pursue research interests. The department chair and individual faculty have attended ADVANCE professional development workshops. Professor Ghate attended a grant writing workshop.

There are other professional development opportunities as well. Professor Chaovalitwongse took a grant writing course sponsored by the Department of Radiology.

E. Authority and Responsibility of Faculty

Industrial & Systems Engineering operates on the principle of shared governance. Faculty are involved in decision making about the curriculum, personnel matters, student admissions, and most other operating details. Faculty decide on service assignments at the annual faculty retreat.

There is a formal committee structure and faculty serve the program by participating on these committees. For example, there is a committee charged with course schedule, another for undergraduate admissions, and a third for graduate admissions. Similarly, committees make decisions concerning appointment of teaching assistants, as well as the awarding of scholarships and fellowships. Personnel decisions are generally taken in full faculty meetings, subject to the rules of the Faculty Code. In particular, the code determines voting privileges on promotion and merit consideration.

There is a regularly scheduled monthly faculty meeting at which discussions are held and decisions made which affect the running of the department. Additionally, there is an annual, full day faculty retreat, held before the beginning of the academic year in the fall. This retreat always considers curricula issues based on a review of the assessment data for education objectives and learning outcomes for the preceding academic year.

The faculty service assignments for 2012-2013 were as follows:

Graduate Advisor: Archis
Graduate Committee (includes Grad Admissions/Fellowships): Archis, Art, Zelda
Undergraduate Advisor: Linda
Undergraduate Committee (includes Undergrad Admissions/Scholarships):
Tom (Autumn), Linda, Richard (Spring)
TA assignments/Course Scheduling Committee: Archis, Art, Christina (head), Kal
Prof. Programs Advisor: Christina
SCTL Rep: Richard
APM Advisor: Benita
Open House: Christina
INFORMS Professional Chapter: Archis
IIE Advisor: Richard
Diversity: Benita
Faculty Search Committee (Health Systems): Art (chair), Zelda, Linda
Faculty Search Committee (Manu/Prod Systems): Archis (chair), Christina, Art, Ramulu

Table 6-1. Faculty Qualifications

Name of Program

Faculty Name	Highest Degree Earned- Field and Year	Rank ¹	Type of Academic Appointment ² T, TT, NTT	FT or PT ³	Years of Experience			Professional Registration/ Certification	Level of Activity ⁴ H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Beamon, Benita	PhD, ISE, 1994	ASC	T	FT	2.5	19	14		Med	High	None
Boyle, Linda	PhD, CEE, 1998	ASC	T	PT	11	12	4	EIT	High	Med	Med
Chaovalitwongse, Art	PhD, ISE, 2003	ASC	T	PT	1	9	2		High	Med	Med
Furness, Tom	PhD, Eng/App Science, 1981	P	T	PT	23	22	22	NC	Med	High	High
Ghate, Archis	PhD, Ind & Operations Eng 2006	ASC	T	FT	0	7	7		Med	Med	None
Heim, Joe	PhD, IE, 1990	I	NTT	PT	25	6	10		Med	High	High
Kapur, Kailash	PhD, IE, 1969	P	T	FT	2	43	19	MI	High	Med	Low

Mastrangelo, Christina	PhD, IE, 1993	ASC	T	FT	4	20	11		High	High	Med
Storch, Richard	PhD, ME, 1978	P	T	FT	10	35	35	WA	High	High	Med
Zabinsky, Zelda	PhD, IE, 1985	P	T	FT	7	28	28		High	High	High

Instructions: Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non Tenure Track
3. Code: FT = Full-time PT = Part-time Appointment at the institution.
4. The level of activity (high, medium or low) should reflect an average over the year prior to the visit plus the two previous years.

Table 6-2. Faculty Workload Summary

Name of Program

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
Beamon, Benita	FT	Aut 430 (4), Win 424 (4), Spr 571 (3)	40	40	20	100
Boyle, Linda	FT	Win 315 (3), 546 (3) Spr 351 (4), 549 (3)	30	30	14	75
Chaovalitwongse, Art	FT	Aut 599 (3), Win 250 (4)	35	35	15	85
Furness, Tom	PT	Aut 455 (4), 543 (1-3), Spr 496 (3)	30	15	5	50
Ghate, Archis	FT	Aut 410 (4), Win 508 (3), Spr 412 (4)	40	40	20	100
Heim, Joe	PT	Aut 337 (4), Win 424 (4), Spr 535 (3)	35	40		75
Kapur, Kailash	FT	Aut 524 (3), Win 316 (4), 521 (3) Spr 315 (3)	40	40	20	100
Mastrangelo, Christina	FT	Aut 595 (6), Win 595 (4) Win 494 (4), Spr 495 (4), Spr 596 (3)	40	40	20	100
Storch, Richard	FT	On sabbatical	0	80	20	100
Zabinsky, Zelda	FT	Aut 591 (1), Win 411 (4), 592 (1) Spr 513, 593 (1)	30	40	30	100

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the self-study is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

Offices

ISE faculty and staff offices are located in three separate buildings. This includes a wing in the Mechanical Engineering Building (MEB) on the ground floor that contains four faculty offices, four staff offices, a copier/supply room, and a conference room. ISE controls a space in the Aerospace Engineering Research Building that has six faculty offices, the Production Systems Laboratory and open space used for student and other group meetings. There is also a block of six offices in the Engineering Annex that is used for teaching assistants, research professors and staff, and visiting faculty. The graduate computer laboratory and graduate student cubicles are in the basement of the MEB. The undergraduate computer laboratory is in the Engineering Annex, which is accessible from the main floor of the Mechanical Engineering Building. Additionally, on the first floor of the MEB there is a meeting room for the student groups and students working on projects and there is a new distance learning classroom.

Classrooms

Classrooms are scheduled and maintained through a central University office called Room Assignments. Courses that require special computer laboratories are routinely scheduled in computer teaching rooms in Mary Gates Hall. IND E 424, Simulation and IND E 455, User Interface Design use these facilities for all class sessions. IND E 410, Linear and Network Programming is scheduled in a similar computer teaching room for the Friday laboratory session. Other courses that have only occasional need for computer laboratory sessions reserve the Undergraduate Computer Laboratory for those specific sessions. IND E 321, Statistical Quality Control and IND E 337, Introduction to Manufacturing Systems are handled this way.

Laboratory and Computing Facilities

The undergraduate computer lab is located in the Engineering Annex and is available to students 24 hours a day, 7 days a week. The lab has 20 new PC workstations funded by a successful proposal to the UW Student Technology Fee committee. The graduate lab has 15 new PC workstations funded by the same proposal. All of the computers run Window 7 Pro. Remote desktop server is available to all engineering students with math and statistical software licensed by the College. The students do not have file storage available from COE. There is a resource on campus that they can use. They do have file space from UW sources such as catalyst.

The following software packages are available in the undergraduate computer lab:

- Microsoft Office 2010
- Microsoft Project 2010
- Microsoft Visio 2010

- UWICK Applications
- AutoDesk 2009 (only 5 computers in B14)
- Maple
- Matlab
- Minitab 16
- R
- Rockwell Arena
- Mathematica
- Adobe Acrobat 8.0
- AIMMS
- LINGO
- ArcGIS 10.1 (only 5 computers in B14)
- GAMS
- GIMP 2
- IOR Tutorial
- Net Logo 4.1.3

Research Labs

Human Factors and Statistical Modeling Lab: At the Human Factors and Statistical Modeling Lab, Professor Linda Ng Boyle's research emphasis is on investigating how people's behavior impacts their risks of injuries and mishaps. This includes exploring why drivers crash and why operator errors occur. Professor Boyle and her research assistants use a wide range of innovative analytical approaches to solve problems related to human factors and transportation systems.

B. Computing Resources

University Computing Resources

The University has computer laboratories established mainly in the Odegaard Undergraduate Library (OUGL). There are approximately 397 General Access Workstations with Dell and Apple iMac computers. The 34 Video Editing Workstations are comprised of HP Z220 and Apple MacPro Dual-Monitor.

The three Collaboration Studio and Collaboration Pods facilitate in-person, interactive, small group projects or meetings.

The Center for Teaching, Learning and Technology is designed to provide walk-in assistance to UW faculty, staff and students who have questions about educational technology.

The Digital Presentation Studio (DPS) is a space to practice presentations and record those sessions for later review.

UW-IT's Videoconferencing Services provide access across the state or around the world, feature professional studio spaces and provide support.

ViDA (Virtual Desktop Access) gives student 24/7 remote access to high-end software normally available only in technology spaces on campus.

Internet connectivity

Each workstation is connected to the campus network with a TCP/IP Ethernet connection (1000baseT in Odegaard Undergraduate Library, 100baseT in Mary Gates Hall.) The campus network then is connected to the rest of the Internet via multiple DS3 circuits.

Internet connectivity is provided into many campus classrooms, enabling instructors and students to interact with course materials available through the web and other sources. The College and many of the departments make computer projection (LCD projectors and overhead displays) available for classroom use. Specifically configured classrooms in EE/CSE and Sieg Hall include built-in computer projection equipment and Internet connectivity.

Classroom Support Services

Classroom Support Services (CSS) provides comprehensive media support and services to students, faculty and staff at the University of Washington. The department offers a full range of audio and video expertise to the campus community while also working with students, faculty and staff to enhance classrooms with new technologies for improved information presentations and student learning outcomes.

SpaceScout

This is an internet application available to run on a smart phone which enables students to find study spots on campus

Tegrity Lecture Capture and Tegrity Manager

Available to all UW students, faculty, and staff, Tegrity allows you to record any audio and video, such as a lecture, and make it available to others. For instructors teaching an official for-credit UW course, the faculty's courses automatically appear in Tegrity, ready for lecture capture, with no action required. Tegrity provides unlimited space for recordings and requires minimal hardware.

Visualization

The Health Sciences Academic Services and Facilities provides equipment, facilities and services for making visualization products such as large-format color print images, still photography, movies, computer animations and interactive graphical presentations in several formats.

College of Engineering Computing Resources

Computing has a large presence in the academic departments and diversity programs within the College. There are more than 500 computers located in departmental and program laboratories and classrooms.

Many of the computer labs are available to students, faculty and staff within the department/program on a drop-in basis or can be reserved by instructors for course presentations or workshops. Specialized computing labs, such as the Instructional Programming Lab (CS&E) and the Electrical Properties Lab (MS&E), focus on providing computing resources for specific course related needs. The computing laboratories throughout the College include various installations of Macintosh, Windows and UNIX/Linux workstations, often linked to lab or departmental data/email/application/web servers and laser-quality printing.

Campus Data Network

Internet connectivity, 10Mb, 100Mb, and 1000Gb technologies, is provided into every office and laboratory in each of the College buildings. The University's Information Technology(UW-IT) department provides centralized support for the campus-wide Internet inter-building and intra-building backbone and the campus connections to the Internet, Internet2 and vBNS national networks. By employing standard 100TX/1000TX network technologies for distribution throughout each building and fiber optics service to each building from one of several campus routing centers, UW-IT provides a robust and reliable connection to the Internet for all College and campus computing resources.

The University-wide, centrally managed wireless service initiative has expanded wireless access throughout all three UW campuses including: central 24x7 management and support of the wireless network as an integral extension of the wired data network; a single point of contact for customer service; consistent security and access controls; and ongoing maintenance and operations support, including upgrades, for all three campuses.

The College of Engineering provides common data storage, database, and web services for COE central services, employing Intel-based Windows and UNIX/Linux systems supported by COE Computing Services. A central web site, www.engr.washington.edu, provides a portal to College resources, news and special events, and links to all College academic departments and diversity/professional programs. A central Oracle database maintains links to various campus data resources such as those from Planning & Budget, Admissions and Capital and Space Planning offices and provides decision support applications (searches, reports, etc) for use throughout the College.

The College of Engineering Computing Services staff includes one manager/director, 7 full-time and 3 part-time technical staff that provide installation, configuration and maintenance for all desktop computers and servers in the office of the Dean, selected academic departments (Industrial Engineering, Materials Sciences and Engineering) and several diversity/professional programs (CELT, CWD, and MESA). The Computing Services staff also provides 2nd-tier support to technical personnel in many other College departments, assisting with server installation/configuration, Internet security, network technology upgrades, etc. Each department has one or more technical staff personnel providing computing support for their faculty, staff, students and laboratories.

The Committee for Information and Technology Exchange (CITE) is a college-wide group of computing support personnel. CITE meets quarterly to discuss a wide range of computing and networking issues, announcements and future technologies. A mailing list also links all CITE

members and is used to distribute announcements, special offers (licenses, grants, etc) and technical application notes.

The Computer Resource, Infrastructure and Strategic Planning (CRISP) process is responsible for the distribution of computing supports funds to College departments and programs and establishing priorities for technology initiatives in College facilities.

Payment for Computing Services:

All UW students contribute quarterly to a Student Technology Fee (<http://techfee.washington.edu>). Funds from this program are distributed annually, based on proposal requests, to UW-IT, university departments and programs.

All registered students must create a personal UW NetID, enabling their access to general-use-computing resources. None of the University computing labs or College computing labs charge a fee for using the facilities or equipment. Per-page fees are charged for printed output in the University facilities and pricing schedules are regularly updated at the UW web site.

Many College departments create local student accounts for their majors and students enrolled in department courses that permit the use of laboratory equipment and facilities. Some of the College departments have established quotas on student accounts limiting disk space usage and printed output (number of pages). Account quotas are often established and adjusted based on course enrollment and instructional requirements.

C. Guidance

Students are most often provided guidance regarding the use of computing resources and software from faculty and teaching assistants during course instruction and office hours. Computing issues not related to coursework specifically are handled by the College of Engineering Computing Team (for example, a lab computer or software package is not working properly). The faculty PIs are responsible for orienting and guiding students who work in their research labs.

D. Maintenance and Upgrading of Facilities

The College of Engineering (CoE) works with the University of Washington administration to obtain Minor Modification Funds. These funds are allocated on a biennium basis. Prior to the funding cycle, the CoE Infrastructure group requests renovation proposals from each department. The proposals are reviewed by the infrastructure group and the funding request is made to the Office of Planning and Budgeting within the Office of the Provost. Once allocated, these funds are used to upgrade and renovate facilities in the College of Engineering Buildings in partnership with the departments in the college.

In addition to this funding mechanism and cycle, the CoE Infrastructure group works with individual departments to secure staffing and in some cases will oversee individual renovation

projects. These projects are requested on an individual basis. Priorities for these projects are set by the individual departments with CoE support.

Since 2007, ISE has received funds to upgrade the undergraduate computing lab, the student resource center, and the new distance learning classroom.

E. Library Services

University of Washington

The University of Washington Libraries (Libraries) provides library and information services that support the teaching, learning, research, and clinical needs of the tri-campus University community – UW Seattle, UW Bothell and UW Tacoma. The Dean of University Libraries is the chief administrator, is a member of the University’s Board of Deans and Chancellors and reports directly to the Provost.

The Seattle campus consists of our five “anchor” libraries: Suzzallo and Allen, Odegaard Undergraduate, Health Sciences, Engineering, Foster Business, and seven smaller subject libraries. A large off-site collections facility is located nearby. The Libraries’ has extensive on-site and online collections and user-centered services. Students and faculty can go online at <http://www.lib.washington.edu/> to search and request books, journals, etc. Electronic periodicals can be searched at <http://uwashington.worldcat.org/>.

The Association of Research Libraries (ARL) investment index ranks the University of Washington Libraries 20th among the top 115 academic research libraries in North America and 10th of U.S. publicly funded universities.

Teaching, learning, and research at the University of Washington is supported by one of the premier library collections in North America, consisting of more than 7 million volumes (ranked 14th among ARL libraries) and sizeable numbers of microforms, manuscripts, technical reports, maps, architectural drawings, photographs, and audio-visual materials. Approximately 88% of the 120,000 current periodical titles are available online, and, when combined with 500,000 e-books extends access beyond the physical collection. These electronic resources are available to the UW community anywhere and anytime. More than seventy librarian liaison subject specialists are active in collection development and work closely with academic programs to select and provide access to information resources needed for the curriculum and research.

Nearly 90% of the Libraries’ currently subscribed serial titles are available electronically. Significant funding, much of it from endowment income, has gone into purchase of electronic journal backfiles. The Libraries has made a strong commitment to expedited delivery of information resources directly to students faculty and staff through interlibrary borrowing, scanning of locally held print journal articles on demand which are sent as PDF files, and in 2011 office delivery of books to faculty and staff.

Engineering Library

The Engineering Library supports all programs within the College of Engineering with the exception of Chemical Engineering, whose materials are housed in Suzzallo Library (which is physically closer to the Department of Chemical Engineering than is the Engineering Library). The Library, with non-staff seating for nearly 300, currently houses approximately 150,000 print volumes, nearly 68,000 print technical reports, over 2.75 million microfiche (of which the vast majority are technical reports), and over 13,000 reels of microfilm. The Library provides access to thousands of current journals and other serial resources, primarily in electronic form. The materials budget is roughly \$700,000 for FY 12-13.

3.875 FTE professional librarians, 3.5 FTE support staff, and students staff the Engineering Library. The Library is open 85 hours per week when classes are in session, with reference service provided during 57 of those 85 hours. Somewhat reduced hours are in effect during summer session and during breaks between quarters. The Library offers its users substantial journal and monograph collections plus a variety of electronic databases and other resources pertinent to the various engineering disciplines and research areas within the departments of the College of Engineering (see <http://www.lib.washington.edu/engineering/resources/englibdb> for a list of relevant databases). Virtually all of these databases are available from any networked computer within the u.washington.edu domain and are available from outside that domain via the use of the UW Libraries proxy server. Some databases also contain the full-text of all or a portion of the journal titles indexed. The UW Libraries online catalog also contains links from entries within the catalog to electronic fulltext of selected materials, both from journals and books. The Engineering Library is also a patent and trademark depository library.

Librarians within the Engineering Library routinely offers generic classes on the use of library resources, and also perform dozens of class-specific information literacy sessions annually designed to meet the needs of a particular instructor and the students in her/his class.

F. Overall Comments on Facilities

The University of Washington has a mature and robust system for managing facilities, particularly in regards to labs and lab safety. Appendix PO presents Presidential Order 55, which outlines the institutional roles, responsibilities, policies, and guidelines concerning the safe use of university facilities. There is an extensive system of implementation of these policies, including regular inspections and extensive training opportunities. With respect to the latter, Figure 7F-1 illustrates a typical set of safety training courses and workshops available for faculty, staff, and students. There have been no incidents involving injuries to students, staff, or faculty involved in instructional activities for as long as such records have been kept.

Our faculty has consistently demonstrated the ability to perform world-class research and instruction. In the case of research, in particular, this is manifested in successful grant and publication outcomes in a highly competitive environment. In the case of instruction, we are

confident that our student outcomes are similarly excellent as documented earlier in this Self Study, and as confirmed by other more longitudinal investigations of our students' career trajectories.

Current Department facilities are adequate for faculty and students.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

The current chair, Richard Storch, has guided the department for almost 10 years. Under his tutelage, ISE has:

- Hired 4 new faculty members and expanded the number of faculty lines
- Chosen strategic research areas and established ISE as a leader in health systems engineering
- Successfully petitioned to have ISE changed from a program to a department
- Increased fundraising revenue and carry forward funds
- Established a new professional master's program
- Increased research expenditures

The faculty are active in helping guide the department through various committees and as a whole through the monthly faculty meetings.

As mentioned previously, Richard will be retiring in June 2014 and the chair position will most likely be filled by an internal search of the senior faculty.

