1.0 Context

The Industrial Engineering Program in the College of Engineering at the University of Washington offers the following degrees:

- Bachelor of Science in Industrial Engineering (B.S.I.E.)
- Master of Science in Industrial Engineering (M.S.I.E.)
- Doctor of Philosophy in Industrial Engineering (Ph.D.)

The Industrial Engineering Program was given academic program status by the Dean of Engineering in the autumn of 1987, and has effectively functioned as a department (with separate administrative and budget control) since that time. We have offered an accredited undergraduate degree (B.S.I.E.) since 1986. We have offered masters and doctorate degrees in Industrial Engineering since 1998. This is our first formal program review by the UW Graduate School, following the approval of our graduate degree programs in 1998.

1.1 Overview of Industrial Engineering

Industrial engineers are, by definition, specialists in designing and operating complex systems that make optimal use of resources when labor, materials, capital, and technology are constrained. Industrial engineers deal with people as well as things, looking at the "big picture" of what makes society perform best: the right combination of human resources, natural resources, and man-made structures and equipment. Bridging the gap between management and operations, IEs deal with and motivate people as well as determine what tools should be used and how they should be used. Often known as "efficiency experts" or "productivity people," the definition of an industrial engineer is changing to a broader term of "knowledge worker."[1]

Industrial engineering is set apart from other engineering disciplines by its broader scope. Instead of specializing in a specific aspect of engineering, industrial engineering is concerned with the management of industry and the complete production process from the mine to the marketplace. Advances in computer technology have made it possible to engage in large-scale modeling to aid in the design, analysis and integration of complex systems. The future competitiveness of industry depends on the field of industrial engineering and its contribution towards enhanced productivity.

Industrial engineering's ideological roots actually go back to the dawn of the industrial revolution in Europe, around 1800, when Adam Smith proposed specialization of labor in the production of goods and Charles Babbage suggested cost accounting fact gathering, as labor was assisted by mechanization. This new industrialized society created many new problems requiring huge capital investment, the need for trained people to operate

[1] Simons, G. R. "Industrial Engineering: From 'Efficiency Expert' to 'Knowledge Worker', Engineering Horizons, pp. 17-19.

the machines, and new techniques of production. The idea of applying science to the workplace was further developed in the early 1900's in the United States by mechanical engineers Frederick Taylor and Frank Gilbreth. They realized the benefits to our society of the engineering approach to a business situation. Frank, and later, Lillian Gilbreth, refined the improvement of work methods and expanded the ideas to non-manufacturing fields, such as hospitals. Industrial engineering progressed to incorporate performance measures and standards with methodologies to improve the use of scarce resources in a variety of applications. After World War II, and with the increased use of computers and subsequent development of sophisticated techniques, industrial engineers have grown in their visibility and effectiveness.[2]

Industrial engineers today can be used in almost any type of organization because of their wide range of skills in the mathematical, physical, and social sciences, together with a strong background in engineering analysis and design. IEs are traditionally employed in a manufacturing setting, working on facilities design, processing, quality, scheduling, personnel and warehousing. Increasingly, IEs work in service sectors such as insurance companies, banks, hospitals, retail organizations, consulting firms, government agencies, airlines, transportation, public utilities and sales. The broad and diverse skills of industrial engineers also make them a prime source of management talent.

According to the U.S. Department of Labor, employment of industrial engineers is expected to continue to grow about as fast as the average for all occupations through 2008. The growth in employment reflects continuing concern for efficiency, more complex business operations, and greater use of automation both in factories and in offices. Jobs also will be created as firms seek to reduce costs and increase productivity through scientific management and safety engineering. Industrial engineering beginning salaries rank in the top group of the high paying engineering disciplines. A common career path for an industrial engineer includes promotion into management, making salary potentials for industrial engineers lucrative. In 1998 the middle 50% of IEs earned between $42,690 and $73,870 annually, and IIE members reported rising salaries with an average annual compensation of $76,000 in 2000, which was up from $71,000 in 1998.[3]

1.2 Industrial Engineering at the University of Washington

1919-1976

The development of industrial engineering at the University of Washington was encouraged by world events, such as the aftermath of World War I, when the world tried to return to a normal business situation. A returning World War I wounded hero, Harry J. McIntyre joined the three-person Mechanical Engineering faculty at the University of

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[2] Selected from a brief history of IE, compiled by Emeritus Professor Bert Drui for the Industrial Engineering Program, UW, 1998.

[3] From IIE web site, http://www.iienet.org/public/articles/index.cfm?cat=290, and https://engineering.purdue.edu/FrE/ESCAPE/fields/industrial/industrial/stats.html , 2002.

Washington in 1919. This marked the introduction of a Commercial Engineering degree, in 1920, at the University of Washington. In the 1920's and 30's, the number of Commercial Engineering degrees grew from an average of six to twelve per year, which accounted for approximately half of the degrees awarded by the Mechanical Engineering department.[4]

The post World War II production era instituted an increased interest in the field of industrial engineering to the point where most schools offered a degree in the area. At the University of Washington, the degree of Industrial Engineering became a second Bachelor's degree attained in a fifth year after completing the requirements for a degree in one of the other branches in engineering such as aeronautical, civil, electrical, or mechanical. The level of student interest was sufficient during this period to increase degrees from 12 per year to a level of 20 per year. The Institute of Industrial Engineers was founded in 1948, and registered professional engineer licenses were issued for industrial engineers by many states after that. Academic research was becoming a requirement for success at major universities, and faculty members were researching several technical aspects of industrial and manufacturing activities, including the use of statistical techniques to control quality of manufacture of products.

Albert B. Drui joined the Mechanical Engineering faculty at the UW in 1960, after twelve years of industry experience. Drui started a student chapter of the Institute of Industrial Engineers. Norman H. Roberts joined the faculty in 1972, and instituted a course in reliability. The student level through the 1960's continued at about 15-20 degrees awarded per year. In the early 1970's, Boeing laid off about 20,000 of their technical employees, due to a marked decline in business. This greatly increased interest in a fifth year, second Bachelor's degree. As a result, annual degrees awarded ballooned to almost 60. Due to the demands of students and faculty research activity, the Master of Science in Engineering (M.S.E.) was employed to institute a Master's program, within the Mechanical Engineering department, for those majoring in Industrial Engineering.

1976-1986

In 1976 a regular four-year B.S.I.E. degree was instituted at the University of Washington, and taught by faculty members of the Mechanical Engineering department. The Mechanical Engineering department at that time totaled 35 professors and was organized into four Interest Groups: Energy and Fluids, Manufacturing and Industrial (M&I), Materials and Design, and Systems and Dynamics. Professor Drui was the Chair of the M&I Group.

In 1982, John Fluke, Sr., the founder and owner of Fluke Manufacturing Company, recognized the need for industrial engineers in the Pacific Northwest, and endowed the John M. Fluke Distinguished Chair in Manufacturing Engineering to support the development of an IE department at the University of Washington. Its first recipient was

[4] Selected from a brief history of IE, compiled by Emeritus Professor Bert Drui for the Industrial Engineering Program, UW, 1998.

Douglas C. Montgomery, who joined the faculty in 1985, specializing in statistical applications to industrial problems.

As a snapshot, there were six faculty members in the academic year of 1985-1986 specializing in industrial engineering:

1 Professor:	Montgomery
4 Associate Professors:	Drui, Iverson, Roberts, Storch
1 Assistant Professor:	Zabinsky

1986-1998

In 1986, the B.S.I.E. degree was accredited by ABET (Accreditation Board for Engineering and Technology). This was, and is, the only industrial engineering degree in the State of Washington. From 1986 through 1998, the number of BSIE degrees awarded annually was approximately 25, with a gradual increase to 30 undergraduate degrees awarded in 1998.

The graduate program in IE developed significantly during this time period. From 1989 to 1994, Industrial Engineering graduated thirty-one master's degrees (through the College of Engineering's interdisciplinary option) and eight doctoral students (through the Mechanical Engineering Ph.D. degree program). In December 1994, the Industrial Engineering program submitted a proposal requesting authorization for two graduate degrees – Master of Science in Industrial Engineering (M.S.I.E.) and Doctor of Philosophy in Industrial Engineering (Ph.D.). Following extensive review of the proposal by the *Industrial Engineering Graduate Program Proposal Review Committee*, official authorization to grant the degrees was given in the summer of 1998.

In 1987, Professor Iverson was appointed the first Director of the Industrial Engineering Program, and the Industrial Engineering Group was separated administratively from the Mechanical Engineering department and given academic program status by the Dean of the College of Engineering. Although technically a program and not a department, Industrial Engineering has effectively functioned as a department since 1987, with independent control over budget and administrative matters. Scott C. Iverson served as Director of IE from 1987-1992. Kailash C. Kapur joined the UW, coming from the University of Oklahoma, where he was a Professor and Director of the School of Industrial Engineering. Professor Kapur served as the Director of IE at UW from 1992-1999. Other additions to the Industrial Engineering faculty during this time period included Professors Furness and Woo. Thomas A. Furness III joined the UW in 1989 as a Professor and Director of the Human Interface Technology Lab. In 1995, Tony C. Woo joined the UW and was appointed to the endowed Fluke Chair of Manufacturing, after being a Professor at the University of Michigan for eighteen years as well as serving as Program Director at the National Science Foundation. Professor Woo is currently the Director of Industrial Engineering at the UW.

As a snapshot, in the academic year of 1997-1998, there were nine faculty members and three emeriti faculty in the Industrial Engineering program:

3 Professors: Kapur, Furness, Woo
4 Associate Professors: Barfield, Iverson, Storch, Zabinsky
2 Assistant Professors: Heim, Smith
3 Emeritus Faculty: Douthwaite, Drui, Roberts

1998 – Present (2002)

From 1998 to the present (2002), the Industrial Engineering Program at the UW has continued to develop into a quality research and teaching program. Research activity is high with two internationally recognized Center directors, and an average of $575,000 research funding per faculty per year (including both Centers). As stated in the last bi-annual report, faculty wrote 23 journal articles, 9 books and book chapters, 29 conference papers and gave 47 presentations. The IE program has awarded an average of 32 B.S.I.E degrees per year, and an average of 10 M.S.I.E degrees per year. Since 1998, the IE program has awarded a total of nine doctoral degrees.

The Industrial Engineering program at the University of Washington is one of 99 schools in the United States with undergraduate industrial engineering degrees accredited by ABET[5]. The IE undergraduate degree program at UW is the only such IE program in the State of Washington. In addition, it is one of only 14 accredited industrial engineering programs in the western United States[6]. Table 1.1 shows the distribution of ABET accredited industrial engineering programs in the west.

Table 1.1:
ABET Accredited Industrial Engineering Programs In The Western United States

Location	School
Arizona, Tempe	Arizona State University
Arizona, Tucson	University of Arizona
California, Berkeley	University of California, Berkeley
California, Fresno	California State University, Fresno
California, Los Angeles	University of Southern California
California, Pomona	California State Polytechnic University, Pomona
California, San Diego	University of San Diego
California, San Jose	San Jose State University
California, San Luis Obispo	California Polytechnic State University, San Luis Obispo
California, Stanford	Stanford University
Montana, Bozeman	Montana State University
New Mexico, Las Cruces	New Mexico State University
Oregon, Corvallis	Oregon State University
Washington, Seattle	University of Washington

[5] From ABET website, http://www.abet.org/
[6] For this document, "western" states were defined as Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, and Washington.

In 2002, the U.S. News and World Report ranked IE at the University of Washington number seventeen. Of the thirteen industrial engineering programs in the western United States listed in Table 1.1, the IE program at the University of Washington is one of only four that made the top 18 list in those 2002 U.S. News and World Report rankings (Table 1.2). While IE at the UW is making progress, other universities are not standing still. The top ten schools in both years are the same set of schools, with minimum changes in rank. Even though IE at UW was not in the top 18 in the most recent report (2003), we are making a significant contribution locally and regionally in terms of education, research, employment base, and industrial support.

Table 1.2:

U.S. News and World Report, 2002 and 2003 Rankings
Undergraduate engineering specialties: Schools with Ph.D. programs: Industrial/Manufacturing (Schools in western U.S. in bold)

Ranking	2002 Ranking of Schools	2003 Ranking of Schools
1	Georgia Institute of Technology	Georgia Institute of Technology
2	Purdue University	University of Michigan, Ann Arbor
3	University of Michigan, Ann Arbor	Purdue University
4	**University of California, Berkeley**	Pennsylvania State University
5	Pennsylvania State University	**University of California, Berkeley**
6	**Stanford University**	**Stanford University**
7	Texas A&M University	Virginia Tech
8	Virginia Tech	Texas A&M University
9	Northwestern University	Northwestern University
10	University of Wisconsin, Madison	University of Wisconsin, Madison
11	Ohio State University	North Carolina State, Raleigh
12	University of Illinois, Urbana-Champaign	University of Illinois, Urbana-Champaign
13	North Carolina State University	Cornell University
14	**Arizona State University**	Massachusetts Inst. of Technology
15	Cornell University	Columbia University
16	University of Florida	Ohio State University, Columbus
17	**University of Washington**	University of Texas, Austin
18	Rensselaer Polytechnic Institute	**Arizona State University**

The number of graduate IE programs in the western portion of the United States is similar to the undergraduate programs, and only three western schools rank in the top 17 of best graduate Industrial/Manufacturing programs (U.S. News and World Report, 2001). It may not be a surprise that these three schools coincide with those highlighted in Table 1.2; University of California, Berkeley, Stanford University, and Arizona State University. The addition of the Master of Science IE degree and a Ph.D. in Industrial Engineering in 1998 at the University of Washington is a substantial contribution to the western United States and especially fills a void in the Pacific Northwest.

As a snapshot, entering the academic year of 2002-2003, there are nine core faculty members and three emeriti faculty in the Industrial Engineering program:

5 Professors:	Kapur, Furness, Storch, Woo, Zabinsky
1 Associate Professor:	Atman
1 Visiting Associate Professor:	Mastrangelo
2 Assistant Professors:	Beamon, Yen
3 Emeritus Faculty:	Douthwaite, Drui, Roberts

The remainder of this document details the activities in Industrial Engineering at the University of Washington. Section 2.0 outlines the roles and responsibilities of IE, and section 3.0 focuses on the educational mission. The undergraduate program is discussed in section 3.1, and the graduate program is detailed in section 3.2. Current research activities led by IE faculty are discussed in section 4.0. Section 5.0 presents the financial setting for IE, and section 6.0 concludes with observations and challenges.

2.0 Roles and Responsibilities

The principal roles and responsibilities for Industrial Engineering are education, research and service. Our educational role focuses on our undergraduate and graduate degree programs and activities within each of them (described in section 3.0). IE's participation in interdisciplinary educational programs is also described in section 3.0. Our research roles and responsibilities are described in section 4.0, and interdisciplinary research and collaborations are highlighted there. Our service activities are also discussed in section 4.0.

In our Strategic Plan, May 1999, (see Appendix I.1) the Industrial Engineering faculty endorsed the following vision and mission statements:

The vision for Industrial Engineering at the University of Washington is to achieve local, national, and international prominence in Industrial Engineering education and research. A distinguishing focus of Industrial Engineering at the UW is the integration of humans, machines, materials and information to achieve optimum performance of operating systems. Focus is primarily on manufacturing and service oriented systems using human factors, operations research, statistical and systems engineering methodologies. Manufacturing systems, as opposed to manufacturing processes, include a broad scope of industries consistent with the "big picture" approach of IEs, such as traditional manufacturing, electronic, and service industries. In addition, research is conducted in human interface technology and engineering education.

Industrial Engineering's mission and goals are aligned with the mission and goals of the University and the College. The primary mission of the University of Washington is the preservation, advancement, and dissemination of knowledge. The mission of the College of Engineering is to provide excellent undergraduate and graduate education and outstanding research opportunities in a student-centered, customer-oriented environment focused on quality and continuous improvement.

Mission

The Industrial Engineering program prepares students for productive careers in an increasingly diverse, dynamic and technological world. IE is dedicated to providing highly skilled and versatile undergraduate, graduate, professional and life-long continuing education; excellence in basic and applied research and creative achievement; and the integration of these activities on a regional, national and international level.

Through excellence in education, research, and in partnership with industry, government and the citizens of Washington, IE will continuously improve the way it educates students to nurture personal and professional growth. The basis for this education will be the scientific knowledge embodied in the discipline of industrial engineering.

Four goals that support the mission include:

1. Educate successful graduates.
2. Increase the quality and quantity of research in IE disciplines.
3. Integrate/link educational programs with research activities.
4. Increase national and international reputation.

We have set a goal for ourselves to become a top Industrial Engineering department, and believe that our activities are leading us along this path. In the 1999 Strategic Plan, a 5-year action plan was established with a list of short-term goals. IE is pleased that all of theses goals, plus additional goals, have been met. This progress is closely aligned with our longer-term goals and mission for IE.

2.1 Demand for Industrial Engineering at the University of Washington

There are many individuals and organizations that have vested interests in the development and existence of Industrial Engineering at the University of Washington.

- **Students**: The most prominent stakeholders are our students, both undergraduate and graduate, who wish to take advantage of the abundant and increasing opportunities offered by a career in industrial engineering.

- **Industry**: Business and industry stakeholders that employ industrial engineers, and apply the results of research that are relevant to industrial applications.

- **University Community**: The University of Washington as a whole benefits from IE through interaction with faculty in multidisciplinary efforts, courses that are offered to all UW students, research opportunities, and bringing the diversity of engineering disciplines to the UW.

- **Other Universities**: Other academic institutions are also stakeholders in the sense that faculty are members of the research community and there is a cross-fertilization between undergraduate and graduate students, and faculty of other academic institutions.

- **State of Washington**: As the only industrial engineering program in the state, this program has a significant impact on Washington through educating its citizens, attracting top students and money (research and industrial support) into the state, transferring research advances to local industry and the employment of Industrial Engineering alumni.

- **Professional Community**: The industrial engineering professional community is enhanced by the Industrial Engineering Program at the UW as faculty and students participate in research conferences and lead research activities in furthering the field of industrial engineering.

The demand for IE from students is steady if not increasing, and we have experienced growth in students applications to the department – especially in the graduate program. This is directly related to demand from industry interested in hiring IE students at all levels, from bachelor's to doctoral students.