B. Program Budget and Financial Support

ISE is supported by a variety of budgets. ISE receives a state budget allocation from the College of Engineering. The budget is based on the previous biennia's allocation plus any merit or cost of living adjustments and is considered permanent money. The new Activity Based Budget system, in which money follows the student, has provided additional money for teaching assistants. In addition, ISE has self-sustaining, research, revenue, and gift budgets. The Graduate School provides some funds for graduate student assistantships and travel.

ISE has a permanent allocation in the state budget for teaching assistant lines. As stated above, additional money for TAs was provided this year by the College of Engineering under the Activity Based Budget system.

The department is able to request infrastructure, facilities, and equipment money through a proposal system. For example, a successful proposal to the Student Technology Fee committee last year made it possible to purchase new computers for the undergraduate and graduate labs. A facilities proposal garnered funds to establish a new distance learning classroom.

ISE, along with all other departments at the UW, have sustained a series of budget cuts over the past few years. But even with those additional constraints, we have been able to hire new

faculty, provide a number of teaching assistants, and upgrade facilities to provide a supportive student learning environment.

C. Staffing

ISE has the lowest ratio of staff to faculty in the College of Engineering. The College average is 0.25 and the ratio in ISE is 0.17. The ISE staff consists of an administrator and budget analyst who have been with ISE since 1999, an academic advisor who has been with the department since 2000, and part-time continuing education coordinator who joined us in 2008 to fill a newly created position. Since 3 members of this team have worked together for 13 years, staff retention is not a problem. An ISE secretary was lost due to budget cuts in 2008. The staff are highly trained and experienced, but can pursue any additional training they believe they need at their own initiative. Computing support for the department is provided by the College of Engineering Computing Services team.

The staff are highly competent, and have successfully managed the operations of the program even though the number of undergraduate students in the Industrial Engineering program have increased from 80 to 120 over the past five years. In this same time period, the number of masters and PhD students, funded research (about 10 to 14% per year), and faculty (3 new faculty and 2 research faculty) have all increased. With the increased workload, the staff continues to be able to provide faculty and student support for advising, budgeting, and day-to-day operations of the program.

The administrator won the UW Distinguished Staff Award in 2000 and the budget analyst was awarded the College of Engineering Staff Innovator Award in 2003. The staff was nominated as a group this year for the university award by the student leaders of IIE and APM.

D. Faculty Hiring and Retention

Hiring

- A. An ad is placed (usually in a national print journal) soliciting applications for a faculty position.
- B. Candidates submit their applications, which are reviewed by a departmental search committee.
- C. A short list of top candidates are identified and interviewed.
- D. The Chair and Department faculty vet the final candidate. An offer is made.
- E. The Department submits appointment paperwork to the Dean's Office. The Dean reviews the appointment and offers his/her support of the new faculty member to the Provost.
- F. The Provost and Board of Regents review and approve the new appointment.
- G. The Provost's Office notifies the new faculty member that their appointment has been approved and welcomes them to the UW.

Retention

- A. Implementing Retention Salary Adjustments – The Dean may request retention salary adjustments for qualified faculty through the Office of the Provost. Retention salary adjustments receive case-by-case review by the Office of the Provost, and additional documentation may be required such as a current curriculum vitae or case specific details. As a general principle, retention salary adjustments are expected to provide a minimum 5% salary increase. Generally, an individual may not receive a retention salary adjustment for a period of three years from the effective date of the most recent retention adjustment.
- B. Making opportunities available for A/B Retention Salary Adjustment - The fundamental purpose of the A/B Salary Policy for Faculty Retention is to insure that sufficient mechanisms exist to support the retention of UW tenured and tenure-track faculty consistent with the University of Washington Faculty Salary Policy. An A/B salary is comprised of an annual base salary with an A salary component and a B salary component. The A component is the state-committed salary support associated with tenure that is matched with an institutional expectation of teaching, research, and service contributions. The B component is the balance of the base salary funded from non-state appropriated sources (e.g., grants, contract, and self-sustaining). The B component is contingent upon the faculty member's ability to generate funding from grants, contracts, or other applicable sources.

E. Support of Faculty Professional Development

The University of Washington and the College of Engineering have extensive faculty professional development programs. Many of them focus on new faculty but some are for all faculty.

The University of Washington's Faculty Fellows Program orients new faculty to the University campus community. It is facilitated by a number of campus educators, including those that have received campus-wide teaching awards. Presenters and facilitators actively engage our new faculty members on a number of topics including, but not limited to, panel discussions with UW students, effective teaching methods and techniques for balancing the demands of successful teaching and research. All of ISE's recent faculty hires participated in the Fellows Program prior to the start of their academic appointment.

The University of Washington's Royalty Research Fund awards grants to faculty of up to \$40,000 to advance new directions in research, in particular:

- * in disciplines for which external funding opportunities are minimal;
- * for faculty who are junior in rank;
- * in cases where funding may provide unique opportunities to increase

applicant's competitiveness for subsequent funding.

Funded projects often lead to new creative activities or scholarly understandings, new scholarly materials or resources, and significant data or information that increase a faculty member's chances of obtaining new external funding.

The University of Washington Provost's Office provides bridge funding to support faculty to span the gap in critical research programs.

Faculty can receive up to \$50,000 (with a required 1:1 match from the department or college, meaning up to \$100,000) to help them maintain research productivity while they seek to obtain external funding for their labs.

There are a number of additional faculty professional development programs run by the College of Engineering:

1) Center for Engineering Learning & Teaching (CELT)

CELT supports the University of Washington, College of Engineering's mission by taking a leadership role in developing and supporting engineering instructional excellence. The CELT faculty development program employs an integrated multi-pronged agenda for improving engineering learning and teaching, which includes working with individual faculty members, conducting teaching workshops and seminars, providing teaching resource materials, and active participation in strategic-level initiatives. The CELT approach to professional faculty development begins with meeting and resolving the immediate concerns of faculty members. Simultaneously CELT helps faculty members place their improvement efforts within a larger cycle of ongoing improvement, implementation, and assessment. Workshop topics and specific instructional development activities and resources are identified through close cooperation with engineering faculty members. CELT services are available to all faculty members in the College of Engineering. For more information on CELT services see the CELT description in Table D-4 *Non-academic Support Units*.

2) ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers

The University of Washington received a \$3,750,000 National Science Foundation (NSF) ADVANCE Institutional Transformation grant in 2001 to increase the participation and advancement of women in academic science and engineering careers. With the grant, it formed the ADVANCE Center for Institutional Change (CIC) which is housed in the College of Engineering. The vision of the CIC is a campus in which all science, technology, engineering, and mathematics (STEM) departments are thriving, all faculty are properly mentored, and every STEM faculty member is achieving his or her maximum potential. UW believes that cultural changes that are designed to help underrepresented groups invariably help all groups and improve the environment for everyone.

The CIC implements programs designed to eliminate existing barriers and to precipitate cultural change at both the departmental and the institutional level. One of the successful strategies the ADVANCE program has employed to impact departmental culture and climate are quarterly leadership workshops for department chairs, deans, and emerging leaders. Prior to ADVANCE, department chairs received little or no professional development beyond their initial orientation to the department chair position. The ADVANCE workshops provide those in leadership positions with a better understanding of the structural, psychological, and behavioral barriers to the advancement of faculty. For each half-day workshop, the department chairs are encouraged to invite an emerging leader so that other faculty can be exposed to academic leadership issues. These workshops have served as a forum for cross-college networking and professional development, and are the only regular department chair professional development gathering on campus. These workshops help develop the next set of department chairs in STEM departments. Department chairs have stated these workshops are the “boot camp” they never got and evaluations of the workshops have been uniformly high.

The UW ADVANCE program has had great impact. ASEE 2011 reports UW has 20.6% women faculty in engineering compared to a national average of 13.9%. Further, UW ranks seventh for number of women faculty in engineering, but institutions one through six have 38-73% more faculty in their colleges. Figure 8E-1 shows the percentage of women faculty in Engineering, compared to the national average.

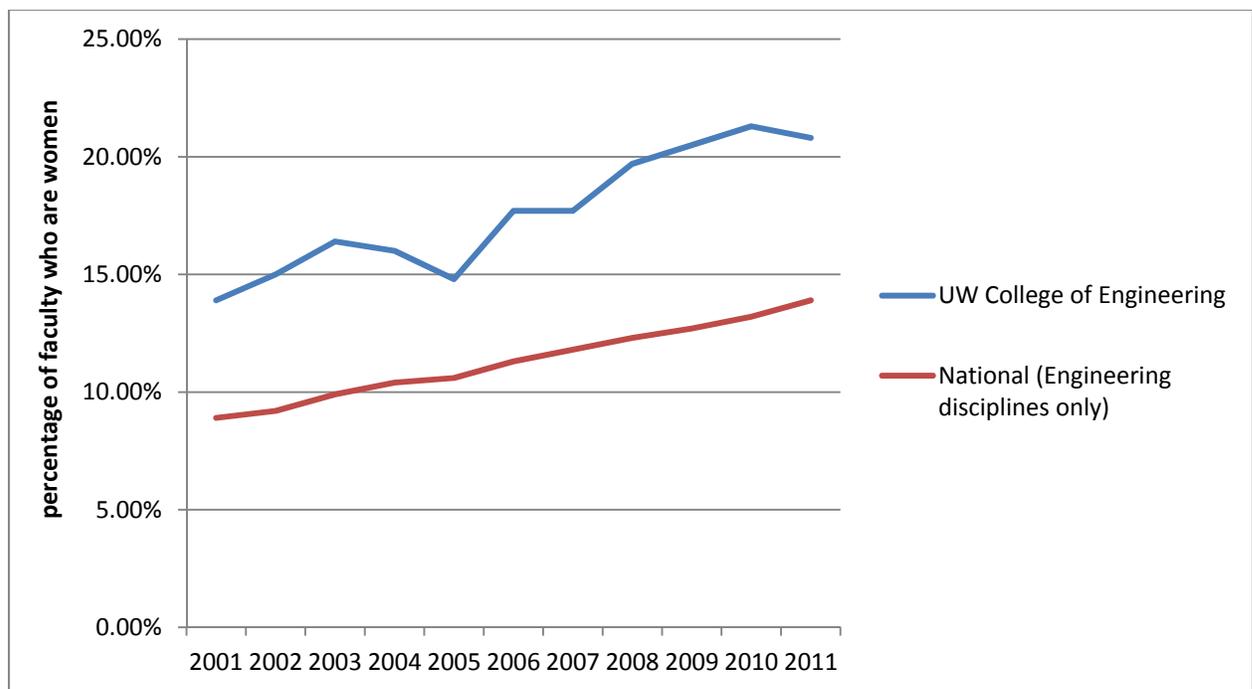


Figure 8E-1: Ladder Faculty Profile by Gender

The ADVANCE CIC also hosts a quarterly Pre-Tenure Faculty Workshop Series for all junior faculty members in STEM fields. This program provides participants the resources to establish a strong academic foundation and navigate the tenure process. Past topics have included the following: managing time and resources; understanding the tenure and promotion process; recruiting and mentoring graduate students; setting up a lab; building strong mentoring relationships; establishing peer networks and support structures; and applying for prestigious national grants, including the National Science Foundation's CAREER award. The workshops have been attended by 177 unique faculty members since 2005.

- 3) The College provides funds for junior faculty or faculty who have been out of research for some time to meet with program managers in Washington D.C. Developing and managing relationships with program managers is an important element in successful grantsmanship.

Finally, University of Washington faculty members are eligible for professional leave (sabbatical) every seven years.

Program Criteria for Industrial Engineering

1. Curriculum

The Industrial Engineering curriculum prepares graduates to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy throughout the course of study. It also includes in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices. In on-going faculty discussions about the curriculum, consideration of the relationship of these criteria to the curriculum was discussed. The faculty has reviewed and discussed each INDE course, including all required and selected elective courses. It was concluded that each course addresses both of these points.

The faculty redesigned the curriculum in the academic year of 2003. The redesign was done following discussions with industry (represented by the departmental Visiting Committee) and alumni. It also was based on benchmarking with other top IE programs around the country. The redesigned curriculum was presented to the College of Engineering and the University committees with oversight of curricula and was approved. It was adopted starting in Autumn Quarter, 2004. Since that time, it is reviewed by the faculty annually, often with input from alumni and industry. Minor changes have occurred since that time, including changing course numbers (usually to reflect the academic year in which students take the courses), and in one case dropping a selective elective course that was no longer deemed important to the curriculum.

The curriculum, as revised in 2003, is based on a number of principles. First, achieving the goals presented by the Institute of Industrial Engineers (as stated above) and providing a program that spans the breadth and depth of the discipline was considered. Since the curriculum teaches the students the need for lifelong learning and provides them the expertise to find new material independently, this new curriculum requires students to take courses that are considered essential, and then, through selected electives, provides an opportunity for further in-depth learning in critical areas.

The flow of the curriculum is such that the student experience and the learning environment are enhanced. Foundational material is taught in the basic mathematics and science courses (this includes IND E 315, (Probability and Statistics For Engineers). This is followed by a wide range of general engineering analysis and computing courses (this includes IND E 250, Fundamentals of Engineering Economy). This provides students with knowledge of materials, information, equipment and energy. It also begins to provide the appropriate analytical, computational and experimental tools. This is complemented by general educational requirements, which provide breadth outside the technical field. This material is intended to be substantially completed in the first two years of study.

The INDE coursework builds on the foundational material to provide in-depth instruction to achieve the curricula goals. INDE required courses provide breadth and depth. IND E 337,

Introduction to Manufacturing Systems, provides students with an introductory understanding of systems and how they are designed and developed. It concentrates on IE analysis tools for measuring and improving systems, including the lean process improvement tools. IND E 315 and 316 (Probability and Statistics For Engineers and Design of Experiments & Regression Analysis) provide in-depth instruction in statistical analysis and experimentation tools. IND E 410 and 411 (Linear & Network Programming and Stochastic Models & Decision Analysis) provide in-depth material in Operations Research. Finally, IND E 494 and 495 (Design in the Manufacturing Firm and Industrial Engineering Design) provide in-depth instruction in design and systems engineering. These courses also provide an in-depth system design experience, based on the material learned throughout the curriculum.

The curriculum next requires further in-depth learning covering the breadth of IE topic areas. The four IE selected elective areas are (1) Operations Research, (2) Statistics, (3) Production/Operations, and (4) Design, which focuses on human factors. In each of these four areas, students gain further understanding and more opportunity to use the tools needed to design, develop, implement and improve integrated systems. They also learn how to apply analytical, computational, and experimental practices to system integration.

Finally, a variety of technical elective courses provide the opportunity for students to expand this tools and integration base, according to their specific interests.

The IE program added an additional outcome that reflects the ideas embodied in the Program Criteria for Industrial Engineering. Outcome 1 is an understanding of the integrated, interdisciplinary nature of the discipline. This outcome maps well into these criteria. As shown in Criterion 4, achievement of this outcome is good and has been consistent since 2007.

2. Faculty

Evidence is provided in Criterion 6 that the faculty understand professional practice and maintain currency. There are a number of faculty who are licensed Professional Engineers. All faculty regularly attend professional conferences, give presentations and publish papers and conduct research. Interactions with industry are frequent. These are documented in detail in Criterion 6.

The faculty code at the University of Washington gives the faculty, with appropriate oversight, the responsibility and the authority to develop and change the curriculum. Faculty review program objectives annually and can and do revise and implement them as needed. Minutes of the annual faculty retreat, which always includes a discussion of the curriculum and review of assessment results, are included in this self-study.

APPENDICES

Appendix A – Course Syllabi

ABET Course Syllabi for IND E 101: Introduction to Industrial Engineering

1. Course number and name: IND E 101: Introduction to Industrial Engineering
2. Credits and contact hours: 1 credit hour, 1 hour per week
3. Instructor's name: Joseph Heim
4. Text book, title, author, and year
None
4a. Other supplemental materials: None
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Examines the basic concepts and methods of industrial engineering through team-based hands-on activities. Explores the profession of industrial engineering. Discusses resources available to Industrial Engineering students at the University of Washington.
 - 5b. Prerequisites or co-requisites: NONE
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective
6. Specific goals for the course

The objective of this course is to introduce students to the industrial engineering profession through a series of hands-on projects, activities and presentations.

 - 6a. Specific outcomes of instruction

This is an introduction and overview of course. Students are exposed to the concepts of modeling of processes and flow, simulation, improving system performance, the changing nature of product quality, lean thinking and industrial engineering careers.
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - a. An ability to apply knowledge of mathematics, science and engineering.
 - b. An ability to design and conduct experiments, as well as to analyze and interpret data.
 - c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
 - l. An understanding of the integrated, interdisciplinary nature of the discipline.
7. Brief list of topics to be covered
 - Modeling process and flow
 - Simulating to understand

- Improving system performance
- Changing nature of product quality
- Quantifying quality
- Guest speakers discuss their careers as industrial engineers
- Lean thinking

ABET Course Syllabi for IND E 250: Fundamentals of Engineering Economy

1. Course number and name: IND E 250: Fundamentals of Engineering Economy
2. Credits and contact hours: 4 credit hours, 5 hours per week
3. Instructor's name: Wanpracha Art Chaovalitwongse
4. Text book, title, author, and year
 - Contemporary Engineering Economics, Chan S. Park, 5th edition, Prentice Hall, 2011.
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Basics of industrial cost analysis and accounting. Application of engineering economics to decision making. Analysis of engineering alternatives based on use of interest computations, valuations, depreciation, and cost estimates.
 - 5b. Prerequisites or co-requisites: None.
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Required.
6. Specific goals for the course

The objective of this course is to introduce the basic concepts of engineering economy and to demonstrate the importance of financial management and engineering decisions in financial project analysis. This includes an overview of financial accounting, time-value of money, risk in financial decisions, and book and tax depreciation.

 - 6a. Specific outcomes of instruction
 - Students will understand the role of profit on decision making such as how decisions affect revenues, costs and profits.
 - Students will understand the role of the time-value of money in making financial decisions.
 - Students will be able to determine whether an investment is a good idea by performing time-value of money analysis.
 - Students will be able to compare investment alternatives and select the best one based on time-value of money analysis.
 - Students will understand the role of financial accounting information.
 - Students will be aware of financial information of public firms that are reported publically.
 - Students will understand the role of managerial accounting information for making decisions and able to perform financial ratio analysis to evaluate and compare firms.
 - Students will understand the role of economics in engineering design decisions and their impact on investment, revenues and profits.

- Students will understand the role of risk in making financial decisions and be aware of the trade-off between risk and return.
- Student will understand the role of hedging and insuring in a risky environment

6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

- a) an ability to apply knowledge of mathematics, science and engineering
- e) an ability to identify, formulate, and solve engineering problems
- h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- l) an understanding of the integrated, interdisciplinary nature of the discipline.