Industry also works closely with IE faculty to apply research to specific applications. Some local companies working with IE faculty, as well as hiring IE students, include: Accenture Consulting, Amazon.com, AT&T Wireless, AVTECH, Battelle Memorial Institute, Boeing, Capital Industries, Chevron, Diversified Industries, Eastman Kodak, Eaton/Cutler Hammer, Eldec, Flow, Fluke, Fujitsu, Genie Industries, Hewlett Packard, Hynomics, Intel, Lockheed Martin, Majiq, Microsoft, Microvision, Nichols Brothers Boatbuilders, Nordstrom, PACCAR, Puget Sound Naval Shipyard, Sharp, Solectron, Starbucks, Sun Microsystems, Todd Pacific Shipyards, and UPS. This close relationship with students and industry provides a significant benefit to the State of Washington.

Given the interdisciplinary nature of industrial engineering, IE faculty are active in the UW community. One indicator is that IE faculty hold adjunct positions in numerous other departments at the University of Washington. These include adjunct appointments in Civil and Environmental Engineering, Electrical Engineering, Mechanical Engineering, and Technical Communications. In addition, Industrial Engineering benefits from 19 adjunct and affiliate faculty that currently hold positions in the IE program, including faculty from those departments already mentioned, as well as from Applied Math, Environmental Health, and Management Science. These cross-campus efforts enhance the program's teaching and research efforts.

Joint degree programs and partnerships with other units on campus exist in conjunction with both our undergraduate and graduate programs. These are outlined in specific detail in section 3.0.

Two IE faculty members (Professors Atman and Furness) are Directors of Centers that span traditional departmental boundaries and enhance the University of Washington at large. These centers include the new Center for the Advancement of Engineering Education (CAEE), the Center for Engineering Learning and Teaching (CELT), and the Human Interface Technology (HIT) Laboratory. These activities promote research and education to the entire spectrum of IE stakeholders, from students and industry through the professional community.

Comparisons can be made to peer departments in other schools on the west coast. These departments were chosen since they most closely resemble the faculty size of the Industrial Engineering program at the University of Washington. Table 2.1 compares characteristics of IE degrees granted at each of the schools, using 2001 data (the most recent available) from the American Society for Engineering Education (ASEE).

Table 2.1:
IE degrees granted in 2001, selected west coast schools
source: American Society for Engineering Education

	Number of Teaching, Tenure Track Faculty	Undergraduate Degrees Awarded	Master's Degrees Awarded	Ph.D. Degrees Awarded
Oregon State University	12	33	5	2
UC, Berkeley	12	48	17	4
Univ. of Southern California	9	22	34	1
University of Washington	**7**	**26**	**7**	**1**

Table 2.1 indicates that although the number of IE faculty at the University of Washington is actually below the numbers at other west coast industrial engineering schools, our degrees awarded are near or even above those at these other institutions. The ASEE database shows seven UW faculty because one member was on sabbatical and a faculty search was underway for the other position. Although ASEE data is not available for 2002, our own internal records indicate that our degrees awarded have increased substantially this last year. The number of degrees awarded in IE in 2002 is shown in Table 2.2.

Table 2.2:
IE degrees granted in 2002 at the University of Washington

UW IE degrees awarded during academic year 2002**:**
BS: 35 MS: 17 Ph.D.: 4

These increases (as compared against 2001 ASEE data), particularly in the number of graduate level degrees awarded, are indicative of an academic program continuing to strengthen and grow.

2.2 Faculty

Industrial Engineering consists of nine core faculty members as of Autumn 2002. As mentioned, the ranking of the faculty breaks down as follows:

5 Professors:	Kapur, Furness, Storch, Woo, Zabinsky
1 Associate Professor:	Atman
1 Visiting Associate Professor:	Mastrangelo
2 Assistant Professors:	Beamon, Yen

In addition, IE receives support from faculty outside of the primary tenure track core faculty, to provide an interdisciplinary perspective, collaboration with industry and overall support:

- 3 Emeriti Faculty
- 12 Adjunct Faculty
- 7 Affiliate Faculty

A list of IE's emeriti, adjunct, and affiliate faculty can be found in Appendix D, and CV's of the core faculty can be found in Appendix G.

Industrial Engineering has received numerous honors and awards at the faculty, student, and student-group levels. Our student chapter of the Institute of Industrial Engineers was granted the Silver Award for 2001 and 2002 by the national chapter. A UW chapter of the Industrial Engineering Honor Society was established in December of 2000. Students received an Honorable Mention designation at the 2001 Material Handling Student Design Competition. Master's student Clara Fernandes was named the Outstanding IE Graduate Student by the Society of Women Engineers in 2001. Professor Tom Furness, together with the HIT Lab, have received several outstanding awards including two Discover Awards for the virtual retinal display and magicbook technology, and the Satava Award for application of human interface technology to medicine. Professor Cindy Atman is the 2002 awardee of the ASEE Chester Carlson award for Innovation in Engineering Education.

The IE faculty at the University of Washington are leaders in several domains. Most noteworthy is the recent award of $10 million from the National Science Foundation for Professor Cindy Atman to establish the Center for the Advancement of Engineering Education (CAEE). Cindy Atman, Director of the Center for Engineering Learning and Teaching (CELT) is a national and international leader in this area. She will lead the new center, which is a collaboration between UW, the Colorado School of Mines, Howard University, Stanford University, the University of Minnesota and several other partners. Accordingly, the HIT Lab, under the direction of Professor Tom Furness, has received over $37 million in funding and equipment over the past twelve years, and has produced over 80 invention disclosures and 20 patents. This productivity has resulted in the startup of 23 companies offering employment in the State of Washinton alone, and about 500 jobs.

All of the IE faculty are active in research and hold Ph.D. degrees. Two IE faculty members are Center Directors, and a third holds the endowed Fluke Chair of Manufacturing. Most of the IE faculty engage in interdisciplinary research, and collaborate across departmental boundaries. The IE faculty are also active with local industry, and all of the full-time faculty have had government or industry experience. Most of the faculty are involved in professional societies such as American Society for Engineering Education (ASEE), American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronic Engineers (IEEE), International Federation for Information Processing (IFIP), Institute of Industrial Engineers (IIE), Institute for Operations Research and Management Sciences (INFORMS), and Society of Manufacturing Engineers (SME). All faculty are involved in research efforts. Faculty focus areas include system integration, optimization, operations research, human factors, engineering education, virtual reality, supply chain management, quality and reliability,

large-scale assembly, manufacturing and engineering design. Each faculty member is a nationally recognized expert in one or more of these areas. The faculty publish in many prestigious journals and hold editorship positions for numerous publications. These are discussed in detail in section 4.0.

Full-time Industrial Engineering faculty teach an average of four courses per academic year. The associated number of credit hours ranges between 12-16. Faculty with 50% appointments regularly teach two courses a year. This is a normal teaching load for the College of Engineering at the University of Washington for faculty with research programs.

The Industrial Engineering faculty is quite diverse. Of the nine members of the faculty, five are women (56% of the total), including one African-American. The nine persons in IE equate to eight full-time equivalents. If using FTE for the diversity calculation instead of number of persons, IE is 50% female. This amount of diversity is particularly noteworthy when compared against other industrial engineering faculties from selected schools (Table 2.3). The percentage of female faculty in IE at UW is also well above the national industrial engineering average of 13%.[7] This is consistent with the UW vision of encouraging diversity.

Table 2.3: Gender Diversity

	Percent of IE faculty who are female
Georgia Tech.*	22%
Oregon State University*	33%
UC, Berkeley*	17%
University of Michigan*	4%
Univ. of Southern California *	0%
University of Washington	**50%**

**Calculations for other institutions come from 2001 ASEE data.*

2.3 Program Organization, Management and Infrastructure

Full-time staff currently consists of Administrator, Academic Advisor, Fiscal/Budget Analyst Lead, Secretary, and Senior Computer Specialist.

The staff was restructured in 1999. Prior to that time, the current Academic Advisor was at the level of Academic Advisor-Intern. The position was reclassified to an Academic Advisor to better serve students and help stop turnover in the position. Fiscal duties were

[7] ASEE Profiles of Engineering and Engineering Technology Colleges, 2001 Edition, http://www.asee.org/colleges/EngProfile01.pdf.

distributed between two people and have been consolidated with the Fiscal Specialist. IE currently employs a full-time Senior Computer Specialist. Previously, computer support was provided by a part-time student and not adequate to support the needs of the program. Of the six staff members, four are women and two are men.

Staff routinely participate in a variety of training and development courses offered through the University. In addition, career enhancement at professional conferences is encouraged. The Academic Advisor has attended a national conference on recruiting top graduate students. Staff are recognized for their accomplishments at the annual IE Awards Ceremony, where the annual award of Outstanding Staff Member is presented. Significantly, staff have been awarded the University Distinguished Staff award, and have received Honorable Mention at the 2002 College of Engineering Staff Recognition Awards.

The IE faculty meet bi-weekly to monthly (depending on the matters on hand) to inform each other of problems and accomplishments, to discuss short term and long term plans, and to provide input to decision processes that affect the program.

Industrial Engineering is represented on the councils and committees in the College of Engineering. The IE Director sits on the College of Engineering *Executive Committee*. Industrial Engineering also has a seat on the College's *Council on Promotion and Tenure Committee, College Council*, and the *Council on Educational Policy Committee*. In addition, the IE staff Academic Advisor currently sits on the *Council on Educational Policy Committee* as the advisor representative for the College.

Two faculty members in Industrial Engineering serve as Undergraduate Faculty Advisor and Graduate Faculty Advisor, and work closely with the staff Academic Advisor on issues regarding advising and generally support the educational mission of IE. Also, several IE faculty committees are in place to facilitate smooth management of the program on a variety of fronts. These include:

- *Admissions Committee*. Made up of the program Director, the Undergraduate Faculty Advisor, and the Graduate Faculty Advisor, this committee evaluates applicants to both the undergraduate and graduate programs in IE, and makes corresponding admission and funding decisions. The staff Academic Advisor also participates with this committee and provides organizational support and recommendations.

- *TA Allocation Committee*. Consisting of the Graduate Faculty Advisor and two other IE faculty members, this committee assigns teaching assistant (TA) positions to Industrial Engineering courses (course prefix of "IND E"). The committee takes into consideration the background and research interests of students when assigning them as TAs to specific courses.

- *Course Scheduling Committee*. Working with the staff Academic Advisor, this committee made up of three faculty members determines the yearly course-

offering schedule for all Industrial Engineering classes. This includes teaching assignments, as well as working through any constraints associated with quarters and specific times a course is to be offered.

The Industrial Engineering program obtains directional guidance from two non-faculty groups, at both the corporate and the student level, specifically the IE Visiting Committee and the Student Advisory Board. Both groups have been in existence for three years.

The Visiting Committee members come from local industries and companies such as Boeing, Genie, Nordstrom, Tektronix, and UPS. They participate in a range of activities from ABET discussions to coordinating and engaging in Mock Interviews that have been organized for students to hone up on their professional interviewing skills. Members of the IE Visiting Committee have contributed financial support to the Senior Design Projects Competition. The Visiting Committee added its first K-12 representative this year. The Chair of Mathematics of Mercer Island High School has agreed to join the Visiting Committee.

The goal of the Industrial Engineering Student Advisory Board (SAB) is two-fold: to encourage student involvement and to advise the IE Director. As a committee of undergraduate and graduate students, the SAB advises the IE program on a variety of issues. Board membership includes student officers from the student chapter of the Institute of Industrial Engineers and Alpha Pi Mu (IE Honor Society), the Graduate and Professional Student Senator for IE, and "at large" representatives for undergraduate and graduate students. Accomplishments include establishing a student suggestion box where students may voice concerns and/or suggestions about the IE program as a whole.

Facilities

Faculty, staff, and laboratories of the Industrial Engineering program are located in the Mechanical Engineering Building (staff and three faculty members), the Aerospace and Engineering Research Building (six faculty members), the Engineering Annex, Fluke Hall, and the Roberts Annex Building. Professor Cindy Atman, as the Director of the Center for Engineering Teaching and Learning (CELT), supervises office and lab space in the Engineering Annex. Professor Tom Furness directs the Human Interface Technology Laboratory (HIT Lab). Located in Fluke Hall, the HIT Lab is a research and development lab in virtual interface technology. In addition, Assistant Professor Benita Beamon is the director of the Production Systems Laboratory, located in the Roberts Annex Building.

Undergraduate and graduate Industrial Engineering students have their own computer labs in the Mechanical Engineering Building (MEB). IE graduate students are housed in the Manufacturing Research Laboratory in room B14 of MEB, with cubicles and additional computer workstations for students with Teaching Assistant and Research Assistant appointments. In addition, room 106 of MEB is designated for exclusive use by Industrial Engineering TAs to hold office hours and meet with students.

The most recent addition to student space is the formation of the Student Resource Center. The Student Resource Center is designed as a space where both undergraduate and graduate students can work on assignments, discuss team projects, and have a space to post and share relevant information regarding program activities. In addition, the space provides a setting for students to meet and feel a part of the IE community.

3.0 Educational Programs

The Industrial Engineering Program offers an ABET-accredited Bachelor of Science degree in Industrial Engineering (described in section 3.1), a Master of Science degree in Industrial Engineering and a Doctorate of Philosophy in Industrial Engineering (described in section 3.2). The B.S.I.E. was originally accredited in 1986 and recently reviewed and accredited through 2004 (see Appendix I.3). Additional educational K-12 and outreach activities, as well as distance learning and collaborations, are discussed below.

K-12 and Educational Outreach Activities

Faculty, students, and staff of the Industrial Engineering Program participate annually in the College of Engineering Open House. The two-day event provides an opportunity to introduce industrial engineering to the K-12 community, as well as to community college students, potential UW students interested in engineering, and the community at large. Organized in the last three years by Assistant Professor Benita Beamon with the assistance of IE student groups including IIE and APM, Industrial Engineering presents 5-6 different interactive exhibits illustrating various industrial engineering concepts. Two recent exhibits were *Augmented Groove* (a virtual multimedia jam session using 3D interaction), and *Who Wants to be an IE Millionaire?* (where participants learn and are quizzed about the industrial engineering discipline). IE received emails from teachers and students commenting specifically on how much they enjoyed the IE exhibits.

A visiting elementary school group plays the computer interactive *Who Wants to be an IE Millionaire*

Industrial Engineering has begun pursuing other opportunities to introduce the discipline to K-12 students. Professor Zelda Zabinsky has been participating for over 10 years in the MITE program, which is a summer outreach program for minority high school students. Contacts have been made with the Principal and Chair of Mathematics at Mercer Island High School on "pipeline" issues. Several Industrial Engineering presentations will be made to Mercer Island High School students, to be coordinated by Assistant Professor Joyce Yen.

The IE Academic Advisor regularly speaks at numerous campus events to promote the Industrial Engineering program. These are done in conjunction with a variety of campus groups such as Women In Science and Engineering (WISE), and Minority Science and Engineering Program (MSEP). Recently, in Fall 2002, he made presentations to a visiting high school group of 250 students from Japan.

Professor Furness and his colleagues at the HIT Lab are active in several outreach settings including hosting part of Math Day, Minority Students Day, and the summer DO-IT (for disabled high school students) study projects run by the University.

Distance Learning and Collaborations

Together with the Mechanical Engineering department, Industrial Engineering administers the Master's in Manufacturing Engineering program, offered through the College of Engineering's distance learning unit, EDGE (Education at a Distance for Growth and Excellence). Established in 1998 with IE Professor Kal Kapur as the first Director, the Manufacturing Engineering program was originally designed for working professionals at Boeing. The program provides an interdisciplinary engineering degree with specialization in manufacturing engineering. Emphasis is placed on providing education in integrated systems in manufacturing, including large-scale systems and integration of product design with manufacturing processes. Courses are delivered to working professionals via web streaming, CD-ROM and videotape. The Industrial Engineering Academic Advisor also serves as the Advisor for students in this program and administers admissions for the program. As of 2002, there have been 19 graduates of the Master's in Manufacturing Engineering program.

Industrial Engineering also offers graduate level IND E courses that are part of the core curriculum for the Program in Engineering and Manufacturing Management (PEMM). PEMM offers a two-year concurrent degree program, leading to receipt of M.B.A. (Masters in Business Administration) and M.S.E. (Master of Science in Engineering) degrees. This program was initiated collaboratively by IE and Management Science. Industrial Engineering graduate level courses required in the PEMM core include Quality Control in Manufacturing (IND E 521), and Robust Design and Quality Control (IND E 524). PEMM students also routinely take additional IE graduate level courses to be used as technical electives in their program. These courses include Linear Optimization Models in Engineering (IND E 513), and Supply Chain Systems (IND E 570).

Professor Kapur has been teaching a two week short course to professionals on "System Safety and Reliability Analysis" though the Engineering Professional Programs during the summer for the last ten years. A special version of this course has been taught by the Federal Aviation Administration (FAA).

Collaborations with other colleges also exist at the undergraduate level. Beginning Autumn 2002, Industrial Engineering undergraduates may apply to a 5 year academic program that leads to two degrees: a B.S.I.E. and an M.B.A. through the UW Business School. Industrial Engineering students in this program option still complete all of the

normal B.S.I.E. degree requirements, with one exception: the B.S.I.E. Technical Elective requirement is replaced with M.B.A. Elective courses. The program admitted 4 Industrial Engineering undergraduates into the program in 2002. Initial response to this new program option has been enthusiastically positive.

Industrial Engineering undergraduates have the option to pursue a double degree in Applied and Computational Math Sciences (ACMS) with an Operations Research pathway. Students with a strong interest in math and operations research can pursue this double degree option, which leads to two Bachelor of Science degrees in both Industrial Engineering and ACMS. One student who completed this double degree option in 2000 went on to receive a prestigious NSF Fellowship to pursue graduate studies. She is currently enrolled in the Industrial and Operations Engineering Department at the University of Michigan.

Many informal collaborations take place between IE faculty and students at the University at large. In addition, courses offered from Industrial Engineering often have students from a diverse set of departments. This representation includes students from departments such as Applied Math, Business, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Forest Resources, Math, Mechanical Engineering, Psychology, and Technical Communications.

3.1 Undergraduate Education

The Industrial Engineering undergraduate program intends to build a solid education in engineering fundamentals. In addition to sound mathematical and scientific fundamentals, the program concentrates on technical writing and communication skills, as well as the use of computers. Through the requirements for coursework in the arts and sciences, IE undergraduates receive education in humanities and social sciences. IE undergraduates have a broad exposure to engineering design and manufacturing, and a sound background in system integration and synthesis. There is a heavy emphasis on statistics and statistical applications, including quality, reliability, system safety, design of experiments and simulation. Additionally, there is a required 2-quarter sequence in operations research (linear and non-linear programming, and stochastic models), and required courses in human factors and user interface design. The opportunity to choose 7 or 8 technical elective courses (23 credits minimum) provides students with the opportunity to tailor a part of the program to areas of specific interest. Areas such as manufacturing, computers, human factors and user interface, business, probability, operations research, and transportation systems are common. The B.S.I.E. degree program culminates in a 2-quarter senior design capstone experience.