7. Brief list of topics to be covered

- Engineering Economic Decisions
- Time is Money
- Understanding Financial Statements
- Cost Concepts and Behaviors
- Understanding Money and Its Management
- Principles of Investing
- Present Worth Analysis
- Annual Equivalent Worth Analysis
- Rate of Return Analysis
- Depreciation
- Capital Budgeting Decisions

ABET Course Syllabi for IND E 315: Probability and Statistics for Engineers

1. Course number and name: IND E 315: Probability and Statistics for Engineers
2. Credits and contact hours: 3 credit hours, 3 contact hours per week.
3. Instructors' Names: Linda Boyle, Kal Kapur, Christina Mastrangelo
4. Textbook:
 - *Applied Statistics and Probability for Engineers, 5th Edition*, Douglas C. Montgomery, George C. Runger, 2011.
5. Specific Course Information:
 - a. Description: Application of probability theory and statistics to engineering problems, distribution theory and discussion of particular distributions of interest in engineering, statistical estimation and data analysis. Illustrative statistical applications may include quality control, linear regression, and analysis of engineering data sets.
 - b. Pre-requisites: Either MATH 136, MATH 307 or AMATH 351.
 - c. This is a required course in the program.
6. Specific goals for the course: In this course students will learn the basic fundamentals of probability and statistics. This course is designed to not only introduce students to the basics, but to develop students' probabilistic and statistical intuition for application in their discipline.
 - a. Specific outcomes: At the end of the course students will be able to do the following:
 - i. Identify various probability distributions.
 - ii. Calculate basic statistical measures.
 - iii. Design and perform hypothesis tests and other evaluative tests.
 - iv. Analyze a problem in which they are able to apply at least 3 different topics from the class.
 - v. Learn a statistical software package.
 - b. Criteria 3 outcomes addressed by the course:
 - a. An ability to apply knowledge of mathematics, science, and engineering.
 - b. An ability to design and conduct experiments, as well as analyze and interpret data.
 - e. An ability to identify, formulate, and solve engineering problems.
 - i. A recognition of the need for, and ability to engage in life-long learning.
 - j. A knowledge of contemporary issues.
 - k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
 - l. An understanding of the integrated, inter-disciplinary nature of the discipline.
7. Brief list of topics covered:
 - Probability: Sample Spaces and Events, Counting Techniques

- Discrete Random Variables and Probability Distributions
- Continuous Random Variables and Probability Distributions
- Random Sampling and Data Description
- Point Estimation of Parameters
- Statistical Intervals for One & Two Sample
- Hypothesis Testing for One & Two Sample

ABET Course Syllabi for IND E 316: Design of Experiments and Regression Analysis

1. Course number and name: IND E 316: Design of Experiments and Regression Analysis
2. Credits and contact hours: 4 credit hours, 4 hours per week
3. Instructor's name: Kailash C. Kapur
4. Text book, title, author, and year
 - Montgomery, Douglas C., Design and Analysis of Experiments, Eighth Edition, John Wiley & Sons, NY, 2013
 - Lecture notes by Dr. Kapur (after seventh week)
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Introduction to the analysis of data from planned experiments. Analysis of variance for multiple factors and applications of orthogonal arrays and linear graphs for fractional factorial designs to product and process design optimization. Regression analysis with applications in engineering.
 - 5b. Prerequisites: IND E 315
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
REQUIRED
6. Specific goals for the course
 - 6a. Specific outcomes of instruction
 - Students will be able understand causes of variation in any product or process
 - Students will be able to design statistical experiments
 - Students will be able to analyze the data from the experiments using Analysis of Variance [ANOVA]
 - Students will be able to design experiments with several factors and interactions
 - Students will be able to develop mathematical models and perform linear and nonlinear regression
 - Students will be able to use the methods of statistical experimental design to improve products and processes and thus improve quality of systems
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - a) an ability to apply knowledge of mathematics, science and engineering (through homework, exams and lectures)
 - b) an ability to design and conduct experiments, as well as to analyze and interpret data (through homework, exams and lectures)

- c) an ability to design a system, component, or process to meet desired needs (in terms of design of experiments through homework, exams and lectures)
- e) an ability to identify, formulate, and solve engineering problems(through lectures and examples in class and discussion and feedback)
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice(through lectures and examples in class and discussion and feedback)
- l) an understanding of the integrated, interdisciplinary nature of the discipline (through lectures and examples in class and discussion and feedback through small projects).

7. Brief list of topics to be covered

- Introduction to design of experiments
- Statistical Analysis and Comparative Experiments
- Single Factor Experiments and Analysis of Variance [ANOVA]
- Selected Topics on Randomized Block Design [RBD] and Latin Squares
- Factorial Design and two or more factors
- Design and analysis of complex experiments with multiple factors using orthogonal arrays and linear graphs
- Applications and case studies

ABET Course Syllabi for IND E 321: Statistical Quality Control

1. Course number and name: IND E 321: Statistical Quality Control
2. Credits and contact hours: 4 credit hours, 5 hours per week
3. Instructor's name: Linda Ng Boyle, Christina Mastrangelo
4. Text book, title, author, and year
Introduction to Statistical Quality Control, 6th edition, Douglas C. Montgomery, 2008
 - 4a. Other supplemental materials: NA
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Design of quality control and assurance systems. Statistical Process Control (SPC) design and implementation. Control charts for attributes and variables. Process capability analysis and process improvement techniques. Statistical tolerance design. Quality management and recent developments.
 - 5b. Prerequisites or co-requisites: IND E 315
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective for b (Statistics).
6. Specific goals for the course

This class provides students an overview of techniques that an engineer or researcher needs to assist companies and organizations generate a quality product. It provides students insights into quality engineering and how processes are controlled and monitored to ensure high quality products. The course is conducted in lecture format and begins with a review of descriptive statistics (means, histograms, frequency distributions) and introduces many statistical quality control techniques used in the real world (application and interpretation of control charts, and, process capability concepts).

 - 6a. Specific outcomes of instruction
 - Students will have a broad knowledge of various modern industrial engineering methods and tools associated with designing systems in manufacturing, health care, transportation, and other related fields.
 - Students will have the ability to apply engineering design methods to represent, integrate and solve problems, including the ability to recognize problem context and integrate knowledge and skills appropriate sources.
 - Students will have the ability to communicate effectively.
 - Students should possess the following professional characteristics: leadership, ethics, the ability to work with others, and an appreciation for other disciplines.

- Students will have an understanding of the integrated, broad nature of the IE discipline with an appreciation of the depth of the field and an ability to find information, when needed.

6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

- a) An ability to apply knowledge of mathematics, science and engineering appropriate to the discipline
- b) An ability to design and conduct experiments, analyze and interpret data
- c) An ability to design a system, component, or process to meet desired needs
- e) An ability to identify, formulate, and solve engineering problems
- h) The broad education necessary to understand the impact of engineering solutions in a societal context
- i) A recognition of the need for, and an ability to engage in life-long learning
- j) A knowledge of contemporary issues
- k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

7. Brief list of topics to be covered

- Descriptive Statistics
- Discrete/Continuous Distributions
- Statistical Inferences
- Methods and Philosophy of Statistical Process Control
- Variable Control Charts
- Attribute Control Charts
- Process Capability Analysis
- Gauge R&R
- CUSUM/EWMA
- Short Production Runs
- Modified and Acceptance Control Charts

ABET Course Syllabi for IND E 337: Introduction to Manufacturing Systems

1. Course number and name: IND E 337: Introduction to Manufacturing Systems
2. Credits and contact hours: 4 credit hours, 4 hours per week
3. Instructor's name: Richard L. Storch
4. Text book, title, author, and year
 - Goldratt, E. and Jeff Cox, "The Goal: A Process of Ongoing Improvement," North River Press, New York, June 15, 2012 (3rd edition)
 - Rother, Mike, "Toyota Kata: Managing People for Improvement, Adaptiveness and Superior Results," McGraw-Hill, 2010.
 - Liker, Jeff and David Meier, "The Toyota Way Fieldbook," McGraw-Hill, 2006.
- 4a. Other supplemental materials: None
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):

Description of manufacturing systems. Includes discussion of current trends in manufacturing. Introduces process flow analysis, manufacturing organizations including job-shop, assembly lines, and group technology, manufacturing inventory philosophies (just-in-time, MRP, OPT), work environment, and work simplification.
 - 5b. Prerequisites or co-requisites: NONE
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Required
6. Specific goals for the course
 - 6a. Specific outcomes of instruction

The objective of this course is to introduce the basic Industrial Engineering concepts that are applied in manufacturing. Students will have a basic understanding of lean principles (including process improvement approaches), manufacturing organization, time and motion study, group technology, process flow mapping, value stream mapping, Gantt charts, OPT, learning curves and job shop scheduling. Additionally, students will learn how to use the library for research purposes and identify current issues in manufacturing.
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - a) an ability to apply knowledge of mathematics, science and engineering
 - e) an ability to identify, formulate, and solve engineering problems
 - g) an ability to communicate effectively
 - h) the broad education necessary to understand the impact of engineering solutions in a global and societal context

- i) an understanding of the integrated nature of the discipline
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- l) an understanding of the integrated, interdisciplinary nature of the discipline

7. Brief list of topics to be covered

- Manufacturing Organization
- Lean Principles (including process improvement)
- Time & Motion Study and Work Sampling
- Process Flow Mapping, Value Streams and Value Stream Mapping
- Group Technology
- OPT
- Learning Curves
- Scheduling (Gantt Charts and Job Shop)
- Global and Contemporary Issues in Manufacturing

ABET Course Syllabi for IND E 351: Human Factors In Design

1. Course number and name: IND E 351: Human Factors In Design
2. Credits and contact hours: 4 credit hours, 5 hours per week
3. Instructor's name: Linda Ng Boyle
4. Text book, title, author, and year
 - Wickens, C.D., Lee, J.D., Liu, Y., Becker, S.E. (2004). *An Introduction to Human Factors Engineering 2nd Edition*. New York: Longman
 - Casey, S. (1998). *Set Phasers on Stun*. Santa Barbara, CA: Aegean.
- 4a. Other supplemental materials: Readings from Atomic Chef (by S. Casey, 2006)
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Engineering considerations of the abilities and limitations of the human aspect in the design of operational systems and components. Functional, psychological, physiological, and environmental considerations.
 - 5b. Prerequisites or co-requisites: NONE
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective for d (Design).
6. Specific goals for the course

The objective of this course is to introduce the basic concepts of human factors and to demonstrate the importance of considering human capabilities and limits in system design. This includes an overview of human characteristics and research and design techniques. Case studies are used to demonstrate how humans have contributed to accidents and students learn from these studies to improve designs.

 - 6a. Specific outcomes of instruction
 - Students will have a broad knowledge of various modern industrial engineering methods and tools associated with designing systems in manufacturing, health care, transportation, and other related fields.
 - Students will develop sensitivity to human capabilities and their implications for system performance.
 - Students will be able to perform task analysis and other skills to understand human/machine interactions and guide human considerations in design.
 - Students will have the ability to apply engineering design methods to represent, integrate and solve problems, including the ability to recognize problem context and integrate knowledge and skills appropriate sources.
 - Students will have the ability to communicate effectively.
 - Students should possess the following professional characteristics: leadership, ethics, the ability to work with others, and an appreciation for other disciplines.

- Students will have an understanding of the integrated, broad nature of the IE discipline with an appreciation of the depth of the field and an ability to find information, when needed.

6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

- c) an ability to design a system, component, or process to meet desired needs
 - e) an ability to identify, formulate, and solve engineering problems
 - f) an understanding of professional and ethical responsibility
 - g) an ability to communicate effectively
 - h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
 - j) a knowledge of contemporary issues.
 - l) an understanding of the integrated, inter-disciplinary nature of the discipline
7. Brief list of topics to be covered
- Human Factors Research Methods (Preparing an Internal Review Board for studying human subjects)
 - Design and Evaluation Methods (including Task Analysis and Decision Matrices)
 - Visual Sensory Systems
 - Auditory, Tactile, Vestibular Systems
 - Cognition, Decision Making
 - Displays, Controls
 - Stress and Workload
 - Safety and Accident Prevention

ABET Course Syllabi for IND E 410: Linear and Network Programming

1. Course number and name: IND E 410: Linear and Network Programming
2. Credits and contact hours: 4 credit hours, 5 hours per week (3 hrs lecture, 2 hrs lab)
3. Instructor's names: Zelda B. Zabinsky, Archis Ghatge
4. Text book, title, author, and year
F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, Ninth Edition, McGraw-Hill, 2010.
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Modeling and optimization of linear network problems. Topics include: optimization of linear systems, mathematical model design, simplex method, primal-dual algorithms, parametric programming, goal programming, network problems and algorithms, and PERT/CPM.
 - 5b. Prerequisites or co-requisites:
either MATH 136 or MATH 308; CSE 142
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Required
6. Specific goals for the course

The goals of the course are to introduce students to Operations Research, and the concept of mathematical modeling for optimization, with specific focus on linear and network programming.

 - 6a. Specific outcomes of instruction
 - Students will be able to formulate a simple LP (set up decision variables, constraints and objective functions).
 - Students will be able to interpret results (feasible/infeasible, unique/multiple optima, shadow prices).
 - Students will recognize some basic theory underpinning linear programming and the simplex method.
 - Students will be able to solve a simple LP from the very beginning of formulation through the interpretation of results.
 - Students will be comfortable with extensions to topics in networks, such as the transportation problem, and PERT/CPM
 - Students will be exposed to goal programming and other topics, as time allows.
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - (a) an ability to apply knowledge of mathematics, science and engineering

- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs
- (e) an ability to identify, formulate, and solve engineering problems
- (i) a recognition of the need for, and ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- (l) an understanding of the integrated nature of the discipline

7. Brief list of topics to be covered:

- Introduction and Examples
- Assumptions & Examples
- Simplex Method
- Excel Solver & Sensitivity Lab
- Other Forms, Postoptimality
- Shadow Prices
- Foundations of the Simplex Method
- Revised Simplex Method
- Fundamental Insight
- Duality Theory
- Duality/Sensitivity Analysis
- Sensitivity Analysis and Parametric
- Goal Programming
- Transportation Problems
- Assignment Problems
- Network Problems
- PERT/CPM

ABET Course Syllabi for IND E 411: Stochastic Models and Decision Analysis

1. Course number and name: IND E 411: Stochastic Models and Decision Analysis
2. Credits and contact hours: 4 credit hours, 5 hours per week (3 hrs lecture, 2 hrs lab)
3. Instructor's names: Zelda B. Zabinsky, Archis Ghatge
4. Text book, title, author, and year
F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, Ninth Edition, McGraw-Hill, 2010.
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Stochastic systems analysis to industrial engineering problems. Topics include: Markov chains, queueing theory, queueing applications, and decision analysis.
 - 5b. Prerequisites or co-requisites:
IND E 315; IND E 410
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Required
6. Specific goals for the course

The goals of the course are to introduce students to OR models that involve high degrees of uncertainty; specifically Markov chains, queueing theory and applications, and decision analysis.

 - 6a. Specific outcomes of instruction
 - Students will be able to set up a simple Markov chain and recognize IE applications (e.g. simple inventory problems).
 - Students will be familiar with terms of Markov chains, such as transition probabilities and stationary distribution.
 - Students will recognize basic queueing models and be able to apply basic results (e.g. M/M/1, M/M/s, M/M/s/K).
 - Students will be able to do basic analysis of queueing systems, such as expected number of customers in the system and in the queue and expected waiting time.
 - Students will be able to set up a simple decision tree and conduct a basic decision analysis.
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - (a) an ability to apply knowledge of mathematics, science and engineering
 - (b) an ability to design and conduct experiments, as well as to analyze and interpret data
 - (c) an ability to design a system, component, or process to meet desired needs
 - (e) an ability to identify, formulate, and solve engineering problems

- (i) a recognition of the need for, and ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- (l) an understanding of the integrated nature of the discipline

7. Brief list of topics to be covered:

- Introduction
- Probability Review
- Decision Making Under Uncertainty
- Decision Trees
- Decision Analysis Using TreePlan and SensIt
- Utility Theory
- Who Wants to be a Millionaire?
- Markov Chains
- Chapman-Kolmogorov Equations
- Classification and Long-Run Properties
- First Passage Times
- IOR Tutorial and Monopoly
- Absorbing States
- Queueing Theory
- Fundamentals of Queueing
- Birth-and-Death Process
- Variations of M/M/s
- Queueing Applications
- Call Center Analysis
- Waiting Cost/Number of Servers
- Other Applications - Jackson Networks, if time

ABET Course Syllabi for IND E 412: Integer and Dynamic Programming

1. Course number and name: IND E 412: Integer and Dynamic Programming
2. Credits and contact hours: 4 credit hours, 5 hours per week (3 hrs lecture, 2 hrs lab)
3. Instructor's names: Archis Ghate, Zelda B. Zabinsky
4. Text book, title, author, and year
F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, Ninth Edition, McGraw-Hill, 2010.
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Modeling and optimization of problems and dynamic programming approach to optimization. Topics include: integer programming formulation techniques, linear and Lagrangian relaxation, branch-and-bound and cutting-plane methods, integer programming applications, and dynamic programming.
 - 5b. Prerequisites or co-requisites:
IND E 411
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective for A (Operations Research)
6. Specific goals for the course

The goals of the course are to expose students to OR models of optimization with integer variables and to general dynamic programming models. When time permits, the students may be exposed to nonlinear optimization models and game theory.

 - 6a. Specific outcomes of instruction
 - Students will be able to formulate a simple IP (set up decision variables, constraints and objective functions).
 - Students will be able to interpret results (feasible/infeasible, optimal).
 - Students will develop an understanding about the difference between an LP and an IP, and modeling and computational implications.
 - Students will be able to formulate a simple DP using states and a DP recursion.
 - Students will develop an understanding about the difference between DP, IP and LP, and modeling and computational implications.
 - Additional topics, including nonlinear programming and game theory, will be addressed if time permits.
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - (a) an ability to apply knowledge of mathematics, science and engineering
 - (b) an ability to design and conduct experiments, as well as to analyze and interpret data

- (c) an ability to design a system, component, or process to meet desired needs
- (e) an ability to identify, formulate, and solve engineering problems
- (i) a recognition of the need for, and ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- (l) an understanding of the integrated nature of the discipline

7. Brief list of topics to be covered:

- Integer Programming (IP):
 - Introductory examples
 - Formulation and modeling techniques
 - LP relaxations
 - Lagrangian relaxation
 - Branch and bound methods
 - Cutting plane methods
 - Applications to industrial and other branches of engineering
- Dynamic Programming (DP):
 - Introductory examples
 - DP concepts including stages, decisions, states, policy, value function, optimal policy etc.
 - Important formulation techniques such as equipment replacement, distribution of effort, capacity expansion, resource allocation etc.
- Nonlinear Programming (NLP):
 - Introductory examples
 - Multi-variable models for unconstrained and constrained formulations
 - Lagrangian multipliers and KKT approaches
 - Gradient search and Newton's method
- Game Theory
 - Two-person, zero-sum games
 - Solution of simple games
 - Mixed strategies
 - Graphical solution procedure
 - Solution by linear programming

ABET Course Syllabus for IND E 424: Simulation

1. Course number and name: IND E 424: Simulation
2. Credits and contact hours: 4 credit hours, 4 hours per week.
3. Instructor's name: Benita Beamon
4. Textbook, title, author, and year:
 - Banks, Carson, Nelson, and Nicol, Discrete-Event Simulation, 4th Edition, Prentice Hall, 2005.
 - Kelton, Sadowski, and Sturrock, Simulation with Arena, 4rd Edition, McGraw-Hill, 2009.
- 4a. Other supplemental materials:
 - Arena ® software, online lecture notes, technical handouts
5. Specific course information:
 - 5a. Brief description of the content of the course (catalog description): In this course, students will learn the processes, tools, and techniques for performing effective simulation analyses, specifically: i) (the basic underlying principles of) how simulations work, ii) how to collect and analyze input data, iii) how to build basic simulation models using Arena, iv) how to verify and validate simulation models, and v) how to interpret (and perform statistical analyses of) simulation output.
 - 5b. Pre-requisites or co-requisites: IND E 411 and IND E 337.
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective.
6. Specific goals for the course: This course is an introductory course in simulation theory and modeling. Therefore, the objectives of this course are for students to understand the underlying mechanisms for how simulations work and to be able to design, execute, verify, validate, and analyze the output of a simulation experiment using Arena.
 - 6a. Specific outcomes of instruction:
 - Students will be able to develop simulation studies in manufacturing and service applications.
 - Students will be able to compare simulated systems on the bases of designed performance metrics.
 - Students will be able to collect and model input data and analyze simulation output.
7. Brief list of topics covered:
 - Simulation of a Queuing System (Hand Simulation)
 - A Guided Tour Through Arena®/Simple Processing System
 - Key Probability Distributions
 - Input Modeling and Data Collection

Input Analyzer, Modeling Basic Arena® Operations, Animation
Verification and Validation
Advanced Arena® Operations: Sets, Variables, and Expressions
Output Analysis, Tests for Random Numbers
Output Analyzer
Warm-up Periods
OptQuest
Generating Random Numbers and Random Variates
Monte Carlo Simulation

ABET Course Syllabi for IND E 426: Reliability Engineering and System Safety

1. Course number and name: IND E 426: Reliability Engineering and System Safety
2. Credits and contact hours: 4 credit hours, 4 hours per week
3. Instructor's name: Kailash C. Kapur
4. Text book, title, author, and year
 - Lecture notes, **Reliability Engineering** by Kailash C. Kapur, 2012
 - Reference books, journals and technical manuals
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Reliability and system safety measures. Life distributions and their applications in reliability. System reliability models. Design by reliability and probabilistic design. Reliability and safety analysis through FMECA and FTA. Reliability estimation and measurement by testing for binomial, exponential, and Weibull distributions.
 - 5b. Prerequisites: IND E 315
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
ELECTIVE
6. Specific goals for the course
 - 6a. Specific outcomes of instruction
 - Students will be able to define and develop measures for reliability and safety
 - Students will be able to model reliability by various life distributions
 - Students will be able to compute system reliability
 - Students will be able to relate reliability and safety factor
 - Students will be able to estimate reliability by product testing
 - Students will be able to understand design and management of reliability programs
 - 6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
 - a) an ability to apply knowledge of mathematics, science and engineering (through homework, exams and lectures)
 - c) an ability to design a system, component, or process to meet desired needs (in terms of reliability – design for reliability)
 - e) an ability to identify, formulate, and solve engineering problems (through homework, exams and lectures)
 - f) an understanding of professional and ethical responsibility (through lectures and examples in class)

- h) the broad education necessary to understand the impact of engineering solutions in a global and societal context (through lectures and examples in class)
- i) a recognition of the need for, and ability to engage in life-long learning (through lectures and examples in class)
- j) a knowledge of contemporary issues (through lectures and examples in class)
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (through homework, exams and lectures)
- l) an understanding of the integrated nature of the discipline (through homework, exams and lectures) and (through lectures and examples in class)

7. Brief list of topics to be covered

- Intro to Reliability & Safety Engineering and Design
- Life Distributions
- Complex System Models & Reliability Block Diagrams
- Design by Reliability & Probabilistic Approach
- Relationship between reliability and Safety Factor
- Failure Modes, Effect and Criticality Analysis [FMECA]
- Fault Tree Analysis [FTA]
- Reliability Estimation – Binomial Distribution
- Reliability Estimation – Exponential Distribution
- Reliability Estimation – Weibull Distribution
- Management of Reliability Programs

ABET Course Syllabus for IND E 430: Manufacturing, Scheduling, and Inventory

1. Course number and name: IND E 430: Manufacturing, Scheduling, and Inventory
2. Credits and contact hours: 4 credit hours, 4 hours per week.
3. Instructor's name: Benita Beamon
4. Textbook, title, author, and year:
 - Hopp, Wallace J. and Mark L. Spearman, *Factory Physics*, 2nd Edition, Irwin McGraw-Hill, 2011.
 - 4a. Other supplemental materials:
Online lecture notes, technical handouts
5. Specific course information:
 - 5a. Brief description of the content of the course (catalog description): In this course, students will learn the basics of manufacturing system design, including forecasting, inventory management, scheduling, and manufacturing systems control.
 - 5b. Pre-requisites or co-requisites: IND E 411 and IND E 337.
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective.
6. Specific goals for the course: This course is an introductory course in manufacturing system design. Therefore, the objectives of this course are for students to understand the underlying mechanisms for how to design, measure, analyze, and compare manufacturing systems. Students also learn the basics of manufacturing scheduling and sequencing, and quantitative inventory modeling.
 - 6a. Specific outcomes of instruction:
 - Students will be able to effectively design and analyze high-performance manufacturing systems.
 - Students will be able to apply and evaluate appropriate inventory models to inventory-based systems.
 - Students will be able to schedule/sequence jobs on machines, using optimal algorithms and heuristics, given specific performance objectives.
7. Brief list of topics covered:
Inventory Control: From EOQ to ROP
The MRP/ERP Crusade
The JIT Revolution
What Went Wrong (with MRP and JIT)
A Science of Manufacturing
Basic Factory Dynamics
Variability Basics

The Corrupting Influence of Variability
Push and Pull Production Systems
Types of Production Systems
Environmentally-Conscious Manufacturing
Energy and Manufacturing
The Human Element in Operations Management
A Pull Planning Framework
Production Scheduling and Forecasting
Supply Chain Management
Synthesis-Pulling It All Together

ABET Course Syllabus for IND E 439: Plant Layout and Material Handling

1. Course number and name: IND E 439: Plant Layout and Material Handling
2. Credits and contact hours: 4 credit hours, 4 hours per week.
3. Instructor's name: Benita Beamon
4. Textbook, title, author, and year:
 - *Facility Design & Engineering* (3rd edition), by Steven R. Hanna and Stephan Konz, Holcomb Hathaway Publishers, 2004.
- 4a. Other supplemental materials:
 - Online lecture notes, technical handouts
5. Specific course information:
 - 5a. Brief description of the content of the course (catalog description): In this course, students will learn how to use material flow in: 1) facilities design (designing high-performance interiors and supporting systems for manufacturing and service facilities) and 2) facilities location (determining optimal facility/object locations within a network of facilities/objects).
 - 5b. Pre-requisites or co-requisites: IND E 410.
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program: Elective.
6. Specific goals for the course: This course is an introductory course in plant layout and material handling. Therefore, the objectives of this course are for students to understand the underlying mechanisms for how to design, measure, analyze, and compare facility layouts and how to make facility location decisions. Students also learn the basics of material handling techniques and how they can be effectively and efficiently used to support facility objectives.
 - 6a. Specific outcomes of instruction:
 - Students will be able to effectively design and analyze facility layouts.
 - Students will be able to apply and evaluate appropriate facility location models.
 - Students will be able to design, measure, and analyze material flow systems.
7. Brief list of topics covered:
 - Introduction
 - Criteria
 - Strategies/Tactics
 - Sustainability and Eco-Efficiency in Facility Design
 - Basic Planning
 - Alternative Machine Arrangements
 - Flow Lines
 - Location Models

Americans with Disabilities Act/Building Details
Aisles and Security
Storage
Shipping and Receiving
Offices
Specialized Areas
Workstations
Unit Loads & Containers
Conveyors
Vehicles
Lifting Devices
Workstation Material Handling
Ethics in Facility Design

ABET Course Syllabi for IND E 455: User Interface Design

1. Course number and name: IND E 455: User Interface Design
2. Credits and contact hours: 4 credit hours, 5 hours per week
3. Instructor's name: Thomas A. Furness III
4. Text book, title, author, and year
 - Course notes

4a. Other supplemental materials:

 - Selected Readings
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):
Design oriented to cover fundamentals of user interface design; models on human computer interaction, software psychology, input devices, usability, cognitive and perceptual aspects of human-computer interaction, advanced interface, and research methodologies.
 - 5b. Prerequisites or co-requisites: IND E 351 or equivalent
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:
Elective for d (Design).
6. Specific goals for the course
 - Demonstrate an ability to identify, analyze and solve a user interface design problem.

6a. Specific outcomes of instruction

 1. Demonstrate proficiency in the practice of user interface design in an industrial engineering context
 - Define a design problem
 - Identify customer needs
 - Generate design alternatives
 - Choose among the design alternatives
 - Justify the correctness of their design solution
 2. Apply engineering analysis to design problems
 - Identify which analytical skills are appropriate
 - Gather necessary data
 - Make necessary and appropriate assumptions
 - Complete analysis in a correct manner
 - Apply results of analysis to their design decision making

3. Manage themselves and others on a design project

- Establish and meet deadlines
- Communicate to others about their progress, results, and methods
- Identify and implement an appropriate design method

6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

- c) an ability to design a system, component, or process to meet desired needs
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
- j) a knowledge of contemporary issues.

7. Brief list of topics to be covered:

- Models of human-computer interaction
- A practical interface design process
- Hardware, software, and human factors elements associated with the design and use of interfaces
- Sensory, perceptual, cognitive and psychomotor aspects of human-computer interaction in real and virtual environments.
- Case studies on good and bad interface designs

IND E 470 SYSTEMS ENGINEERING

FALL QUARTER

Elective

CATALOG DATA: SYSTEMS ENGINEERING, 4 credits
Concepts of system approach, system hierarchies, functional analysis, requirements, trade studies, and other concepts used to define and integrate complex engineering systems. Introductions to risk analysis and reliability, failure modes and effects analysis, writing specifications, and lean manufacturing. Offered: jointly with AA 470.

PREREQUISITES BY TOPIC: Computer literacy of spreadsheets, power point and, word processors.

TEXTBOOK: Systems Engineering and Analysis 4th Ed., Blanchard, B. and Fabrycky, W. 2005.
Optional

REFERENCES: None

OBJECTIVE: This course will provide students with the basic concepts used to perform fundamental systems engineering tasks such as mission analysis, functional analysis, requirements and constraint development and allocation, product and program specification generation, systems testing, operations, risk analysis, delivery, and disposal. It is designed to provide a systems viewpoint that examines all functional interfaces and considers a product over its entire life cycle. The course will focus on engineering communication, particularly writing and documenting requirements and project management.

OUTCOMES:

- 1) Students will be able to quantitatively evaluate system interfaces.
- 2) Students will be able to quantify risk and reliability.
- 3) Students will be able to write a simple component specification.
- 4) Students will be able to develop elements of a project plan

TOPICS:

- 1) System Definition
- 2) Project Management (PERT, Gantt, WBS, Budgets, Teams)
- 3) Risk Assessment
- 4) Specialty Engineering (Reliability, Maintainability, Human Factors)
- 5) Engineering Requirements
- 6) Writing Specifications
- 7) Failure Modes and Effects Analysis
- 8) Lean Manufacturing, 6-sigma design
- 9) Systems Architecture

CLASS SCHEDULE: Two 110 minute lectures per week

LABORATORY PROJECTS: None

COMPUTER USAGE: 1) Microsoft Word, Project, and Excel

PROFESSIONAL COMPONENT: Technical Writing and Communication. Risk Assessment.

THE DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

RELATIONSHIP TO ABET OUTCOMES:

- a) An ability to apply knowledge of mathematics, science, and engineering.
- c) An ability to define a system, component, or process to meet desired needs.
- e) An ability to identify, formulate, and solve engineering problems.
- g) An ability to communicate effectively
- h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- i) A recognition of the need for, and an ability to engage in life-long learning.
- k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

COORDINATOR: Adam Bruckner, Professor, Apr. 2007

PREPARED BY: Undergraduate Committee, 4/2007

ASSESSMENT:

- 1) Homework – 4 Writing Projects
- 2) Exams (Mid Term and Final)
- 3) Group Projects – 1 Specification Writing Project, 1 Project Plan Writing Project, 1 Failure Analysis Project

ABET Course Syllabi for IND E 494: Design in the Manufacturing Firm

1. Course number and name: IND E 494: Design in the Manufacturing Firm
2. Credits and contact hours: 4 credit hours, 4 contact hours per week.
3. Instructor's Name: Christina Mastrangelo
4. Textbook: None, but the course uses publically available material for supplemental reading.
5. Specific Course Information:
 - a. Description: Engineering design in manufacturing firms is presented. Topics include design methodology, concurrent engineering, and project management. Focus on the relationship between product design and manufacturing (design for production and assembly).
 - b. Pre-requisites: IND E 337.
 - c. This is a required course in the program.
6. Specific goals for the course: In this course, students will utilize a system engineering methodology and other supporting techniques to frame their senior design project. This culminates in a design project proposal for INDE 495.
 - a. Specific outcomes: At the end of the course students will be able to do the following:
 - i. Conduct a systems analysis.
 - ii. Analyze an engineering-oriented ethical situation using an analysis framework and codes of ethics.
 - iii. Communicate project work in oral and written forms.
 - iv. Understand the project management process and supporting tools.
 - v. Conduct a risk assessment that identifies both technical and external factors.
 - b. Criteria 3 outcomes addressed by the course:
 - a. An ability to apply knowledge of mathematics, science, and engineering.
 - b. An ability to design and conduct experiments, as well as analyze and interpret data.
 - c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
 - d. An ability to function on multi-disciplinary teams
 - e. An ability to identify, formulate, and solve engineering problems.
 - f. An understanding of professional and ethical responsibility
 - g. An ability to communicate effectively
 - h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
 - i. A recognition of the need for, and ability to engage in life-long learning.
 - j. A knowledge of contemporary issues.

- k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- l. An understanding of the integrated, inter-disciplinary nature of the discipline.

7. Brief list of topics covered:

- Systems Analysis Method
- Design Project Fair
- Learning in Teams (Jim Borgford-Parnell)
- Evaluating Alternatives
- AHP
- Engineering Ethics
- Risk Management & Other Design Considerations
- Intellectual Property Issues
- Project Management Techniques

ABET Course Syllabi for IND E 495: Industrial Engineering Design

1. Course number and name: IND E 495: Industrial Engineering Design
2. Credits and contact hours: 4 credit hours, 4 contact hours per week.
3. Instructor's Name: Christina Mastrangelo
4. Textbook: None.
5. Specific Course Information:
 - a. Description: Capstone senior design project involving identification and synthesis of industrial engineering skills. Students apply their knowledge of industrial engineering to actual industrial problems..
 - b. Pre-requisites: IND E 494.
 - c. This is a required course in the program.
6. Specific goals for the course: In this course, student teams complete their senior design project.
 - a. Specific outcomes: At the end of the course students will be able to do the following:
 - i. Demonstrate proficiency in the practice of design in an industrial engineering context by being able to define a design problem, to identify customer needs, to generate design alternatives, to choose among the design alternatives, and to justify the correctness of their design solution.
 - ii. Apply engineering analysis to design problems to identify which analytical skills are appropriate, gather necessary data, make necessary and appropriate assumptions, complete analysis in a correct manner, and apply results of analysis to their design decision making.
 - iii. Manage themselves and others on a design project by establishing and meeting deadlines, communicating to clients and others about their progress, and identifying and implementing an appropriate solution.
 - b. Criteria 3 outcomes addressed by the course:
 - a. An ability to apply knowledge of mathematics, science, and engineering.
 - b. An ability to design and conduct experiments, as well as analyze and interpret data.
 - c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
 - d. An ability to function on multi-disciplinary teams
 - e. An ability to identify, formulate, and solve engineering problems.
 - f. An understanding of professional and ethical responsibility
 - g. An ability to communicate effectively
 - h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
 - i. A recognition of the need for, and ability to engage in life-long learning.

- j. A knowledge of contemporary issues.
 - k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
 - l. An understanding of the integrated, inter-disciplinary nature of the discipline.
7. Brief list of topics covered: Not applicable as each team meets individually with the faculty advisor on a weekly basis for project review.

ABET Course Syllabi for INDE 496: Technology-based Entrepreneurship

1. Course number and name: INDE E 496: Technology-based Entrepreneurship
2. Credits and contact hours: 3 credit hours, 4 hours per week
3. Instructor's name: Thomas A. Furness III
4. Text book, title, author, and year
 - Foster, Jack. *How to get Ideas*. Berret-Koehler Publishers, Inc. 2007
 - 4a. Other supplemental materials¹:
 - TED Talks about entrepreneurship
 - Altucher, James. *How to be the luckiest person alive!* –(ebook-download) – 2011
 - Other supplemental readings from:
 - Harvard Business Review
 - *Discovering New Business Opportunities* – Jack English and Babette Moate
 - *The Art of the Start* – Guy Kawasaki
 - *Welcome to the Experience Economy* – Gilmore & Pine
 - *How to be the luckiest person alive!* – Altucher
 - *First you break all the rules* –Buckingham & Coffman
 - *The Innovator's Dilemma* – Christensen
 - *Seeing What's Next* – Christensen, Roth, Anthony
 - *The Age of the Spiritual Machine* – Ray Kurzweil
 - *Accelerating Intelligence* – Ray Kurzweil
 - World Future Society Predictions + a Challenge to those predictions
 - National Academy of Engineering: Grand Challenges
 - *First break all the rules* – slideshare – Alex Grech
 - Disruptive Technology Forecast 2011
5. Specific course information
 - 5a. Brief description of the content of the course (catalog description):

This course concentrates on hands-on aspects of creative problem solving, innovation and entrepreneurial enterprise in product development.
 - 5b. Prerequisites or co-requisites: NONE
 - 5c. Required, elective, or selected elective (as per Table 5-1) course in the program:

Elective for d (Design).
6. Specific goals for the course
 - Students will examine relationships between ideation, invention, innovation, iterative prototyping, testing and marketing. In turn, students will identify market

¹ Note: The instructor for this course has had extensive experience in technology-based new business startups (25 companies, 2 traded on NASDAQ at a market capitalization of > \$7B) and will draw intensively on that experience in teaching the course.

opportunities, create new technology-based products and services to satisfy customer needs, and construct a plan for developing, marketing and distributing a product.

6a. Specific outcomes of instruction

- The course is organized into three parts: creation/ideation process, decision process, execution process. The learning outcomes of each are given below:

Part 1: Creation/Ideation

- Gain an understanding of the processes of creation, including the elements of environment, culture, practice and
- Develop an understanding of how to use tools that stimulate creativity
- Develop an understanding of tools that organize the creative process
- Develop skills in using tools for creation and critical thinking.

Part 2: Decision Process

- Show the ability to work within the dynamic framework of assessing the interaction of ‘technology pushes’ and ‘application pulls’ to identify useful product concepts and address societal needs that have built-in market potential including the following:
 - How to look at grand challenges
 - Learn Furness Dynamic Framework (FDF) for achieving marketable products
 - Conduct a ‘what if’ exercise to link elements of foundational science and enabling technologies to product ideation, markets and fulfilment of grand challenges
 - Learn to differentiate between ‘what’ and ‘so what’

Part 3: Execution

- Demonstrate introductory knowledge of the commercialisation pathway broadly, and more specifically for technology-based applications including:
 - Identifying appropriate route-to-market strategies for your technology
 - Business models and start-up funding opportunities
 - Intellectual Property protection strategies
 - Guerrilla marketing
- Act professionally by:
 - communicating in writing (social media, blogging, venture feasibility analysis)
 - communicating verbally (pitching to an investor)
 - working independently and in teams
- Students will have the ability to apply engineering design methods to represent, integrate and solve problems, including the ability to recognize problem context and integrate knowledge and skills appropriate sources.
- Students will have the ability to communicate effectively.

- Students should possess the following professional characteristics: leadership, ethics, the ability to work with others, and an appreciation for other disciplines.
- Students will have an understanding of the integrated, broad nature of the IE discipline with an appreciation of the depth of the field and an ability to find information, when needed.