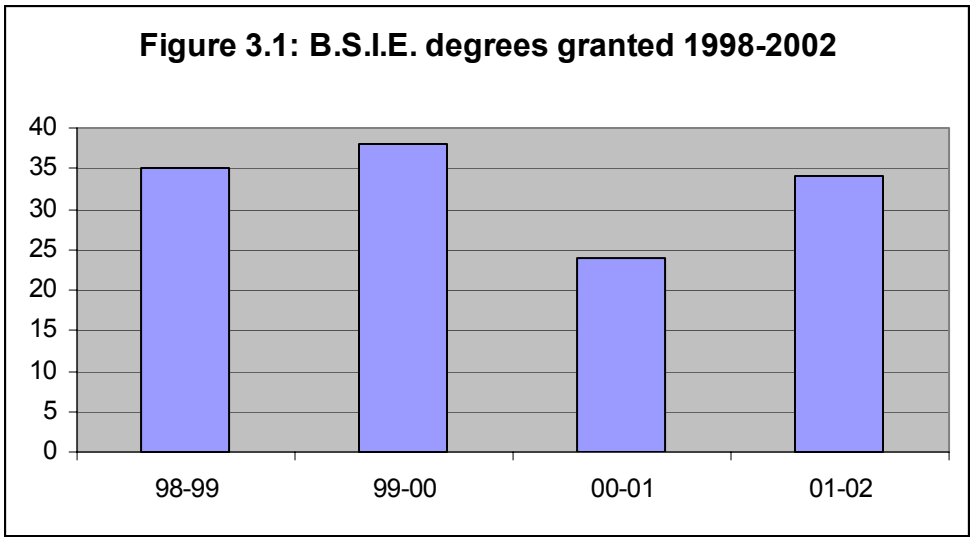
Students must apply for admission into the B.S.I.E. program. There are three categories of admission groups. Entering freshmen are eligible for the *Early Decision Group*. The Industrial Engineering Program enrolls up to 10% of its incoming class directly out of high school, prior to the completion of university-level prerequisites. Freshman applicants to the University of Washington, listing Industrial Engineering as their

intended major, will be automatically considered. Competitive applicants will have taken or be taking calculus and at least one year of laboratory science (preferably physics). The majority of UW and transfer students apply for the *Upper-Division Admission* Group. These students are required to complete a 3-quarter Calculus series, a 2-quarter Chemistry series, a 3-quarter Physics series, and one University approved English Composition course to be eligible to apply. In addition, current UW students who have completed at least 15 credits at this campus are eligible for the *Early Admission Group* (as early as the end of the freshman year). This group differs from the *Upper-Division Admission Group* only in that they are eligible to be considered after completing only a fraction of the required Chemistry and Physics courses (10 credits as opposed to 25 credits). For the most recently completed admission cycle (Autumn 2002), 72% of applicants were to the *Upper-Division Admission Group*, 26% to the *Early Admission Group*, and 2% to the *Early Decision Group*. During the admission process, applicants will regularly meet with the staff Academic Advisor and/or the faculty Undergraduate Advisor to discuss any questions they may have about applying to the program.

Students that are admitted into the B.S.I.E. program are welcomed at an orientation. They are mentored by the staff Academic Advisor and the faculty Undergraduate Advisor, as well as hosted by representatives from student organizations such as the Institute of Industrial Engineers and Alpha Pi Mu. Students are given a handbook outlining degree requirements and the departmental continuation policy.

A student preparing to graduate meets with the staff Academic Advisor, who verifies that all required courses have been taken and passed. The student then meets with the faculty Undergraduate Advisor, who reviews the work of the staff Academic Advisor, verifies that acceptable technical electives have been taken to satisfy that requirement, and forwards the graduation application to the registrar for final approval. Students also complete an exit interview at this time with the faculty advisor. Each spring the IE program hosts a graduation reception for all graduates and their friends and family. Usually held the morning prior to UW Commencement, each graduate is recognized individually for their accomplishments while in the program.

Admission to the program is competitive, with the average entering GPA for incoming IE students being around a 3.1. Currently, the average number of students registered is 63. A summary of the number of undergraduate degrees granted is summarized in Figure 3.1:



The B.S.I.E. program is defined by the graduation requirements specified by the faculty of Industrial Engineering, subject to the more general requirements of the College of Engineering and the University. Changes to the curriculum require approval by the Industrial Engineering faculty, approval by the College of Engineering (through the Council on Educational Policy) and finally by the University Curriculum Committee. Once approved, the curriculum is publicized in the General Catalog of the University, both in electronic and paper versions, and on the Industrial Engineering Program web page. The faculty reviews the curriculum annually to assure that it meets program objectives and that course offerings for the following year are properly organized for this purpose.

Curriculum Structure

A total of 180 quarter credits are required for graduation, of which 122 are for specific courses, and the remaining 58 are chosen within pre-determined categories. The requirements in terms of subject area include 24 credits of mathematics (calculus with analytic geometry, differential equations, linear algebra and probability and statistics), 25 credits of physical sciences (physics and chemistry, including laboratories), 12 credits of written and oral communications, 30 credits of visual, literary & performing arts (VLPA) and individuals & society (I&S), with a minimum of 10 credits from each of those two categories, 28 credits of introductory engineering/computing, 38 credits of industrial engineering core courses, and 23 credits of technical electives to be chosen from an approved list. Although there is no specifically required timing for the courses in the overall curriculum, many courses have prerequisites to assure that the necessary foundation material for later courses has been obtained by the students in earlier courses. A list of all required courses and a sample quarterly plan can be referenced in Appendix I.4A.

The curriculum spans a nominal 12 quarters over four years. The average time to degree for undergraduates is 4.4 years for non-transfer students, and 3.7 years for transfer

students.[8] This is comparable to the College of Engineering, with an average of 4.6 years for non-transfer students and 3.0 years for transfer students.[9] A variety of reasons sometimes result in additional time being required to complete the degree program, including time dedicated to working and point of admission to the department.

Industrial Engineering undergraduates studying in the IE computer laboratory

A 2-quarter capstone design sequence, involving team projects sponsored by the local industrial community, completes the curriculum. The capstone design projects are actual design problems posed by local companies. The student teams visit the companies, conduct interviews, collect data, and develop possible solutions subject to the actual constraints posed by the situation. These include existing facility and organizational and regulatory constraints, as well as financial constraints. The capstone design sequence requires the students to exercise and synthesize their skills in industrial engineering. The experience culminates in a poster session competition where each student team presents their solutions to their given problems. Judged by industry and faculty representatives, the winning teams receive prize money. In the past, the senior design competition has been sponsored by Accenture (formerly Andersen Consulting) and by the IE Visiting Committee. Response from participating companies has been positive. John Koegler of TKL Productions noted that "the student team's insight into our scheduling problem was unexpected. They were able to cut away the personal agendas and get at the heart of the problem. Their proposal was very detailed even to the point of creating a program to analyze our data in real time. We will be able to use their recommendations to improve our on-time delivery. Please thank them for a job well done".

In addition to the senior design competition, two undergraduate students are chosen each year by the IE faculty and staff to receive the Outstanding Undergraduate Awards. Presented at the annual awards ceremony, these students excel not only academically, but also in promoting the IE program and its growth on campus.

[8] UW Office of Institutional Studies electronic reports, http://www.washington.edu/admin/factbook/OisAcrobat/2001_timetodeg_dept.pdf

[9] UW Office of Institutional Studies electronic reports, http://www.washington.edu/admin/factbook/OisAcrobat/2001_timetodeg_college.pdf

Mechanisms for Curriculum Revision

Over the last couple of years, several changes and additions to the undergraduate curriculum have been implemented in keeping with the ABET feedback loop, and as a result of feedback from two main constituents. These constituents, specifically, are industry (as represented by the IE Visiting Committee) and the students themselves. The undergraduates provide feedback through a structured focus group process administered by CIDR, an exit interview with the undergraduate faculty advisor, and the Student Advisory Board. Graduate students generate feedback though an exit interview with the graduate faculty advisor, and the Student Advisory Board. Issues brought up from these groups are discussed by the IE faculty, and actions are taken as appropriate.

Changes have been made in several areas. First, the faculty decided to streamline the curriculum, provide more flexibility for students, and to offer special topics courses. Prior to 2001, students were required to complete ME 354, Behavior of Engineering Materials, and ME 355, Manufacturing Processes. Questions were raised on the necessity of requiring these classes. In the spring of 2001 it was decided that it would be in the best interest of the students to remove the ME 354/355 requirement. These two courses have been moved to options under the technical elective requirement. As a replacement, students will now choose between two Industrial Engineering courses (Scheduling and Inventory, and Plant Layout and Material Handling), and also choose between a Chemical Engineering thermodynamics course and a Computer Engineering programming course that focuses on Java. It was felt, particularly given the broad multidisciplinary nature of industrial engineering, that broadening the technical elective requirements will allow students greater flexibility in designing their own area of focus in the program. Additional changes along these lines included recognizing a need to increase exposure to ethics and professional practice issues. As a result, both engineering ethics and professional practice issues courses have been offered as special topics, and concepts from these courses have been refined and added to the Introduction to Manufacturing Systems class (IND E 237) and the senior design class (IND E 494). In addition, other special topics courses have been offered to supplement students' technical elective offerings, including Enterprise Control, Industrial Integration on the Internet, Information Systems, Principles of Decision Quality, Quantitative Methods in Human Factors, Web Enabled Collaborative Tools, Web Enabled Inventory Systems, and Enterprise Control.

A second area of change has been to increase students' experiences with current software and technology. In addition to software used in special topics courses like Information Systems and Quantitative Methods in Human Factors, a variety of current software programs are used in core IE undergraduate courses. For example, students get exposed to AutoCad, Arena, Excel Solver, MPL, SPSS, and well as software that is packaged with textbooks. Knowledge of computer skills in word processing (e.g. Word), graphics (e.g. Visio), and presentation (e.g. Powerpoint) software is presumed in all courses.

Both industry and student feedback emphasized the importance of industry experience. Co-op and internship experiences are highly valued. Opportunities for these experiences

are sought in individual contacts by faculty to industry and in conjunction with Senior Design. As opportunities arise, they are publicized through the undergraduate email list and with posted notices. IE students have been commended on their interaction with industry. Feedback was given to the IE Academic Advisor from a supervisor at Avtech, a local company where two IE undergraduates were hired as interns. Their supervisor, Suzanne Schumacher, wrote that the students' efforts "have helped us make great strides in our Lean Manufacturing implementation over the past year. As recognition for their contributions, both Courtney and Kathrine were presented with Avtech's Employee of the Month award earlier this week."

An additional comment voiced by students expressed a high degree of confidence in their teamwork skills and that they feel they had ample opportunities to be members of work teams in their classes. Many IE courses contain team project work as part of the class. In addition, the curriculum is designed to provide opportunities for individual work and study. The faculty intend to continue this mix of team and independent assignments in the undergraduate curriculum.

Undergraduate Participation in Research

Industrial Engineering undergraduates are encouraged to participate in research activities through out campus. Students regularly sign up for research credits (IND E 499) under the direction of individual faculty. These opportunities often arise in conjunction with research being conducted in centers directed by IE faculty, such as the Human Interface Technology Lab, the Center for Engineering Teaching and Learning, and the Production Systems Lab. From 1998-2002, IE has averaged engaging five undergraduates in research per quarter. Almost all of the IE faculty have participated in supervising undergraduate research. This has been popular enough that the IE program is currently planning to add an undergraduate research course number (IND E 497) to encourage student involvement in research activities while earning credits that can be used toward technical elective requirements.

Students participate in the annual Mary Gates UW Undergraduate Research Symposium. One IE undergraduate student was selected to be a Mary Gates Scholar. Undergraduates, under the guidance of IE faculty, annually make submissions to the symposium. These have included:

1999:
Susan Hermanto, *Optimal Scheduling Policies for Air Traffic Control.*
Professor Zelda Zabinsky, faculty mentor

2000:
Jake Burghardt, *Defining the Users of an Educational Website.*
Jake Burghardt, Ka Man L. Cheung, Jennifer Chin, Julie Christensen, Jennifer Temple, Bettina Vuong, *An Application of Verbal Protocol Analysis to Engineering design: Lessons Learned.*
Professor Cynthia Atman, faculty mentor

2001:
Jennifer Temple and Jana Littleton, *Production Scheduling Optimization.*
Jana Littleton and Jennifer Temple, *Optimization Algorithms of Univariate Lipshitz Functions with Applications in Science and Engineering.*
Professor Zelda Zabinsky, faculty mentor

2002:
Michelle Valeriano, *Characterizing Industrial Engineering Students Conception of their Profession and the Role of Concept Maps as an Assessment Tool.*
Professor Cynthia Atman, faculty mentor

Iqbal Bhinderwala and Hermann Chong, *Fixture for Radiation Oncology.*
Brendan Walker, *Local Positioning System.*
Eric Webster, *Font Invariant Recognition*.
Professor Tony Woo, faculty mentor

Retention and Career Placement

The retention rate for B.S.I.E. students for the period of 1999-2002 was 87%. Graduates of the IE undergraduate program go on to a variety of positions, ranging from industry to graduate study at universities across the country. A representative list of these companies and graduate schools can be found in Appendix E.3.

3.2 Graduate Education

Industrial Engineering grants M.S.I.E. degrees (with both a Thesis and Coursework Only option) and Ph.D. degrees. Officially established in 1998, the Industrial Engineering graduate program is developing nicely. A target goal, as stated in the Strategic Plan, is a total of 50 graduate students, and we are close to that goal with 45 students enrolled in 2001.

As illustrated in Figure 3.2, the number of Ph.D. degrees awarded has increased since 1998. The number of M.S.I.E. degrees with the Coursework option has also increased, while the number of M.S.I.E. degrees with the Thesis option took a dip.

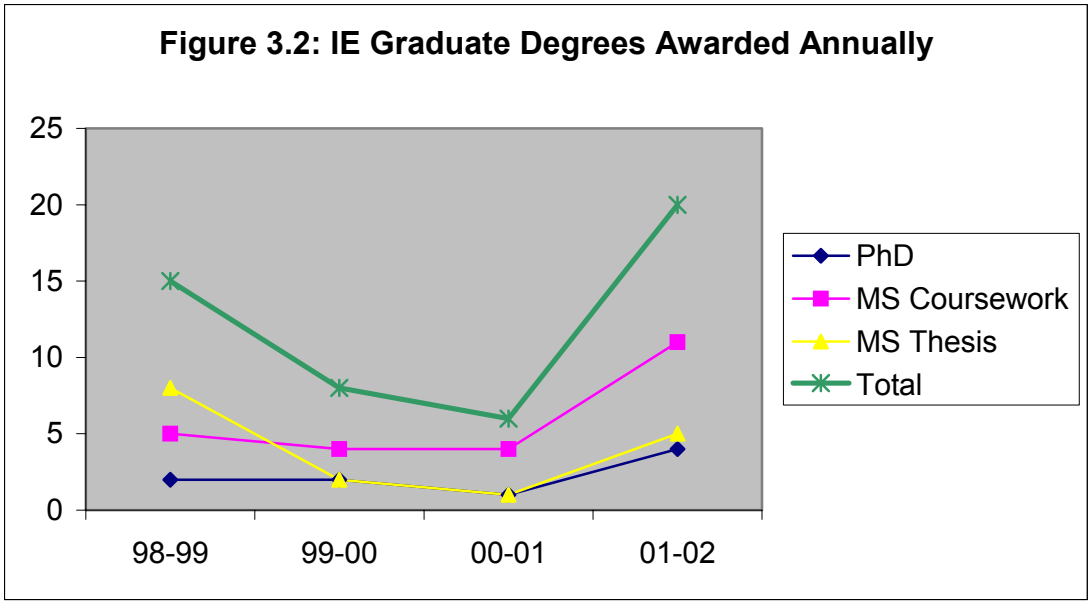


Table 3.1 highlights these statistics. The majority of students in the program in 1998 were M.S. students (67%), with the majority of these students going on to pursue the Thesis option (62%). By 2001 the number of MS and PhD students had changed to near equal percentages (53% Ph.D., 47% M.S.). In addition, the composition of the M.S. students has nearly made a complete switch, with only 33% of the M.S. students in 2001 pursuing the Thesis option, while a large majority of 67% was pursuing the Coursework Only option.

Table 3.1: Statistics on Enrolled IE Graduate Students

	Autumn 1998	**Autumn 2001**
Enrolled PhD students	7 (33%)	24 (53%)
Enrolled MS students	14 (67%)	21 (47%)
% MS Thesis students	*62%*	*33%*
% MS Coursework Only students	*38%*	*67%*
Total number of enrolled graduate students	21	45

If the current trend of the majority of MS students choosing the Coursework Only option holds true, it would be expected that the number of degrees awarded in this category would remain quite high (11 MS Coursework Only degrees were granted in 2001-2002 as compared to 5 MS Thesis degrees). MS students choosing the Coursework Only option can easily complete degree requirements in two years, if not sooner. This allows for a steady flow of MS Coursework Only students to go through the program.

Student Demographics

Again using Autumn 2001 as the most recent complete data for analysis, demographic information is presented below in Table 3.2. Twice as many international as domestic students were registered. The majority of international students are of Asian descent.

Table 3.2:
Graduate Student Demographics, Autumn 2001

Male	26	58%
Female	19	42%
Domestic	15	33%
International	30	67%
Caucasian	14	31%
Asian or Pacific Islander	27	60%
Hispanic	0	
Afro-American	0	
Native American	0	
Other/Not Reporting	4	9%

Recruitment of Graduate Students

The Industrial Engineering Program has seen notable increases in the number of applicants to its graduate program since it was approved in 1998. The total number of applications received for Autumn 1998 was 33. Total applications for Autumn 2002 (the most recently completed admission cycle) was 134. This is an increase of over four times as many applications in as many years.

The quality of the applications, and those applicants who have accepted admission offers, has also improved. Using GRE scores as a measure of quality, Table 3.3 shows the increase in average GRE scores of applicants accepting admission from the two periods.

Table 3.3:

GRE profile of students accepting admission to IE Graduate Program

	Autumn 1998	**Autumn 2002**
Average Verbal	437	523
Average Quantitative	732	765
Average Analytical	613	675

The IE Program now regularly invites top applicants currently in the U.S. to visit and meet with IE faculty and to tour the facilities available to them at UW. These visits have been feasible from recruitment travel money awarded to the Program from the UW Graduate School Fund for Excellence and Innovation (GSFEI). Coupling this money (which can be used towards airfare) with departmental funds that cover food and lodging for the applicant, the Program has been able to afford top applicants the chance to view IE at UW first-hand, as well as allowing IE faculty to better gauge the quality of the applicant.