6b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

- c) an ability to design a system, component, or process to meet desired needs
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
- j) a knowledge of contemporary issues.

7. Brief list of topics to be covered

- Ideation and Critical Thinking Methods
- What makes an idea good?
- Self Analysis of Skill Sets and Passions
- Review of Grand Challenges and World Demographics
- Reading the waves and trends in the market place
- Decision Making process related to product focus
- Product Development Strategies
- Marketing Strategies
- Business Plan Development
- Financing Strategies
- Intellectual Property Consideration

Appendix B – Faculty Vitae

1. Name: Benita M. Beamon

2. Education – degree, discipline, institution, year

Ph.D. Industrial and Systems Engineering, Georgia Institute of Technology, 1994.
M.S. Operations Research, Cornell University, 1990.
B.S. Industrial Engineering, Northwestern University, 1988.

3. Academic experience – institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

2006 – Present, Associate Professor, Industrial Engineering, University of Washington.
2010 – Present, Adjunct Associate Professor, Global Health, University of Washington.
1999 – 2006, Assistant Professor, Industrial Engineering, University of Washington.
1994 – 1999, Assistant Professor, Industrial Engineering, University of Cincinnati.

4. Non-academic experience – company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

1990 – 1991, Merck (Pharm. Mfg. Division), West Point, PA, Industrial Engineer, full time.
1989, The RAND Corporation, Santa Monica, CA, Engineering Consultant, full time.

5. Certifications or professional registrations

None.

6. Current membership in professional organizations

Alpha Pi Mu, Member, 2000 – present.

7. Honors and Awards

Winner, National CIEADH/IIE Innovations in Curriculum Award, “Humanitarian Logistics”, 2008

Winner, Outstanding Industrial Engineering Faculty Award, University of Washington, 2001.

Winner, College of Engineering Outstanding Professor Award, University of Cincinnati, 1995.

Most outstanding paper of 1999 in *Logistics Information Management*: “Designing the Green Supply Chain” (Beamon, 1999), Vol. 12, No. 4, pp. 332-342.

Most outstanding paper of 1998 in *Logistics Information Management*: “A Process Quality Model for the Analysis, Improvement, and Control of Supply Chain Systems” (Beamon and Ware, 1998), Vol. 11, No. 2, pp. 105-113.

8. Service activities (within and outside of the institution)

Within institution (For active participation since 2012)

- ISE ABET committee, 2010 to present
- ISE rep for College of Engineering (COE) Council on Educational Policy, 2013- present
- Engineering Discovery Days, ISE Coordinator, 2012-present
- Alpha Pi Mu Faculty Adviser, 2000 – present
- Representative, Industrial and Systems Engineering Diversity, 2009 – present.

Outside of institution (For active participation since 2012)

Editorial advisory board member, *Journal of Humanitarian Logistics and Supply Chain Management* (JHLSCM), 2010 - present.

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

1. Krejci, Caroline C. and Benita M. Beamon (2013). “Modeling Food Supply Chain Sustainability Using Multi-agent Simulation”, *The International Journal of Environmental, Cultural, Economic and Social Sustainability*, in press.
2. Krejci, Caroline C. and Benita M. Beamon (2012). “Modeling Food Supply Chains Using Multi-Agent Simulation”, *Winter Simulation Conference*, December 9-12, Berlin, Germany,
3. Beamon, Benita M. (2012). “Engineering for Life: Food Sustainability and Humanitarian Relief”, *Pacific Science Center Science Café*, June 5, Seattle, Washington.
4. Beamon, Benita M., “From HIV to Hurricanes: Interactions between the Environment and Human Health”, Plenary Panelist, *9th Annual Western Regional International Health Conference*, April 27-29, 2012, University of Washington, Seattle, Washington.
5. Beamon, Benita M. and Katherine Anderegg (2012). “Evaluating the Sustainability of Global Water Supply Chains”, *8th International Conference on Environmental, Cultural, Economic and Social Sustainability*, January 10-12, U. of British Columbia, Vancouver, Canada.
6. Krejci, Caroline and Benita M. Beamon (2012). “Modeling Food Supply Chain Sustainability Using Multi-agent Simulation”, *The 8th International Conference on Environmental, Cultural, Economic and Social Sustainability*, January 10-12, U. of British Columbia, Vancouver, Canada.
7. Benita M. Beamon and Katherine A. Anderegg (2012). “Evaluating the Sustainability of Public and Private Water Supply Chains”, *8th International Journal of Environmental, Cultural, Economic and Social Sustainability*, 8(1), pp. 15-26.
8. J. Meschke, S. Bolton, L. Thompson, B. Beamon, S. Kim, J. Lawler, C. Lowe, J. Olden, B. Spencer, J. Voss, J. Walson, D. Zang (2011). “Critical Review of Metrics for Assessing Health and Environmental Co-Benefits from Adaptation Strategies in Response to Climate Change”, poster presentation, *Global Health Conference*, November 13-15, Montreal, Canada.
9. Krejci, Caroline C. and Benita M. Beamon (2010). “Environmental Sustainability in Support of Disaster Resilience in Food Supply Chains”, *POMS Conference*, May 7-10, Vancouver, Canada [with refereed proceeding].
10. Balcik, Burcu, Benita M. Beamon, Caroline C. Krejci, Kyle M. Muramatsu, and Magaly Ramirez (2010). “Coordination in Humanitarian Relief Chains: Practices, Challenges and Opportunities”, *International Journal of Production Economics*, 126(1), pp. 22-34.
11. Krejci, Caroline C. and Benita M. Beamon (2010). “Environmentally-Conscious Supply Chain Design in Support of Food Security”, *Operations & Supply Chain Management: An International Journal*, 3(1), 14-29.
10. Chen, Xi, Burcu Balcik, and Benita M. Beamon (2008). “Planning For Inventory and Procurement in Humanitarian Relief Chains”, *INFORMS Annual Meeting*, October 15, Washington, DC.
11. Beamon, Benita M. (2008). “Sustainability and the Future of Supply Chain Management”, *Operations and Supply Chain Management*, 1(1), 4-18.
12. Balcik, Burcu, Benita M. Beamon and Karen Smilowitz (2008). “Last Mile Distribution in Humanitarian Relief”, *Journal of Intelligent Transportation Systems*, 12(2), 51-63.
13. Balcik, Burcu and Benita M. Beamon (2008). “Facility Location in Humanitarian Relief”, *International Journal of Logistics: Research and Applications*, 11(2), 101-121.
14. Beamon, Benita M. and Burcu Balcik (2008). “Performance Measurement in Humanitarian Relief Chains”, *International Journal of Public Sector Management*, 21(1), 4-25.

15. Briefly list the most recent professional development activities

- Faculty Fellow, College of the Environment and Department of Global Health, 2009-present.

1. Name: Linda Ng Boyle

2. Education – degree, discipline, institution, year

BS Industrial Engineering, State University of NY at Buffalo, Buffalo, NY 1986
MS Inter-Engineering, University of Washington, Seattle, WA 1994
PhD Civil & Environmental Engineering, University of Washington, Seattle, WA 1998

3. Academic experience – institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

U. of Washington, Dept. of Industrial & Systems Engineering, *Associate Professor*, 2009–present
U. of Washington, Dept. of Civil & Environmental Engineering, *Associate Professor*, 2009–present
U. of Iowa, Dept. of Mechanical & Industrial Engineering, *Associate Professor*, 2008–2009
U. of Iowa, Dept. of Mechanical & Industrial Engineering, *Assistant Professor*, 2002–2008
U. of Iowa, Public Policy Center, Iowa City, IA, *Assistant Professor*, 2002–2007
U. of Washington, Dept. of Civil & Environmental Engineering, *Research Associate*, 1998–2000
U. of Washington, Dept. of Civil & Environmental Engineering, *Research Assistant*, 1995–1998
U. of Washington, *Research Assistant*, Industrial Engineering Program, 1992–1994

4. Non-academic experience – company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

U.S. Department of Transportation–Volpe Center, Office of Safety and Security, Cambridge, MA, USA, *Senior Researcher*, 2000–2002, full-time
KDD & Associates, Seattle, WA, *Senior Traffic Engineer Consultant*, 1998–2000, part-time
The Boeing Company, Seattle, WA, *Industrial Engineer*, 1987–1992; full-time, 1993: part-time

5. Certifications or professional registrations

Engineer in Training (WA State, certificate # 23224)

6. Current membership in professional organizations

Puget Sound Human Factors and Ergonomics Society, Member, 2011-present
Institute of Industrial Engineers, Member, 2006–present
American Statistical Association, Affiliate, 2003–present
Human Factors and Ergonomics Society, Member, 2002–present

7. Honors and awards

NSF Career Award, 2007-2013
U. Washington, College of Engineering, Community of Innovators Award: Research, 2011
U. Iowa IIE Outstanding Professor Award, 2005
U. Iowa IIE Outstanding Educator Award, 2003

8. Service activities (within and outside of the institution)

Within institution (For active participation since 2012)

- ISE ABET committee, 2010 to present
- ISE rep for College of Engineering (COE) Faculty Council, 2010 to present

- Engineering Discovery Days, ISE Information Session & Demonstrations, 2012
- ISE Undergraduate Adviser, 2012
- Associate Director, PacTrans University Transportation Center, 2012 to present

Outside of institution (For active participation since 2012)

- Associate Editor, *Accident Analysis and Prevention*, 2008–present
- Panel Reviewer, The National Academies–Soldier Systems Panel, Aberdeen, MD, 2009–present
- Chair, The National Academies–Transportation Research Board, Committee on Statistical Methods, ABJ80, 2011–present
- Conference Organizer for (1) International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design, 2013 (Lake George, NY) and (2) AutomotiveUI (AUTO-UI), International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Portsmouth, NH (Oct, 2012)

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

- Peng, Y. **Boyle, LN**, Hallmark, S. (2013). Driver’s lane keeping ability while distracted: insights from a naturalistic study, *Accident Analysis and Prevention*, 50, 628-634.
- Neyens, D. and **Boyle, LN** (2012) Crash risk factors related to individuals sustaining and drivers following traumatic brain injury, *Accident Analysis and Prevention*, 49, 266-273.
- Xiong, H., **Boyle, LN**, Moeckli, J., Dow, B., Brown, T. (2012). Use Patterns Among Early Adopters of Adaptive Cruise Control (ACC), *Human Factors*, 54, 5, 722-733.
- Westlake, B. and **Boyle, LN** (2012). Perceptions of Driver Distraction Among Teenage Drivers, *Transportation Research Part F*, 15, 644-653.
- Xiong, H. and **Boyle, LN** (2012). Driver’s adaptation to adaptive cruise control: examination of automatic and manual braking, *IEEE Transactions on Intelligent Transportation Systems*, 13, 3, 1468-1473.
- Ghazizadeh, M., Lee, JD, and **Boyle, LN** (2012). Extending the technology acceptance model to assess automation, *Cognition, Technology & Work*, 14, 1, 39-49.
- **Boyle, LN**, and Lee, J. (2010) Using driving simulators to assess driving safety. *Accident Analysis and Prevention*, 42, 785-787.
- Lee, Y. Lee, J. and **Boyle, LN** (2009) The interaction of cognitive load and attention-directing cues in driving. *Human Factors*, 51, 271-280.
- **Boyle, LN**, Tippin, J., Paul, A., and Rizzo, M. (2008) Driver performance declines in the moments surrounding a microsleep. *Transportation Research Part F*, 11, 2, 126-136.

10. Briefly list the most recent professional development activities

- Developed a workshop for human factors researchers and practitioners on how to use the statistical package, R.
- Developed workshops on using driving simulators for researchers and practitioners who use this tool.

1. Name: Wanpracha “Art” Chaovalitwongse

2. Education

BEng	Telecommunication Engineering, King Mongkut Institute of Technology, Ladkrabang, Thailand	1999
MS	Industrial & Systems Engineering, University of Florida, Gainesville, FL	2000
PhD	Industrial & Systems Engineering, University of Florida, Gainesville, FL	2003

3. Academic experience

Univ. of Washington, Dept. of Industrial & Systems Eng., *Associate Professor*, 2011–present
Univ. of Washington, Dept. of Radiology (joint), *Associate Professor*, 2011–present
Princeton Univ., Dept. of Operations Research & Financial Eng., *Visiting Associate Professor*,
2011

Rutgers Univ., Dept. of Industrial & Systems Eng., *Associate Professor*, 2010–2011
Rutgers Univ., Dept. of Industrial & Systems Eng., *Undergraduate Director*, 2010–2011
Rutgers Univ., Rutgers Center for Information Assurance, an NSA National Center of Academic
Excellence in Information Assurance – Research and Education, *Director*, 2008–2011
Rutgers Univ., Dept. of Industrial & Systems Eng., *Assistant Professor*, 2005–2010
Univ. of Florida, Dept. of Neurology and Brain Institute, *Postdoctoral Associate*, 2003
Univ. of Florida, Dept. of Neurology and Brain Institute, *Research Assistant*, 2000–2003

4. Non-academic experience

ExxonMobil Research & Engineering, Corporate Strategic Research, Annandale, NJ, USA,
Postdoctoral Fellow (equivalent to Member of the Technical Staff), 2004–2005, full-time

5. Certifications or professional registrations

N/A

6. Current membership in professional organizations

Institute of Electrical and Electronics Engineers (IEEE), Senior Member, 2005–present
Institute for Operations Research and the Management Sciences, Member, 2001–present

7. Honors and awards

Senior Member, Institute of Electrical and Electronics Engineers (IEEE), 2011
Presidential Fellowship for Teaching Excellence, Rutgers University, 2010
Outstanding Service Award, Association of Thai Professionals in America and Canada, 2009
Faculty Academic Service Increment Program (FASIP) Award for Research, Teaching and
Service, Rutgers University, 2006–2009
Pierskalla best paper award for research excellence in health care management science, Institute
for Operations Research and the Management Sciences (INFORMS), 2008
Nomination for the National Security Science and Engineering Faculty Fellowship (NSSEFF)
Program, Rutgers University (nominated by Rutgers President McCormick), 2008
Notable Alumni, King Mongkut Institute of Technology at Ladkrabang, 2007
NSF CAREER Award, National Science Foundation, 2006
Faculty Member, Omega Rho International Honor Society for Operations Research and
Management Science, 2006

Pierskalla best paper award for research excellence in health care management science, Institute for Operations Research and the Management Sciences (INFORMS), 2004
Annual Award for Excellence in Research, University of Florida, 2003

8. Service activities (within and outside of the institution)

Within institution (For active participation since 2012)

- ISE Graduate Committee, 2011 to present
- ISE Faculty Search Committee, 2011 to present

Outside of institution (For active participation since 2012)

- Area Editor, *Annals of Operations Research*, 2012–present
- Associate Editor, *IEEE Transactions on Human-System*, 2013–present
- Associate Editor, *Journal of Global Optimization*, 2010–present
- Associate Editor, *Optimization Letters*, 2006–present
- Associate Editor, *Journal of Combinatorial Optimization*, 2005–present
- Editorial Board Member, *International Journal of Electronic Transport*, 2009–present
- Editorial Board Member, *Recent Patents in Computer Science*, 2009–present
- Panel Reviewer, Directorate for Biological Sciences, National Science Foundation, 2013
- Executive Vice President, Association of Thai Professionals in America and Canada (ATPAC), 2007–present

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

- Reinforcement Learning Framework for Online Adaptive Seizure Prediction. S. Wang, **W. Chaovalitwongse**, and S. Wong. Forthcoming in *IEEE Transactions on Knowledge and Data Engineering*, 2013. (Finalist of the 2012 INFORMS Data Mining Student Paper Competition)
- A Network-Based Model for the Integrated Weekly Aircraft Maintenance Routing and Fleet Assignment Problem. Z. Liang and **W. Chaovalitwongse**. Forthcoming in *Transportation Science*, 2013.
- Mathematical Programming Formulations and Algorithms for Discrete k-Median Clustering with Time Series Data. O. Seref, Y.J. Fan, and **W. Chaovalitwongse**. Forthcoming in *INFORMS Journal on Computing*, 2013.
- Multicriteria Variable Selection for Classification of Production Batches into Two Categories. M.J. Anzanello, S.L. Albin, and **W. Chaovalitwongse**. *European Journal of Operational Research*, 218, 97-105, 2012
- Pattern Recognition Approaches for Identifying Subcortical Targets During Deep Brain Stimulation Surgery. **W. Chaovalitwongse**, Y.S. Jeong, M.K. Jeong, S.F. Danish, and S. Wong. *IEEE Intelligent Systems*, 26(5), 54-63, 2011.
- On the Network Flow Based Model for Aircraft Maintenance Routing Problem. Z. Liang, **W. Chaovalitwongse**, H.C. Huang, and E.L. Johnson. *Transportation Science*, 45(1), 109-120, 2011.

10. Briefly list the most recent professional development activities

- Grant writing course, Dept. of Radiology, UW Medical Center, 2012.

1. Name: Thomas A. Furness III

2. Education – degree, discipline, institution, year

BS Electrical Engineering, Duke University, Durham, NC -1966

PhD Engineering & Applied Science, University of Southampton, ENGLAND -1981

3. Academic experience –

U. of Washington, Industrial & Systems Engineering, *Professor*, 2003–present, part time

U. of Washington, Industrial & Systems Engineering, *Professor*, 1989–2003, full time

U. of Washington, Human Interface Technology Lab, *Founding Director*, 1989–present, part time

U. of Washington, Electrical Engineering, *Adjunct Professor*, 1993–present, part time

U. of Washington, Mechanical Engineering, *Adjunct Professor*, 2005–present, part time

U. of Washington, Human-Centered Design & Engrg, *Adjunct Professor*, 1993–present, part time

U. of Washington, Aeronautical Engineering, *Adjunct Professor*, 2003-2007, part time

U. of Canterbury, Human Interface Technology Lab – NZ, *Adjunct Professor*, 2002-present, part time

U. of Canterbury, Human Interface Technology Lab – NZ, *International Director*, 2002-present, part

U. of Tasmania, School of Computing, *Adjunct Professor*, 2008-present, part time

U. of Tasmania, Human Interface Technology Lab – AU, *International Director*, 2208-present, part

4. Non-academic experience

RATLab LLC, *Founder & President*, (engrg. Services company, perform development of electro-optical and photonic systems), 2005-present, part time

ARToolworks Inc., *Co-Founder & Chairman*, (develop and distribute Augmented Reality software toolkits and libraries), 2001-present, part time

United States Air Force–Armstrong Lab-Visual Display Systems (develop advanced cockpits for military aircraft), Wright-Patterson AFB, Ohio, USA, *Branch Chief-Supervisory Electronics Engineer*, 1971-1989, full-time

United States Air Force–Armstrong Lab-Human Engineering Division, Wright-Patterson AFB, Ohio, USA, *Air Force Officer-Electronics Engineer*, 1966-1971, full-time

5. Honors and awards

2013	SPIE Prism Award – Green Photonics – (for the invention for the spectrum pattern matching technology)
2002	Erskine Fellowship, University of Canterbury, Christchurch, NZ
2001	Richard Satava Award for Excellence in Virtual Reality and Medicine
1998	Discover Award for Technological Innovation (for the Virtual Retinal Display)
1993	Golden Key National Honor Society, Honorary Member
1993	Eta Kappa NU, Electrical Engineering Honor Society, Honorary Member
1986	Department of the Air Force, Meritorious Civilian Service Award
1970	Air Force Systems Command Scientific Achievement Award
1969, 1970	Nominated by the USAF for America's Ten Outstanding Young Men
1969	Human Engineer of the Year, Air Force Aerospace Medical Res Lab.