The GSFEI money has also been used in other ways to secure top applicants. Industrial Engineering has received Research Assistant (RA) funds from GSFEI to be used to recruit top students. Additional GSFEI funds awarded to IE have been used to supplement an available 9-month RA position into a 12-month position, which has proven a necessity in order to facilitate the approval of visa and immigration documents for international students. In addition, GSFEI money has also come in the form of resident tuition waivers, which were used this current year to recruit a highly qualified Washington State applicant who might have gone elsewhere without the financial award. These GSFEI funds are pivotal in Industrial Engineering's capability of recruiting top students who apply to the program.

Industrial Engineering has taken numerous steps to promote the graduate program to potential applicants. The IE Academic Advisor regularly makes presentations highlighting the graduate program to different groups on campus. These have included presentations for Women in Science and Engineering (WISE) and the Minority Science and Engineering Program (MSEP). In addition, informational sessions have been organized to promote graduate education to our undergraduate IE students. Consisting of brief presentations from both the Academic Advisor, current IE graduate students, and Professor Zelda Zabinsky (the Graduate Program Coordinator), the session highlights the steps needed to apply to any graduate program in the U.S., and then specifically details and promotes the IE graduate program here at UW. As a result, IE-UW undergraduates have applied to the IE-UW graduate program. Since 1999, eight former undergraduates have been admitted and accepted offers into the M.S.I.E. program. An interesting observation is that all of the current M.S.I.E. students who were former undergraduates in the IE program at UW had experience working on research with IE faculty as undergraduates.

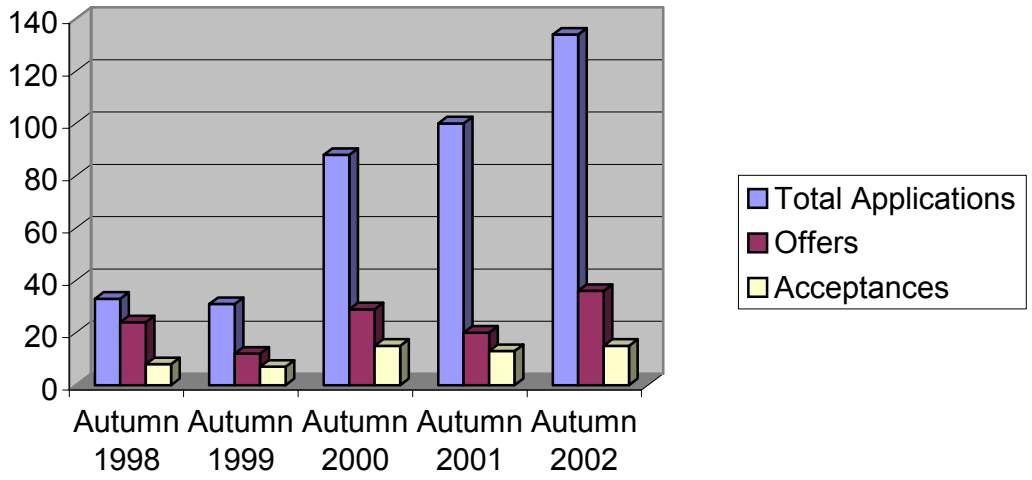
In addition to promoting the graduate program to students on the UW campus, the IE Program has taken steps to recruit graduate students at the national level. Recruitment posters have been sent to every school in the U.S. with an industrial engineering program. These posters include inquiry cards that can be sent back to the IE Advising Office to receive more information about applying. Other publications have been created as well. A general fold-out brochure highlighting the IE graduate program and the admission process has been published. A copy of this brochure can be found in Appendix I.5.

As part of a general plan to have up-to-date information available to the general public, the IE Academic Advisor designed the departmental web page and highlighted the faculty

research and graduate program. This included expanding the faculty profile sections so that potential students can investigate current research areas and projects being conducted by the program, as well as putting all necessary application materials available to download on-line. The Graduate School portion of the application process can actually be completed on-line. These changes to a web-based inquiry and application process have significantly reduced the time and money that was previously spent sending out paper application materials to potential applicants.

Results of such recruitment efforts have been favorable. There have been substantial increases in the number of graduate applications received each year. Currently, applications are accepted for Autumn and Spring quarters only. The overwhelming majority of applicants continue to submit materials for Autumn admission. As noted earlier, total applications received has increased over four times in Autumn 2002 as compared to Autumn 1998. Figure 3.3 shows the increases in applications received over the last few years. Also of note is that the number of admission offers made, in contrast, has remained somewhat constant, with only slight increases. This reflects the fact that the IE program is near its goal of having 50 graduate students enrolled at any given time. The increased number of total applications has afforded us the opportunity to increase quality by choosing from a much larger pool of qualified applicants for our limited openings.

Figure 3.3: Graduate Applications Received



Another element of recruitment and retention of graduate students is financial support. Almost all of our Ph.D. students are supported, either as a teaching assistant (TA) or a research assistant (RA). Some of our Ph.D. students are supported through government fellowships. Our policy is to have Ph.D. students serve as a TA at least once during their graduate experience. In addition, promising master's students may also be supported as a TA or RA. This encourages strong master's students to consider staying on for a doctoral degree. The retention rate for graduate students from 1999-2002 has been 86%.

Graduate Student Service Appointments

Graduate student service appointments are made to help the faculty carry out Industrial Engineering's teaching and research missions. These consist of Teaching Assistantships (TAs) and Research Assistantships (RAs). Assistantships constitute IE's principal form of financial assistance to graduate students and provide experience—essentially an apprenticeship—for graduate students as they prepare for careers in teaching and research. Because we believe it is important for Ph.D. students to have some teaching experience, we give Ph.D. students priority when assigning TA appointments.

IE strives to make annual appointments to assure continued financial commitment. However, because funding for some assistantship lines runs for less than a year, or are of uncertain duration, some appointments may be made on a quarter-to-quarter basis. The compensation schedule for TA and RA salary stipends are consistent with the approved Graduate School rates and reflect the student's standing (Master's, Pre-Doctoral, or Doctoral Candidate). TA positions are supervised by the faculty member in charge of instructing that particular course. In addition, the Graduate Program Coordinator receives quarterly feedback on TA performance from both the instructor and student. Students awarded TA positions participate in both the Graduate School and College of Engineering TA orientations. Furthermore, all international students participate in the Center for Instructional Development and Research (CIDR) TA workshop.

RA positions are supervised by the faculty member associated with the research. RA support has come in part from NSF and other grants, as well from industrial support. Industrial Engineering typically supports 7 TAs and 10 RAs per quarter. Approximately 85% of the Ph.D. students are supported by departmental TA and RA positions, and 45% of the Master's students are supported with a TA or an RA.

Master of Science in Industrial Engineering Program

The M.S.I.E. degree can be earned by completing either a Thesis or Coursework Only (non-thesis) option. The minimum requirement imposed by the Graduate School for a Master's degree is 36 credits. The M.S.I.E. degree (under both options) requires a minimum of 41 credit hours for completion. A complete M.S.I.E. curriculum description can be found in Appendix I.4B.

Both the Thesis and Coursework Only options require a specific number of graded graduate level (500) IND E courses, in addition to three credits of IE Seminar (IND E 591, 592, 593). A list of graduate level IE courses is included in Appendix I.6. Typical graduate courses offered annually or biannually include:

INDE 510	Applications of Optimization in Engineering Design
INDE 513	Linear Optimization Models in Engineering
INDE 515	Fundamentals of Optimization
INDE 521	Quality Control in Manufacturing
INDE 524	Robust Design and Quality Engineering
INDE 526	Reliability in Product Design and Testing

INDE 533	Computational Methods in Design and Manufacturing
INDE 535	Simulation
INDE 538	Large Assembly Manufacturing Systems
INDE 543	Virtual Interface Technology
INDE 570	Supply Chain Systems
INDE 599	"Stochastic Processes for Industrial Engineering"

The Master's degree also requires a minimum number of graded credits earned in Technical Electives. These credits may be earned from IND E courses, but the student is also able to select from courses in other departments and colleges as well. Routinely, all courses from departments in the College of Engineering can be applied toward the Technical Elective requirement. In addition, upon approval from the Graduate Advisor, courses from other colleges may be used toward this requirement if they support the student's research interests, including Applied Math, Education, Psychology, the School of Business, or Statistics. A maximum of 9 Technical Elective credits may be earned from 400 level courses, while the remainder must be earned from 500+ level courses. Students pursuing the Thesis option replace 9 credits of coursework with 9 credits Master's Thesis (IND E 700). Specific credit requirements for both degree options are as follows:

M.S.I.E. Coursework Only Option:

21 Graded course credits in Industrial Engineering (500 level or above)
17 Graded course credits in Technical Electives (maximum of 9 credits allowed from 400 level courses)
3 Credits of IE Seminar: IND E 591, 592, 593
41 Total credits for degree