6. Service activities (within and outside of the institution)

Within institution

- College – Council on Educational Policy – 2010-Present
- College – Promotion & Tenure Committee – 1993-1999

Outside of institution

- Founding Co-Editor, *Presence*, MIT Press- 1995-2000
- General Chairman, IEEE VRAIS Conference, Seattle, WA- 1993
- Editorial Board, *Journal of CyberTherapy & Rehabilitation*, 2007-present

7. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

>> 200 invited presentations, >100 keynote addresses, 31 PR Journal articles, 3 books/chapters, 66+ conference proceedings, 16 patents:

- 8,081,304 Method, apparatus, and article to facilitate evaluation of objects using electromagnetic energy
- 8,076,630 System and method of evaluating an object using electromagnetic energy
- 7,996,173 Method, apparatus, and article to facilitate distributed evaluation of objects using electromagnetic energy
- 6,867,753 Virtual image registration in augmented display field
- 6,639,570 Retinal display scanning of image with plurality of image sectors
- 6,563,105 Image acquisition with depth enhancement
- 6,497,649 Alleviating motion, simulator, and virtual environmental sickness by presenting visual scene components matched to inner ear vestibular sensations
- 6,317,103 Virtual retinal display and method for tracking eye position
- 6,294,775 Miniature image acquisition system using a scanning resonant waveguide
- 6,288,816 Miniature optical scanner for a two axis scanning system
- 6,008,781 Virtual retinal display
- 5,751,465 Miniature optical scanner for a two axis scanning system
- 5,659,327 Virtual retinal display
- 5,596,339 Virtual retinal display with fiber optic point source
- 5,467,104 Virtual retinal display
- 5,162,828 Display system for a head mounted viewing transparency

8. Briefly list the most recent professional development activities

- Developed the curriculum for the Human Interface Technology Major, School of Computing, University of Tasmania.
- On panel that developed the MHIT and Ph.D. academic degrees at the Human Interface Technology Laboratory at the University of Canterbury

1. Name: Archis Ghate

2. Education – degree, discipline, institution, year

BTech, MTech Chemical Engineering, Indian Institute of Technology, Bombay, India, 2001
MS Management Science and Engineering, Stanford University, Stanford, California, 2003
PhD Industrial and Operations Engineering, University of Michigan, Ann Arbor, Michigan, 2006

3. Academic experience – institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

U. of Washington, Dept. of Industrial & Systems Engineering, *Assistant Professor*, 2006–2012
U. of Washington, Dept. of Industrial & Systems Engineering, *Associate Professor*, 2012–present

4. Non-academic experience – company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

None

5. Certifications or professional registrations

None

6. Current membership in professional organizations

Institute of Industrial Engineers
Institute for Operations Research and the Management Sciences

7. Honors and awards

CAREER Award, National Science Foundation, 2011-2016
Award for Excellence in Teaching Operations Research, Institute of Industrial Engineers, 2012
Outstanding Professor Award, Dept. of Industrial and Systems Engineering, U. of Washington, 2009, 2010, 2011, 2012

8. Service activities (within and outside of the institution)

Within institution (For active participation since 2012)

- Chair of ISE Graduate Admissions Committee
- Member of the ISE Teaching Schedule and TA Allocation Committee
- Chair of ISE Faculty Search Committee

Outside of institution (For active participation since 2012)

- Reviewer for various scientific articles submitted for publication in journals in the area of Operations Research
- Panel Reviewer for various grant proposals

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

- A. Ghate, and R. L. Smith, A linear programming approach to nonstationary infinite horizon Markov decision processes, forthcoming in *Operations Research*, 2012
- M. Kim, A. Ghate and M. Phillips, A stochastic control formalism for dynamic biologically conformal radiation therapy, *European Journal of Operational Research*, 219 (3), 541-556, 2012
- X. Chen, A. Ghate, and A. Tripathi, Dynamic lot-sizing in sequential online retail auctions, *European Journal of Operational Research*, 215 (1), 257-267, 2011
- A. Ghate, D. Sharma, and R. L. Smith, A shadow simplex method for infinite linear programs, *Operations Research*, 58 (4), 865-877, 2010
- S. Baumert, A. Ghate, S. Kiatsupaibul, Y. Shen, R. L. Smith, and Z. B. Zabinsky, Discrete hit-and-run for sampling points from arbitrary distributions over subsets of integer hyper-rectangles, *Operations Research*, 57 (3), 727-739, 2009
- A. Ghate, and R. L. Smith, Optimal backlogging over an infinite horizon under time-varying convex production and inventory costs, *Manufacturing and Service Operations Management*, 11, 362-268, 2009

10. Briefly list the most recent professional development activities

Attended a CAREER proposal writing workshop organized by the National Science Foundation for junior faculty

1. Name: Joseph A Heim

2. Education – degree, discipline, institution, year

BS	Mechanical Engineering, University of Louisville, Louisville, KY	1975
ME	Math and Computer Science, University of Louisville, Louisville, KY	1976
MS	Industrial Engineering, Purdue University, West Lafayette, IN	1988
PhD	Industrial Engineering, Purdue University, West Lafayette, IN	1990

3. Academic experience – institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

U. of Washington, Dept. of Industrial & Systems Engineering, *Senior Principal Research Scientist/Engineer*, 2009-present

U. of Washington, Dept. of Industrial & Systems Engineering, *Adjunct Assoc. Professor*, 2003-2008

U. of Washington, Dept. of Industrial & Systems Engineering, *Assistant Professor*, 1993-1998

National Research Council, *Senior Program Officer*, Washington, DC, 1992-1993

National Academy of Engineering, *J Herbert Holloman Fellow*, Washington, DC, 1990-1992

Purdue University, Dept. of Industrial & Systems Engineering, *Research Assistant*, 1987–1990

Purdue University, Dept. of Industrial & Systems Engineering, *Teaching Assistant*, 1986–1987

4. Non-academic experience – company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

Terex Corporation, AWP Division, *Director of Marketing Analytics; Director of Supply Chain Planning and Analysis*, Redmond, WA, 1998-2009; full time.

Integrated Production Systems, Inc., *VP Product Development and Marketing*, Louisville, KY, 1983-1986; full-time.

InfoSystems Design Corp., *Co-founder and President*, Louisville, KY, 1977-1985; full-time.

Chemetron Corp., *Mechanical Engineer*, Louisville, KY, 1976–1977; full-time

5. Certifications or professional registrations

Toyota Production System Study Mission (Shingujitsu training), Japan, 2000.

6. Current membership in professional organizations

Institute of Industrial Engineers (IIE), Member

7. Honors and awards

J Herbert Holloman Fellowship, NAE 1990-1992

U. Washington, IE Program, Teaching Award for 1993-1994.

8. Service activities (within and outside of the institution)

Outside of institution

- IIE Advisory Council for Industrial Engineering (CIE) Board, 2005-2008.
- Impact Washington (Washington State NIST MEP) Board Member, 2005-present.

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

Wang, H., Heim, J. A., Zabinsky, Z. B. "Analyzing Clinical Laboratories using Object-oriented Hierarchies and Discrete-event Simulation," Proceedings of the 2013 Industrial and Systems Engineering Research Conference (ISERC), Puerto Rico, May 2013.

Huang, H., Heim, J. A., Zabinsky, Z. B., Zangeneh-Khamooshi, S., Wellner, M., Astion, M., Cruz, D., Vincent, J., and Jack, R., "Simulation-based Resource Planning for in-house Delivery of Employee Healthcare Services," Abstract accepted in *Proceedings of the 2012 Industrial and Systems Engineering Research Conference (ISERC)*, Orlando, FL, May 2012.

Zangeneh-Khamooshi, S., Zabinsky, Z. B., and Heim, J. A., "A Multi-shift Vehicle Routing Problem with Windows and Cycle Times," *Optimization Letters*, a special issue on Vehicle Routing and Scheduling: Recent Trends and Advances, in press.

10. Briefly list the most recent professional development activities

- Developed planning and modeling workshops for Clinical Laboratory Health Care Professionals

1. Name: Kailash C. Kapur

2. Education – degree, discipline, institution, year

B.E.	Mechanical Engineering, Delhi University, India	1963
M.Tech.	Industrial Engineering, Indian Inst. of Tech, Kharagpur, India	1965
M.S.	Operations Research, University of California, Berkeley, CA	1968
Ph.D.	Industrial Engineering, University of California, Berkeley, CA	1969

3. Academic experience – institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

University of Washington, Dept. of Industrial & Systems Engineering, Professor, 1992-present

University of Washington, Dept. of Industrial & Systems Engineering, Director, 1992- 1999

University of Oklahoma, Norman, School of Industrial Engineering, Director, 1989 -1992

Wayne State University, Detroit, MI, Department of Industrial Engineering, Professor 1980-1989, Associate Professor 1973-1980, Assistant Professor 1970-1973

University of California, Berkeley, Research Assistant, 1966-1969

4. Non-academic experience – company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

General Motors Research Laboratory, Warren, MI, Senior Research Engineer, 1969-1970

US Army, Tank Automotive Command, MI, Senior Reliability Engineer, 1978 [Visiting]

Ford Motor Company, Dearborn, MI, Visiting Scholar, Summer 1973

5. Certifications or professional registrations

Registered Professional Engineer, State of Michigan (Certificate #21845)

6. Current membership in professional organizations

Institute of Industrial engineers [IIE], Fellow

American Society for Quality [ASQ], Fellow

Institute of Electrical and Electronics Engineers [IEEE], Member

INFORMS, Senior Member

7. Honors and awards

1987 Allan Chop Technical Advancement Award, Reliability Division, ASQ

1989 Craig Award, Automotive Division, ASQ

1990 **Fellow**-American Society of Quality (ASQ)

1991 **Fellow**-Institute of Industrial Engineers (IIE)

1993, 1999, 2003, 2005, 2006, 2008 - Voted the **Outstanding Professor** in industrial engineering by the students

Biographical citations in over dozen publications [like Who's Who]

8. Service activities (within and outside of the institution)

Within the Institution

- The College of Engineering Council [2003-2007], Chair [2004-2005]
- College of Engineering P&T [2003-2005, 2011-cont], Faculty Senate [2004-2006]

Outside of the institution

- Editorial Board [during different times] for Journal of Quality Engineering, Inter. Journal of Six Sigma and Competitive Advantage, Inter. Journal of Performability, Inter. Journal of Productivity and Quality Management, Inter. Journal of Quality Technology & Quantitative Management, etc.
- Chair, Edwards Medal Award Committee, American Society for Quality, 2003-2006.
- President Elect, Division of Quality Control and Reliability Engineering, Institute of Industrial Engineers, 2005 –2006 and the President during 2006-2007 term.
- Member, Deming Medal Award Committee, American Society for Quality, 2003-2006.

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

- M. G. Pecht, **K. C. Kapur**, Rui Kang, and S. Zhang, *Foundation of Reliability Engineering*, Publishing House of Electronics Industry, Beijing, June 2011. [ISBN 978-7-121-13488-3].
- Feng, Q. and **Kapur, K. C.**, *Quality Control*, a major chapter in the *Operations Research and Management Science Handbook*, Ed. By A. Ravindran, 904pp, Taylor and Francis, 2008.
- Liu, Y. and **Kapur, K. C.**, “New Patient-Centered Models of Quality-of-Life Measures for Evaluation of Interventions for Multi-Stage diseases”, *IIE Transactions, Special Issue on Health Systems*, Vol. 40, Sep 2008, pp 870-879.
- Reed, Dorothy A., **Kapur, K. C.** and Christie, Richard, “Methodology for Assessing the Resilience of Networked Infrastructure”, *IEEE Systems Journal, special issue on Resilience Engineering*, Vol. 3, No. 2, June 2009, pp 174-180 .
- Weininger, S., **Kapur, K. C.** and Pecht, M., “Exploring Medical Device Reliability and Its Relationship to Safety and Effectiveness”, *IEEE Transactions on components and Packaging Technologies*, Vol. 33, No. 1, March 2010.
- **K. C. Kapur** “How to Achieve Safety First & Reliability Primary” **Invited Keynote Speech**, *9th International Conference on Reliability, Maintainability and Safety [ICRMS]*, Guiyang, China, June 12-15, 2011.

10. Briefly list the most recent professional development activities

- Developed, participated and lead a workshop in **TQM and six sigma in Education**
- **System Safety and Reliability Analysis** - Designed, developed this one week course which has been offered through the Engineering Professional Programs at many locations throughout in USA and other countries...
- **Sabbatical** leave during 2010-2011 and visited Beihang University of Aeronautics and Astronautics, Beijing, China and Mechanical Engineering Department, University of Maryland, College Park for professional development.

1. **NAME:** Christina M. Mastrangelo, Associate Professor

<u>INSTITUTION AND LOCATION</u>	<u>DEGREE</u>	<u>YEAR(s)</u>	<u>FIELD OF STUDY</u>
Arizona State University, Tempe AZ	Ph.D.	1993	Industrial Engineering.
Arizona State University, Tempe AZ	M.S.	1990	Industrial Engineering.
Arizona State University, Tempe AZ	B.S.	1986	Industrial Engineering.

3. **ACADEMIC EXPERIENCE**

9/05-Present **Associate Professor**, Industrial & Systems Engineering, University of Washington

9/02-9/05 **Visiting Associate Professor**. Industrial & Systems Engineering, University of Washington

5/00-5/02 **Associate Professor**. Department of Systems and Information Engineering, University of Virginia

8/93-5/00 **Assistant Professor**. Department of Systems Engineering, University of Virginia

4. **NON-ACADEMIC EXPERIENCE**

7/92-8/93 **Process Control Engineer**. AlliedSignal Aerospace, Phoenix, Arizona.

5/85-8/88 **Production Systems Engineer**. AlliedSignal Aerospace, Phoenix, Arizona.

5. **CERTIFICATIONS/PROFESSIONAL REGISTRATIONS**

ASQ Green Belt Certification

6. **PROFESSIONAL ORGANIZATION MEMBERSHIPS**

American Society for Engineering Education, Member

American Society for Quality Control, Member

American Statistical Association, Member

Institute of Industrial Engineers, Senior Member

Institute for Operations Research and the Management Sciences, Member

International Council on Systems Engineering, Member

7. **AWARDS/HONORS**

Frontiers in Engineering Education Symposium, 2009, National Academy of Engineering

Innovations in Curriculum Award, 2009, Institute of Industrial Engineers/CIEADH

Welliver Faculty Fellowship, Boeing, 2005.

8. **SERVICE (2005-)**

Developing application for new Masters of Engineering degree, 2011-

Professional Masters Program, Director, 2009-

Course Scheduling Committee, Chair, 2008-

Faculty Coordinator, GISE (Globally Integrated Systems Engineering) & Engineering

Leadership Certificate Programs, 2006-

UW Council on Educational Policy, Scholarship & Fellowship Committee Chair, 2006-11

UW Council on Educational Policy, 2004-11.

UW Chair, Council on Educational Policy, 2007-08.

UW College of Built Environments Dean Review Committee, 2012

UW Chemical Engineering Program Review Committee, 2009

Organizer and Conference Chair, ASA Joint Research Conference, May 2014
 ASQ Feigenbaum Medal Selection Committee, 2011-
 NSF Proposal Reviewer for Service Enterprise Systems, Dec 2011, Aug 2012, Dec 2012
 Editorial Board Member, Journal of Quality Technology, 1994-2004, 2007-2012
 ASA Quality & Productivity Natrella Scholarship Committee 2005-
 ASQ Shewhart Medal Selection Committee, ASQ, 2004-
 Editorial Board Member, IIE Transactions on Quality and Reliability, 1996-
 Organizer & Conference Chair, 10th International Workshop on Intelligent Statistical Quality Control, Seattle, WA, August 18-20, 2010.
 NSF Proposal Reviewer for Innovations in Engineering Education, Curriculum, and Infrastructure, March 2010.
 Past Chair, Quality & Productivity Section, ASA 2006.

9. **PUBLICATIONS**

- Erto P., G. Pallotta and C.M. Mastrangelo. "A Bayesian Approach to Monitor Weibull Percentiles." In review with Technometrics.
- Gillan1, A. and C.M. Mastrangelo, "Monitoring Hospital-Associated Infections with Control Charts." Accepted for publication in Frontiers in Statistical Quality Control Springer-Verlag. IF=NA.
- Chang1, Y.C. and C.M. Mastrangelo (2011), "Addressing Multicollinearity in Semiconductor Manufacturing," Quality and Reliability Engineering International, 27(6) pp. 843-854. IF=1.03.
- Kumar1, N., C.M. Mastrangelo and D.C. Montgomery (2011), "Hierarchical Modeling Using Generalized Linear Models," Quality and Reliability Engineering International, 27(6), pp. 835-842. IF=1.03.
- Krueger, D.C., D.C. Montgomery, and C.M. Mastrangelo (2011), "Application of Generalized Linear Models to Predict Semiconductor Yield Using Defect Metrology Data," IEEE Trans on Semiconductor Manufacturing, 24(1).
- Mastrangelo, C.M., N. Kumar1, D. Forrest1 (2010), "Hierarchical Modeling for Monitoring Defects." Frontiers in Statistical Quality Control 9. pp. 225-236. IF=NA.
- Fellows1, H.E., C.M. Mastrangelo and K.P. White (2009), "An Empirical Comparison of Spatial Randomness Models for Yield Analysis." IEEE Transactions on Electronics Packaging Manufacturing 32(2), pp. 115-120.
- Limaye1, S., C.M. Mastrangelo, D. Zerr (2008), "A Statistical Approach to Reduce Hospital Associated Infections." Quality Engineering, 20(4), pp. 414-425. IF=NA, CC=2.
- Limaye1, S. C.M. Mastrangelo, D. Zerr, H. Jeffries (2008), "A Case Study in Monitoring Hospital-Associated Infections with Count Control Charts." Quality Engineering, 20(4), pp. 404-413. IF=NA.
- Kundu2, B, K.P. White, and C.M. Mastrangelo (2008), "Classification of Defect Clusters on Semiconductor Wafers via the Hough Transformation." IEEE Transactions on Semiconductor Manufacturing, 21(2), pp. 272-278.

10. **PROFESSIONAL DEVELOPMENT**

Developed course material, courses, graduate certifications and degree programs. Achieved Six Sigma Green Belt certification.

1. Name: Richard Lee Storch

2. Education – degree, discipline, institution, year

BS Naval Architecture and Marine Engineering, Webb Institute, Glen Cove, NY 1967
MS Ocean Engineering, MIT, Boston, MA 1968
PhD Mechanical Engineering, University of Washington, Seattle, WA 1978

3. Academic experience – institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

U. of Washington, *Chair and Professor*, Dept. of Industrial & Systems Engineering, 2009–present, full time
U. of Washington, *Director and Professor*, Industrial Engineering Program, 2005–2009, full time
U. of Washington, *Acting Director and Professor*, Industrial Engineering Program, 2003–2005, full time
U. of Washington, *Professor*, Industrial Engineering Program, 2001–2003, full time
U. of Washington, *Associate Professor*, Industrial Engineering Program, 1986–2001, full time
U. of Washington, *Associate Professor*, Mechanical Engineering, 1985–1986, full time
U. of Washington, *Research Assistant Professor*, Mechanical Engineering, 1978–1985, full time
U. of Washington, *Lecturer*, Mechanical Engineering, 1977–1978, full time

4. Non-academic experience – company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

The Glosten Associates, Seattle, WA, *Naval Architect*, 1972–1978, full time
Executive Office of the President, Council on Environmental Quality, Washington, DC, *Staff Member*, 1971–1972, full time
U. S. Coast Guard, Washington, DC, *Naval Architect and Officer*, 1968–1971, full time

5. Certifications or professional registrations

Professional Engineer (WA State, certificate # 14497)

6. Current membership in professional organizations

Society of Naval Architects and Marine Engineers, Fellow, 1963-present
Institute of Industrial Engineers, Senior Member, 1985–present
International Federation of Information Processing, WG5.7, IPC Member, 1991-present
International Conference on Computer Applications in Shipbuilding, IPC Member, 1986-present

7. Honors and awards

Kennedy Award, Society of Naval Architects and Marine Engineers, 2011
Puget Sound Engineers Council, Academic Engineer of the Year, 2003
Fellow, Society of Naval Architects and Marine Engineers, 1995
U. Washington, IE Outstanding Professor Award, 1995, 1996, 1998, 2000, 2001, 2003

8. Service activities (within and outside of the institution)

Within institution

- Chair, Industrial & Systems Engineering, 2003 - present
- Program Review Coordinator, 2008

- Faculty Search Committee Chair, 2000 - 2002
- Undergraduate Advisor, September, 1998 - 2012
- Undergraduate and graduate admissions committee, 1998 – present
- ABET coordinator, 1998 – 2009
- Graduate Seminar Organizer, September 1986 - June 1995
- AA Chair search committee, chair, 2009
- EE Chair review committee member, 2003
- TC Chair review committee member, 2002
- IE Chair search committee member, 2000 - 2001
- College Council, 1999 – 2003, chair, 1999 - 2000
- Alternate Graduate Program Coordinator, Inter-Engineering MSE program, 1989 - 1996
- Interdisciplinary MS/MSE committee, 1986 - 1996
- Engineering Graduate Fellowship Awards Committee, 1988 - 1996
- Educational Policy Committee, 1988 - 1991, 1993 - present, Chair, 1991, 1996-1997, writing subcommittee member, 1994 - 1995, ENGR courses subcommittee member, 1993 - 1994, curriculum subcommittee chair, 1990
- COE representative on UW DEOHS External Advisory Committee, 2006-present
- Faculty Senate, 1995 - 1996

Outside Institution

- CIEADH, Member 2003 – present
- New Faculty Colloquium presenter on Promotion & Tenure, 2008 – present
- Innovation in Curriculum Award committee 2007 – 2009 (Chair, 2008).
- SNAME, Executive Committee Member, 2002 - present
- Ship Production Committee, 1986 - present
- Shipyard Production Process Technology Panel, Member, 1998 – present

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation

- Tu SP, Feng S, Storch R, Yip M, Sohng H, Gu M, Chun A., “Applying Systems Engineering to Implement an Evidence-based Intervention at a Community Health Center,” J Health Care Poor and Underserved, 23:1399–1409, 2012.
- Kim, T-w., Storch, R. L., Hopman, J. J., and Erikstad, S. O., “Applications in ship and floating structure design and analysis,” Journal of Computer-Aided Design, Vol. 44, No. 3, March, 2012.
- Sharma, R., Kim, T-w., Storch, R. L., Hopman, J. J., and Erikstad, S. O., “Challenges in computer applications for ship and floating structure design and analysis,” Journal of Computer-Aided Design, Vol. 44, No. 3, March, 2012.
- Storch, R. L., Lim, S., and Kwon, C., “Impact of Customization on Delivery Schedules,” Journal of Ship Production and Design, vol. 27, No. 4, November, 2011.
- Lu, R.F., Petersen, T.D., and Storch, R.L., “Asynchronous stochastic learning curve effects in engineering-to-order customization processes,” International Journal of Production Research, vol. 47, no. 5, January 2009.
- Lu, R.F., Petersen, T.D., and Storch, R.L., “Modeling Customized Product Configuration in Large Assembly Manufacturing With Supply Chain Considerations,” International Journal of Flexible Manufacturing Systems, vol. 19, no. 4, December, 2007.

10. Briefly list the most recent professional development activities

1. Name: Zelda B. Zabinsky

2. Education – degree, discipline, institution, year:

B.S.	Mathematics (Magna Cum Laude)	University of Puget Sound, WA	1977
M.S.	Industrial and Operations Engineering	University of Michigan, MI	1984
Ph.D.	Industrial and Operations Engineering	University of Michigan, MI	1984

3. Academic experience:

Univ. of Washington, Dept. of Industrial & Systems Engr. (ISE), *Professor*, 1998–present
Dept.s of ME, EE, and CEE, *Adjunct Professor*, 1998–present
Univ. of Washington, Acting Chair for one year, Associate Chair of ISE for one year, 2011–2013
Sabbatical Leave from UW, Visiting Prof. in Thailand, Australia and China, Jan.–Dec. 2008
Univ. of Washington, Industrial Engr. Program, *Associate Professor*, 1993–1998
Dept.s of Mechanical and Civil & Environmental Engr., *Adjunct Assoc. Prof.*, 1993–1998
Sabbatical Leave from UW, Visiting Prof. in Australia, July–Oct. 1996
Univ. of Washington, Industrial Engr. Program, *Assistant Professor*, 1985–1993
Dept. of Mechanical Engr., *Adjunct Assistant Professor*, 1985–1993

4. Non-academic experience:

Atigeo, LLC, Bellevue WA, *Consultant*, 2012-present, part-time
Clearsight Systems, Inc., Bellevue WA, *Consultant*, 2005-2012, part-time,
Jan.-Dec. 2004, full-time (on professional leave from the University of Washington)
Microsoft, Hynomics, XYPoint, Hunt-Wesson, METRO, *Consultant*, 1992-2003, part-time
Vector Research, Inc., Ann Arbor MI, *Senior Systems Analyst*, 1980-1984, full-time
Boeing Computer Services, Seattle WA, *Programmer/Analyst*, 1977-1978, full-time

5. Certifications or professional registrations

N/A

6. Current membership in professional organizations

Institute of Industrial Engineering (IIE)
Institute for Operations Research and the Management Sciences (INFORMS)
Mathematical Optimization Society (formerly Mathematical Programming Society)

7. Honors and awards

Nominated for the 2012 Community of Innovators: Research, College of Engr., UW
IIE Fellow Award, May 2009
Voted *Outstanding Professor* by the students in IE, University of Washington, 2000-2001, 2006-2007 & 2007-2008 and *Excellence in Teaching Award* 1995-1996, 1996-1997, 1998-1999
Awarded an *Erskine Fellowship* from the Univ. of Canterbury, Christchurch, New Zealand, 1998

8. Service activities (within and outside of the institution)

Within institution (For active participation since 2012)

- ISE Acting Chair, ISE Associate Chair, ISE Graduate and Search Committees

Outside of institution (For active participation since 2012)

- Associate Editor, Journal of Global Optimization

- Session organizer for INFORMS and ISMP
- Organizing Committee Member of the 2014 INFORMS MSOM, Seattle, June 2014
- Board member of Pacific Institute for the Mathematical Sciences (PIMS), 2006-2013
- Reviewer for NSF, IJPE, OR, MMOR, CAIE, OMEGA, EJOR, IIE, JOGO

9. Important publications and presentations from the past five years:

- *Keynote Speaker*, Third World Congress on Global Optimization (WCGO-III), China, 2013
- **Zabinsky, Z. B.** and Smith, R. L., “Hit-and-Run Methods,” chapter in the Encycl. of Operations Research & Mgmt. Science 3rd Ed., Ed.s: S. Gass & M. Fu, Springer, to appear
- **Zabinsky, Z. B.**, “Random Search Algorithms,” chapter in the Wiley Encycl. of Operations Research and Management Science, Editor J. J. Cochran, John Wiley & Sons, to appear
- Zangeneh-Khamooshi, S., **Zabinsky, Z. B.**, and Heim, J. A., “A Multi-shift Vehicle Routing Problem with Windows and Cycle Times,” forthcoming in Optimization Letters
- Mete, H. O., and **Zabinsky, Z. B.**, “Pattern Hit-and-Run for Sampling Efficiently on Polytopes,” Operations Research Letters Vol. 40, Issue 1, pages 6-11, 2012
- Li, L., and **Zabinsky, Z. B.**, “Incorporating Uncertainty into a Supplier Selection Problem,” International Journal of Production Economics, Volume 134, Issue 2, pages 344-356, 2011
- Barker, T. J., and **Zabinsky, Z. B.**, “A Multi-Objective Decision Making Model for Reverse Logistics Using Analytical Hierarchy Process,” Omega 39, pages 558-573, 2011
- Liu, H., **Zabinsky, Z. B.**, and Kohn, W., “Rule-based Forecasting and Production Control System Design Utilizing a Feedback Control Architecture,” IIE Transactions, 43(2), pages 143-152, 2011
- Mete, H. O., Shen, Y., **Zabinsky, Z. B.**, Kiatsupaibul, S., and Smith, R. L., “Pattern Discrete and Mixed Hit-and-Run for Global Optimization,” Journal of Global Optimization, 50(4), 597-627, 2011
- **Zabinsky, Z. B.**, Wang, W., Prasetio, Y. M., Ghate, A., and Yen, J. W., “Adaptive Probabilistic Branch and Bound for Level Set Approximation,” *Proceedings of the 2011 Winter Simulation Conference*, Jain, Creasey, Himmelpach, White, and Fu, eds., Phoenix, AZ, 11-14 December, 2011
- Liu, H., **Zabinsky, Z. B.**, and Kohn, W., “Rule-based Control System Design for Smart Grids,” *Proceedings of the IEEE Power Energy Society (PES)*, Minneapolis, MN, July 2010
- Mete, H. O., and **Zabinsky, Z. B.**, “Stochastic Optimization of Medical Supply Location and Distribution in Disaster Management,” Int’l Journal of Production Economics, 126(1), 76-84, 2010
- **Zabinsky, Z. B.**, Bulger, D., and Khompatraporn, C., “Stopping and Restarting Strategy for Stochastic Sequential Search in Global Optimization,” J. of Global Opt., 46(2), 273-286, 2010
- Baumert, S., Ghate, A., Kiatsupaibul, S., Shen, Y., Smith, R. L., and **Zabinsky, Z. B.**, “Discrete Hit-and-Run for Generating Multivariate Distributions over Arbitrary Finite Subsets of a Lattice,” Operations Research, Vol. 57, No. 3, pages 727–739, 2009
- Molvalioglu, O., **Zabinsky, Z. B.**, and Kohn, W., “The interacting-particle algorithm with dynamic heating and cooling,” Journal of Global Optimization, Vol. 43, pages 329-356, 2009

10. Briefly list the most recent professional development activities

N/A

Appendix C – Equipment

There are no major pieces of equipment used by the program in support of instruction other than computers.

Appendix D – Institutional Summary

1. The Institution

- a. Name and address of the institution:

University of Washington, Seattle, WA 98195

- b. Chief executive officer of the institution:

Michael K. Young, President

- c. Self-study report submitted by:

Judy Ramey, Interim Dean, College of Engineering

Effective July 15, 2013, Michael B. Bragg will be the new Dean of the College of Engineering.

- d. Institution (University of Washington) is accredited by:

Northwest Commission on Colleges and Universities (NWCCU)

Initial University of Washington accreditation evaluation:

April 1918

Most recent University of Washington accreditation evaluation:

Accreditation was reaffirmed based on the Spring 2011 Year One Evaluation.

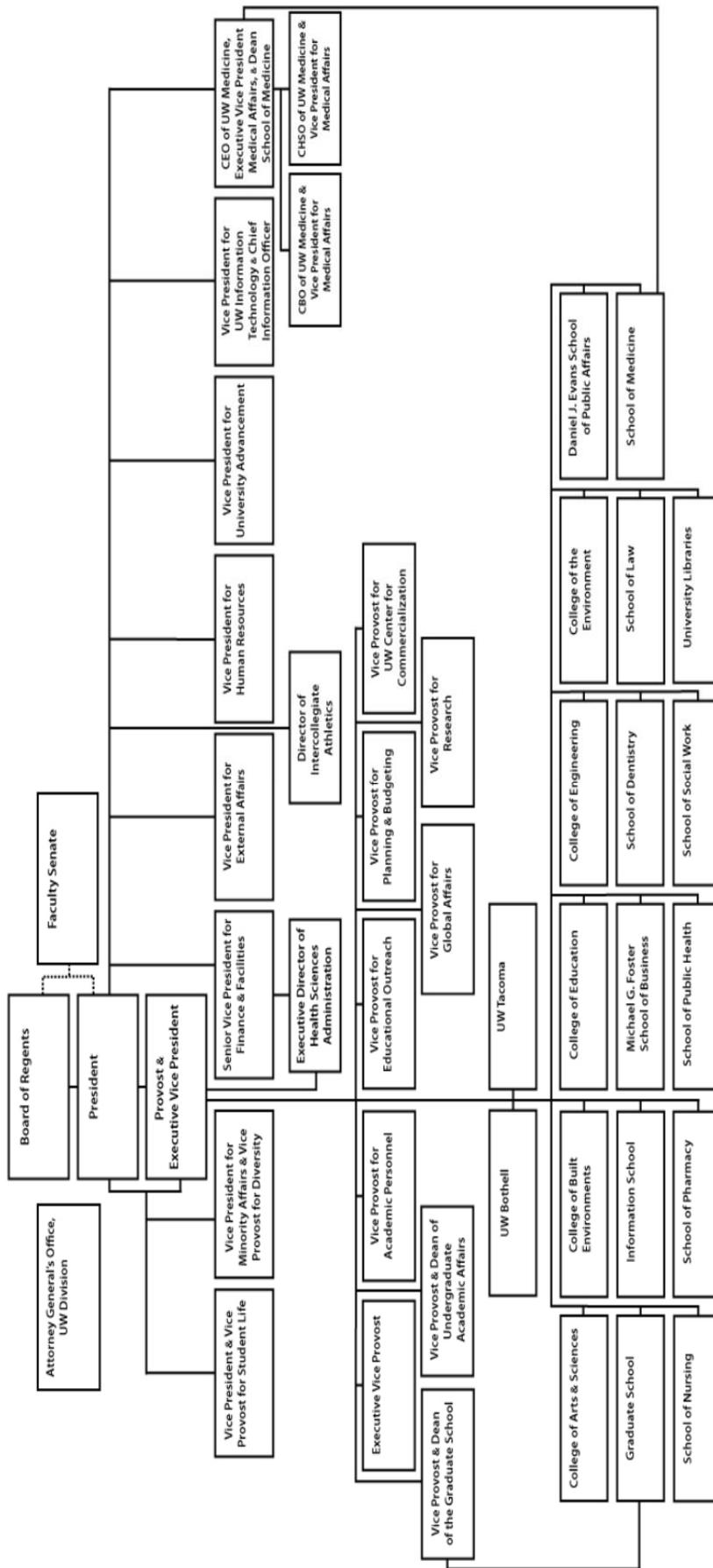
2. Type of Control

State-assisted Public Research University

3. a. Educational Unit

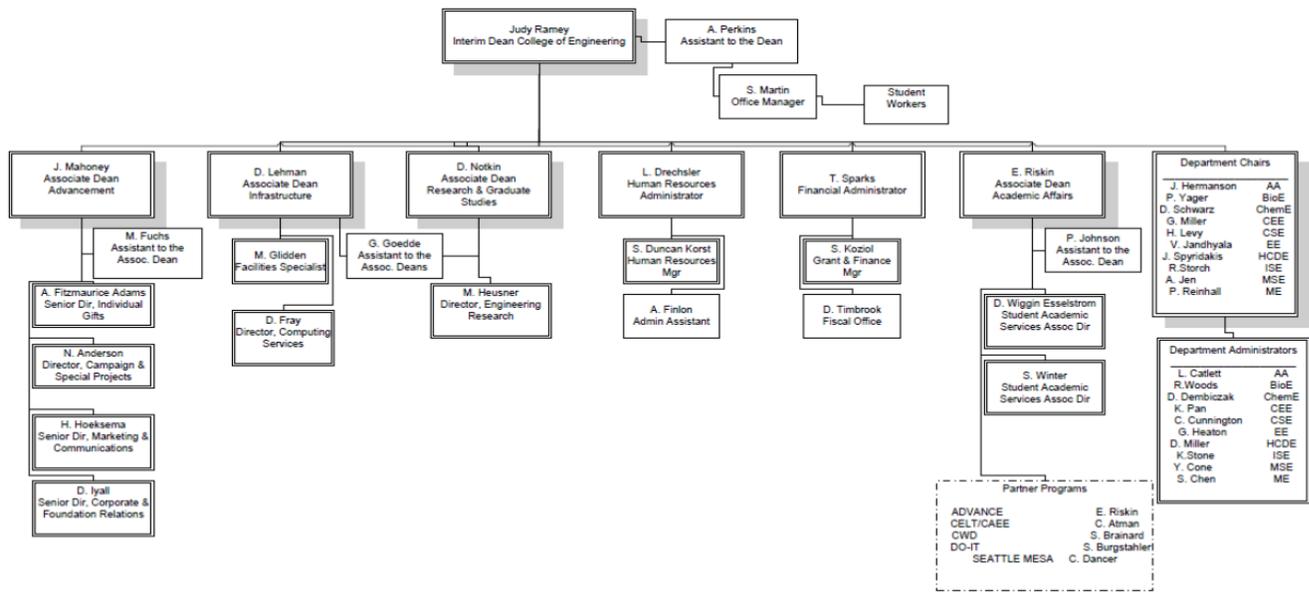
The University Organization Chart shows the position of the College of Engineering within the University of Washington. The College of Engineering is a separately organized unit with its own budgetary and program control within the University of Washington. Judy Ramey became the Interim Dean of the College effective January 1, 2013, when the previous Dean of the College, Matthew O'Donnell, stepped down. Judy Ramey reports to the Provost and Executive Vice President, Ana Mari Cauce.

University Organization Chart (Approved by the President by authority of the *Board of Regents Governance*, Standing Orders, Chapter 1) This chart reflects the reporting relationships of the University of Washington's administrative offices, schools, colleges, and campuses. Select any box on this chart to link to APS 1.2, University Wide Leadership List, where more information is available



The College of Engineering Organizational Chart and the College’s listing in the University Wide Leadership List show the engineering academic departments / programs and their reporting relationship within the College of Engineering. The names of the College of Engineering Department Chairs are listed as well as names and titles of the administrative heads of the principal units of the College of Engineering.

COLLEGE OF ENGINEERING ORGANIZATIONAL CHART



University Wide Leadership List

Engineering, College of	Acting Dean—Judith A. Ramey Assistant to the Dean—Andrea Perkins
Academic Affairs	Associate Dean—Eve A. Riskin
Computing Services	Director—David T. Fray
Development and External Relations	Assistant Dean—Judy K. Mahoney
Infrastructure	Associate Dean—Dawn Lehman
Research and Graduate Studies	Associate Dean—David Notkin
Departments	

Aeronautics and Astronautics	Chair—James Hermanson
Bioengineering (with School of Medicine)	Chair—Paul Yager
Chemical Engineering	Chair—Dan Schwartz
Civil and Environmental Engineering	Chair—Greg Miller
Computer Science and Engineering	Chair—Henry (Hank) Levy
Electrical Engineering	Chair—Vikram Jandhyala
Human-Centered Design and Engineering	Chair—Jan Spyridakis
Industrial and Systems Engineering	Chair—Richard Storch
Materials Science and Engineering	Chair—Alex Jen
Mechanical Engineering	Chair—Per Reinhall

Engineering Programs

Disabilities Opportunities Internetworking Technology (DO-IT)	Director—Sheryl Burgstahler
Mathematics, Engineering, Science Achievement (MESA)	Director—James Dorsey
Workforce Development, Center for (CWD)	Director—Suzanne G. Brainard

3. b. University of Washington Engineering Initiative

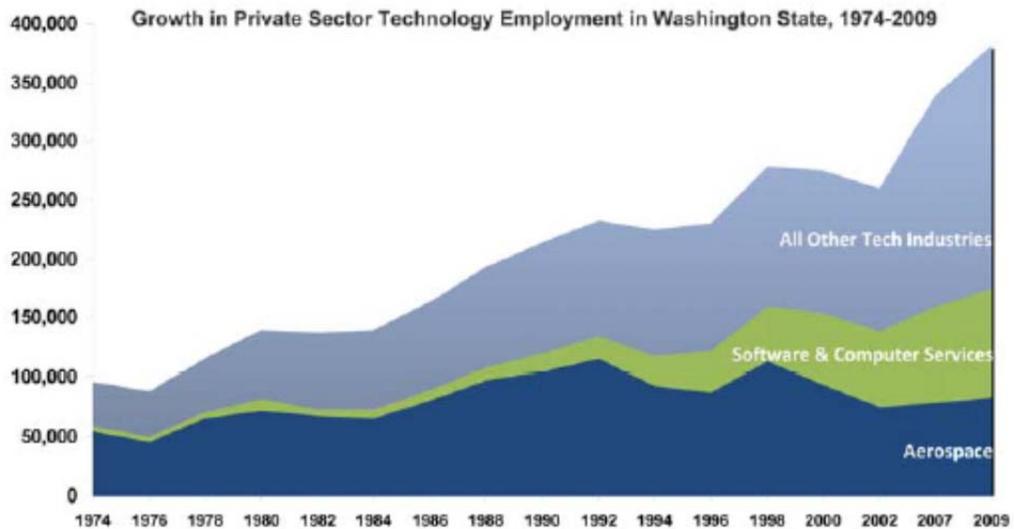
Objective

Send nearly 2,000 additional Engineers into the Washington workforce over the next 10 years by leveraging partnerships, requiring relatively modest additional State investment.

Washington State: “Innovation is in our nature”

Innovation defines Washington State. In the most recent Kauffman Foundation *New Economy Index*, Washington ranks second overall among the 50 states, behind only Massachusetts. As shown in Figure 1, technology industry employment in Washington has quadrupled since 1974.

Figure 1: Washington's technology industry employment has quadrupled since 1974.



Source: Technology Alliance: *The Economic Impact of Technology-based Industries in Washington State, 2010*

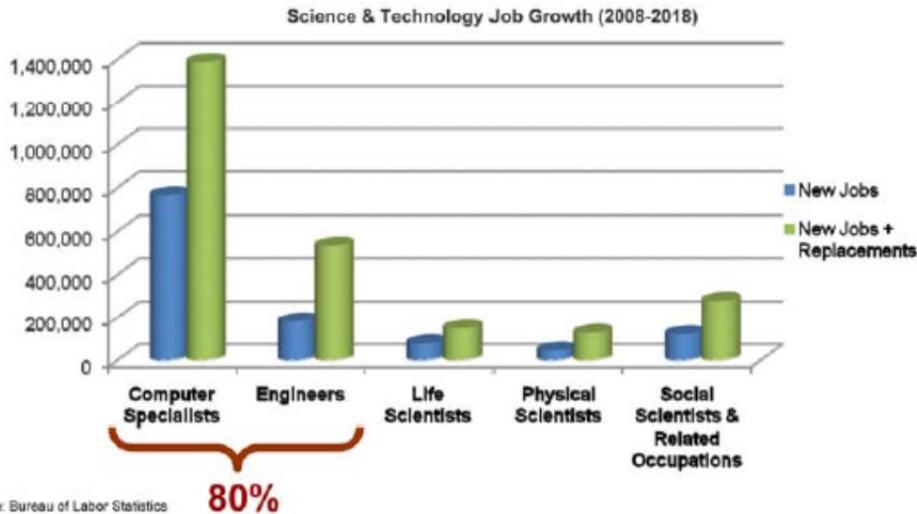
STEM graduates drive innovation

Individuals with degrees in STEM fields (Science, Technology, Engineering, and Mathematics) drive this innovation. They create and staff the companies. And these jobs create other jobs: economists estimate that the 381,000 jobs in Washington's technology industries support nearly 827,000 other jobs throughout our state economy, accounting for a total of more than 1.2 million jobs – equivalent to 42% of Washington employment.

Not all STEM is created equal

When it comes to future job growth, “not all STEM is created equal.” As shown in Figure 2, the U.S. Bureau of Labor Statistics projects that in the current decade, 80% of all new jobs in all STEM fields will be in Computer Science and other fields of Engineering. Washington State workforce projections mirror this.

Figure 2: STEM (Science, Technology, Engineering, and Mathematics) careers are where the growth is – but *not all STEM is created equal*.



Washington STEM degree production does not match Washington workforce needs

Unfortunately, Computer Science and other fields of Engineering are precisely where Washington’s higher education system has the greatest shortfall. Washington ranks 45th among the 50 states (and 7th among ten top technology states) in Computer Science degree production relative to the number of jobs in the field (Figure 3). Washington similarly ranks 45th (and 9th among ten top technology states) in Engineering degree production relative to the number of jobs in the field (Figure 4). Washington also ranks among the bottom states in *per capita* degree production in these fields, at both undergraduate and graduate levels.

Figure 3: Washington ranks very low in Computer Science degree production relative to Computer Science occupations.

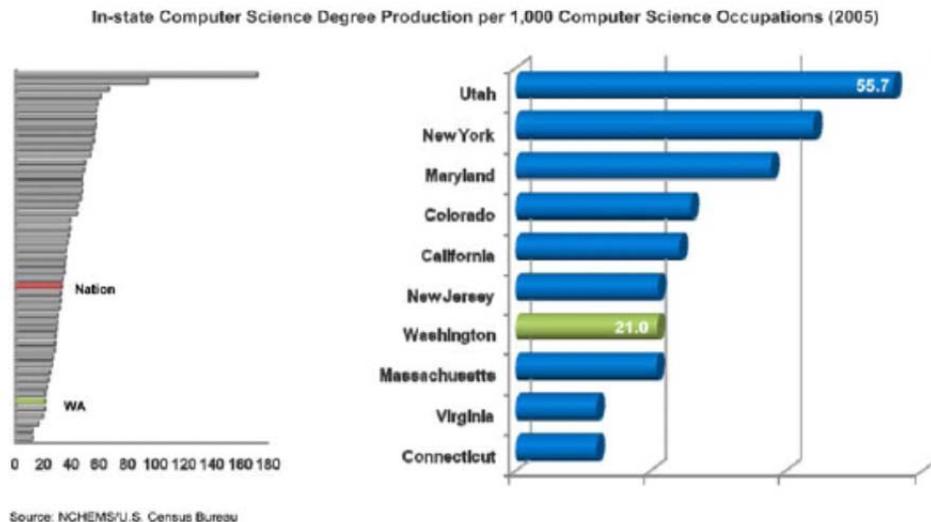
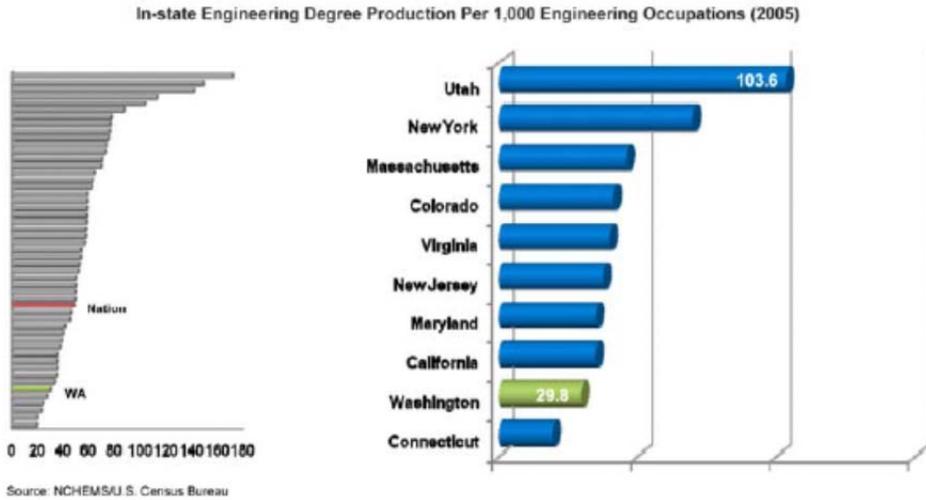
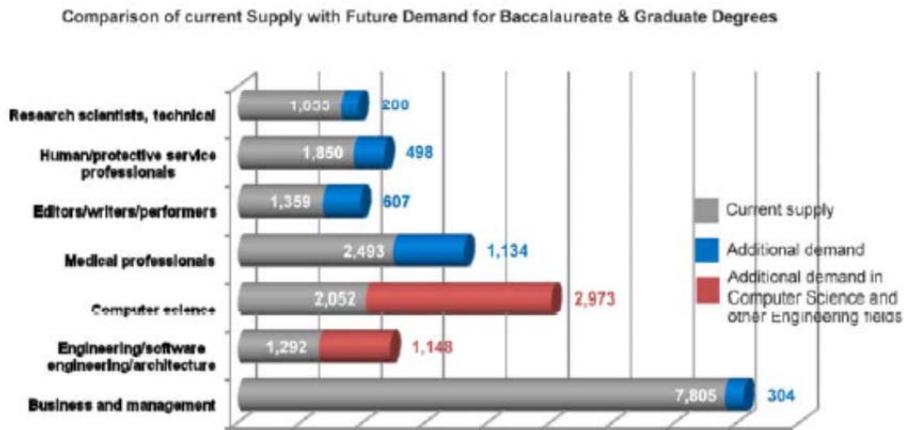


Figure 4: Similarly for other fields of Engineering.



A recent analysis by the Washington State Higher Education Coordinating Board indicates that Computer Science and other fields of Engineering rank first and second, among all fields requiring a bachelors education or greater, in the gap between workforce demand and degree production (Figure 5). A recent analysis of WorkSource job postings and Occupational Employment Statistics data by the *Seattle Times* shows that Computer Science and related fields dominate *all* job availability in Washington (Figure 6). This gap between supply and demand in Computer Science and other fields of Engineering threatens the future of Washington’s economy, and it deprives our children of the opportunity to be first-tier participants in the innovation economy.

Figure 5: In Washington, the gap between demand and supply is greater in Computer Science and other fields of Engineering than in all other fields.



Source: Higher Education Coordinating Board, *Regional Needs Analysis Report*, 2011. Analysis of Employment Security Department and IPEDS data.

Figure 6: Currently, Computer Science dominates all job availability in Washington.

57% of the job openings among the top 10 occupations are in computing.



Where the jobs are and aren't

Some employers are hiring, but the openings don't overlap much with the jobs most commonly lost to the economic downturn.



* King, Snohomish, Pierce and Kitsap counties



Sources: Seattle Times analysis of WorkSource job postings and Occupational Employment Statistics data

MARK NOWLIN / THE SEATTLE TIMES

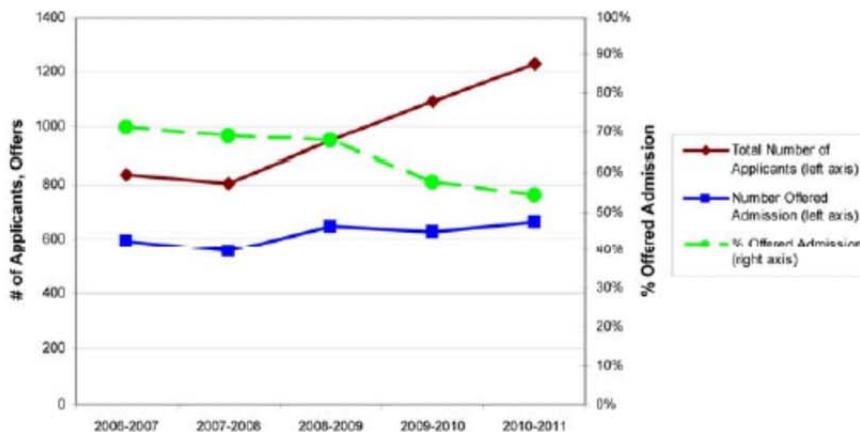
Source: Used with permission from the Seattle Times.

At UW, we have the student demand – we lack the program capacity

Although nationally there is a pipeline issue, at the University of Washington the limitation is program capacity, not student interest. As shown in Figure 7, in the most recent year, the UW College of Engineering was able to accommodate only 54% of undergraduate applicants. More than 500 undergraduates seeking to major in a UW Engineering program – *students who were already enrolled at UW or at a Washington State Community and Technical College and who had successfully fulfilled the pre-requisites for entry to Engineering* – had to be turned away last year. In the Department

Figure 7: It's a capacity problem! Last year the UW College of Engineering had to turn away more than 500 prospective undergraduate majors.

UW College of Engineering Annual Admissions



of Computer Science & Engineering, the most over-subscribed program in the College of Engineering, 70% of applicants had to be turned away – only 30% could be accommodated. More than 40% of the students that the College of Engineering was unable to accommodate, and more than 60% of the students that the Department of Computer Science & Engineering was unable to accommodate, had college grade point averages of 3.25 or above – successful college students are being turned away due to lack of capacity.

The University of Washington Engineering Initiative

Responding to the needs of Washington State's economy, technology businesses, and students, the University of Washington has crafted an opportunity for 425 additional students to join the College of Engineering.

This initiative will require a financial partnership between the University, UW students, and the State, including \$3.75 million per year in new State funding. In the past, the State funding request for an Engineering enrollment increase of this size would have been roughly \$8.5 million – 2.25 times as great. Under the University of Washington Engineering Initiative, however:

- Overall University of Washington enrollment will not increase as a result of the Initiative. Rather, responding to student demand, UW will shift enrollments towards Engineering from other fields. Thus, only the "marginal cost" of an Engineering education must be funded – the "base cost" of each student's education is already covered.
- A substantial proportion of the tuition generated by Engineering students will be retained by the College of Engineering, decreasing the subsidy required. (Engineering students take roughly half their courses in other fields – the remaining tuition helps to defray these costs.)
- The State will fund only the remaining "gap" – the marginal increment required to produce an Engineering degree, minus the portion covered by tuition.

Impact and scope of the initiative, however, also relies on the state's ability to mitigate additional budget reductions to higher education.

The University of Washington Engineering Initiative is an extremely cost-effective investment in the future of our state, our technology businesses, and our children. As a result of this initiative, supported by a relatively modest, targeted investment on the part of the State, the University of Washington will be able to send nearly 190 additional engineering graduates annually into the workforce – almost 2,000 over the next decade.

4. Academic Support Units

Each Engineering department requires certain courses in mathematics, natural sciences, communication, and engineering fundamentals. Table D-3 contains the course outline, description, or syllabus for each of the required mathematics, statistics, biology, chemistry, physics, applied mathematics, and writing courses required by some or all of the engineering departments.

<u>Unit</u>	<u>Head</u>
Applied Mathematics	Jose Nathan Kutz, Professor and Chair
Biology	H.D. 'Toby' Bradshaw, Professor and Chair
Chemistry	Paul B. Hopkins, Professor and Chair
Mathematics	Selim Tuncel, Professor and Chair
Physics	Blayne R. Heckel, Professor and Chair
Statistics	Elizabeth Thompson, Professor and Chair

5. Non-academic Support Units

Descriptions of the non-academic support units are in Table D-4.

<u>Unit</u>	<u>Head</u>
UW Enrollment Services	Philip Ballinger, Assistant Vice President for Enrollment, Admissions
UW Career Center	Susan Terry, Director
UW Information Technology (UW-IT)	Kelli Trosvig, Vice President and CIO
University of Washington Libraries	Lizabeth (Betsy) A. Wilson, Dean
College of Engineering Office of Student Academic Services	Eve Riskin, Associate Dean for Academic Affairs
UW ADVANCE Center for Institutional Change (CIC)	Eve Riskin, Professor and Director
Center for Engineering Learning & Teaching (CELT)	Cynthia J. Atman, Professor and Director
Center for Workforce Development	Suzanne Gage Brainard, Executive Director
College Computing Services	David T. Fray, Director
Disabilities, Opportunities, Internetworking,	Sheryl Burgstahler, Director

and Technology (DO-IT)

Education at a Distance for Growth and
Excellence (UW/EDGE)
and Engineering Professional Programs (EPP)

David P. Szatmary, Vice Provost
UW Educational Outreach

Engineering Library

Mel DeSart, Head

GenOM – Genomics Outreach for
Minorities Project

Lisa Peterson, Director

Seattle MESA (Mathematics, Engineering,
Science Achievement

Clarence Dancer, Director

6. Credit Unit

The College of Engineering adheres to the traditional ratio of one contact hour and two outside hours per week for each credit of coursework, which is the University guideline. Contact hours can include many different formats, including laboratories and quiz sections. As a rule of thumb, two hours of scheduled lab or quiz per week counts toward 1 credit, but exceptions may be warranted. Considering the flexibility allowed by the University and the diversity of teaching styles and learning environments, the College of Engineering's Council on Educational Policy will consider approving courses that do not meet these guidelines. For such courses, faculty should present written material justifying the departure from the traditional ratio and, additionally, should be prepared to justify the course credit/contact hour ratio to the Council on Educational Policy in person.

7. Tables

Table D-1. Program Enrollment and Degree Data

INDUSTRIAL ENGINEERING

Academic Year		Enrollment								Degrees Awarded		
		Year					Total Undergrad	Total Grad	Bachelors	Masters	Doctorates	
		1st	2nd	3rd	4th	5th						
Current Year	2012-2013	FT	3	15	39	46	0	103	37	Available approximately mid-July		
		PT	0	0	0	7	0	7	16			
1	2011-2012	FT	2	6	24	58	0	90	22	51	9	3
		PT	0	0	0	4	0	4	15			
2	2010-2011	FT	4	6	43	45	0	98	33	32	13	6
		PT	0	0	0	2	0	2	8			
3	2009-2010	FT	7	15	27	52	0	101	34	48	6	3
		PT	0	0	2	6	0	8	22			
4	2008-2009	FT	3	6	29	50	0	88	25	29	12	2
		PT	0	0	0	2	0	2	9			

Table D-2. Personnel

INDUSTRIAL ENGINEERING

Year¹: **Autumn 2012 (Active Employees)**

	HEAD COUNT		FTE
	FT	PT	
Administrative ²	2	3	2.00
Faculty (tenure-track) ³	7	2	7.60
Other Faculty (excluding student Assistants)	8	19	6.33
Student Teaching Assistants ⁴	4	2	4.00
Technicians/Specialists	1	1	1.63
Office/Clerical Employees	1	2	1.00
Others ⁴ Student Research Assistants	15	0	15.00

College of Engineering notes:

- TA and RA at 50% or greater equals 1 FTE
- Data source is the CoE Data Resources website.

ABET notes:

Report data for the program being evaluated.

¹ Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

² Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

³ For faculty members, 1 FTE equals what your institution defines as a full-time load.

⁴ For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc.

⁴ Specify any other category considered appropriate, or leave blank.

Signature Attesting to Compliance

By signing below, I attest to the following:

That Industrial Engineering has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the *ABET Accreditation Policy and Procedure Manual*.

Judy Ramey, Interim Dean


Signature


Date