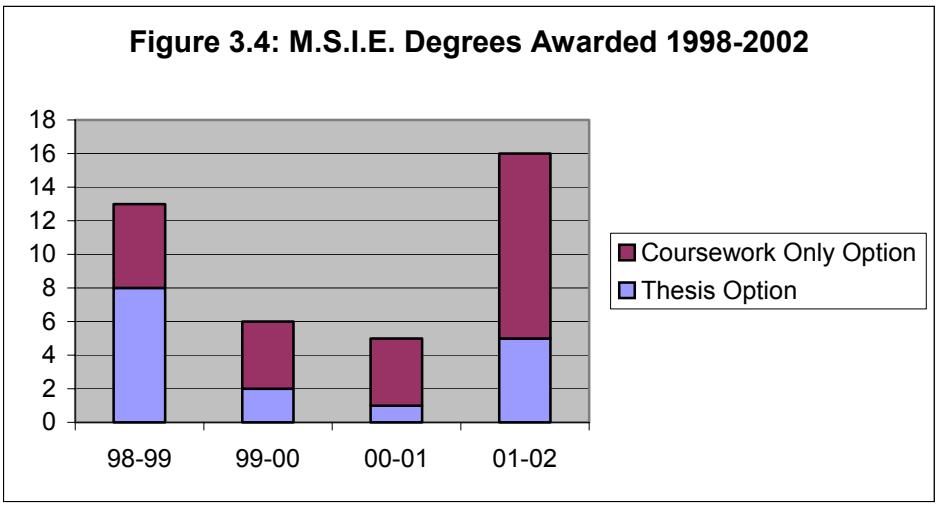
M.S.I.E. Thesis Option:

18 Graded course credits in Industrial Engineering (500 level or above)
11 Graded course credits in Technical Electives (maximum of 9 credits allowed from 400 level courses)
9 Credits of Master's Thesis (IND E 700)
3 Credits of IE Seminar: IND E 591, 592, 593
41 Total credits for degree

Full-time enrollment for graduate students is 10 credits per quarter, and this is a requirement for all students with either a RA or TA position from the program. As such, it is routinely observed, and expected, that Coursework Only students complete their degrees in 4-5 quarters. Students pursuing the Thesis option routinely take longer to complete their degree due to additional time spent on research and writing of the thesis. The average time to degree for all IE Master's students (including those under the Thesis

option) is 2.6 years.[10] This is comparable to the overall average for all Master's students in the College of Engineering, which is 2.4 years.[11]

Figure 3.4 illustrates the number of master's degrees awarded, as well as the shift from thesis option to coursework only option over the last several years. This is deemed a desired outcome, because it allows for a steady stream of new M.S.I.E. students to enter the program. Students completing the Thesis option have researched a wide variety of subject areas. A complete list of Master's thesis titles can be found in Appendix E.2. In addition, Appendix E.2 documents employment positions accepted by all M.S.I.E. graduates (Thesis and Coursework Only).



Ph.D. Degree

The Ph.D. pathway consists of a progression of Qualifying Exam, General Exam and Final Defense. Students must have a Master's degree in a technical field before being admitted into the Ph.D. program. A complete description of the Ph.D. curriculum can be found in Appendix I.4C. Typically, Ph.D. students take coursework during their first year, which includes a 3-quarter IE seminar sequence. A list of IE seminars is included in Appendix I.7. The students are encouraged to explore research interests with faculty.

Entering Ph.D. students are given up to 15 months to complete the necessary courses in preparation for the qualifying exam. The exam, which is currently offered at the beginning of Winter quarter, is only offered once per academic year. The guidelines of the exam note that students must take the exam no later than the second time it is offered while in residence. For example, a Ph.D. student entering the program in Autumn 2002

[10] UW Office of Institutional Studies electronic reports, http://www.washington.edu/admin/factbook/OisAcrobat/2001_timetodeg_dept.pdf
[11] UW Office of Institutional Studies electronic reports, http://www.washington.edu/admin/factbook/OisAcrobat/2001_timetodeg_college.pdf

would not be required to take the exam until it was offered in the Winter of 2004. This allows sufficient time to complete courses and prepare for the exam.

Currently, the Ph.D. qualifying exam is broken into three sections:

Section A: Deterministic Methods- Optimization and Computational Methods:
Courses that cover relevant topics include:
IND E 510, Applications of Optimization.
IND E 513, Linear Optimization Models.
IND E 533, Computational Methods in Design and Manufacturing.

Section B: Probabilistic Methods- Applied Statistics and Stochastic Processes:
Courses that cover relevant topics include:
IND E 521, Quality Control in Manufacturing.
IND E 524, Robust Design and Quality Engineering.
IND E 599, "Stochastic Processes for Industrial Engineering".

Section C: Applications in Industrial Engineering:
Courses that cover relevant topics include:
IND E 543, Virtual Interface Technology.
IND E 570, Supply Chain Systems.

The qualifying exam has a breadth and a depth component. Students are expected to satisfy a breadth requirement by completing at least one course in each of the three sections, and a depth requirement by completing at least two courses in one of the sections. Students must also answer written questions from two sections.

For the written exam (administered as a take-home), students choose to answer one question (each) from two of the three sections. Each question corresponds to the topic area of each individual course and is written by the faculty member associated with that particular course. The written portion of the exam is followed by an oral exam before the faculty, where the student is asked to summarize their answers and is asked questions by the faculty.

The structure and composition of the qualifying exam has evolved over the last several years. In 1996-98, before the Ph.D. in IE was approved, the questions were individualized for those Ph.D. students interested in IE. In 1999, we administered the first standardized qualifying exam. Since that time, we have given the qualifying exam to 4 students in 2000, 3 students in 2001, and 11 students in 2002.

The courses and sections for the qualifying exam have also changed over time. In 1996, the IE faculty agreed upon five focus areas that were used to outline the Ph.D. qualifying exam, with each area having one core course. As outlined at that time, the focus areas were Deterministic Methods and Optimization, Statistical and Empirical Engineering, Modeling Methodology, Manufacturing, and Human Factors and Human Interface Technology. Since then, several changes to the faculty occurred. This, combined with

the practicalities of providing sufficient access to the courses in the Ph.D. qualifying exam, resulted in changes from the initial structure. After many discussions, the IE faculty decided five focus areas could not be sustained, and consequently adopted the current structure of three sections.

Students are encouraged to begin forming their Supervisory Committee following successful completion of the qualifying exam. The committee consists of a minimum of four members. The student chooses three members, with at least two (including the Chair) coming from Industrial Engineering. The fourth member, the Graduate School Representative (GSR), is appointed by the Graduate School. Additional members can be appointed at the discretion of the committee Chair.

Ph.D. students must also meet the University's coursework requirements for a doctoral degree. Prior to scheduling the General Examination, completion of 60 credits must be completed, with at least 18 credit hours of 500-level courses. A master's degree from the UW or another institution may be used to substitute for 30 of these 60 credits. Following these credit requirements, the General Examination may be scheduled. The General Exam consists of an oral exam of a dissertation proposal. A written copy of the dissertation proposal must be distributed to the committee at least two weeks prior to the exam.

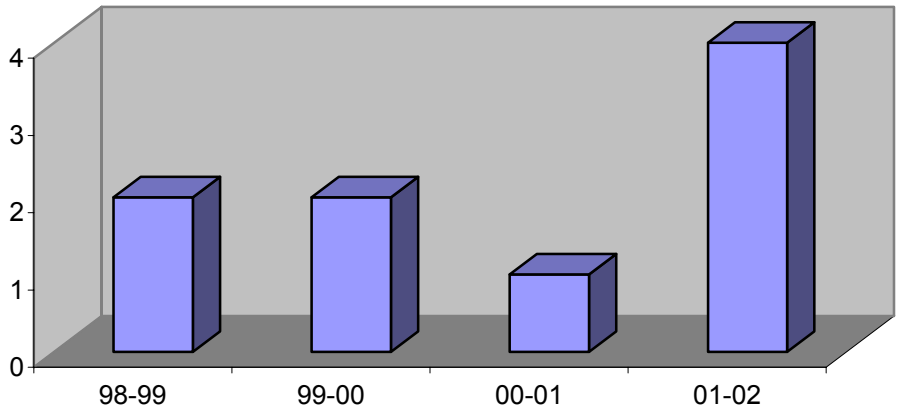
Before a student may schedule their Final Examination, a doctoral Reading Committee, consisting of a Chair and two additional members, must be established. The Reading Committee usually corresponds directly with the make-up of the Supervisory Committee minus the Graduate School Representative. The dissertation must be reviewed by the Reading Committee before the Final Examination is scheduled. At least 3 members of the Supervisory Committee, including the Chair and GSR, must be present at the Final Examination. Following successful completion of the Final Examination, a student has 60 days to submit copies of their dissertation to the Graduate School. The Graduate School requires registration for both the quarter the Final Examination is taken *and* the quarter the dissertation is actually submitted (if a different quarter), regardless if the 60 day time period has expired. A copy of the dissertation is also required to be given to the Industrial Engineering Advising Office, to be kept by the program.

Over the past four years a total of nine Ph.D. degrees have been awarded by Industrial Engineering. Figure 3.5 summarizes these numbers. It is expected that these numbers will rise because IE has admitted more Ph.D. students recently and expects several students to complete their dissertations in the near future. Currently, as of September 2002, there are 22 active Ph.D. students in the program. The average time to degree is 7.5 years for IE Ph.D. students[12], which is slightly higher than the average time to degree of 6.0 years for the College of Engineering[13]. However, for the four students that earned

[12] UW Office of Institutional Studies electronic reports, http://www.washington.edu/admin/factbook/OisAcrobat/2001_timetodeg_dept.pdf
[13] UW Office of Institutional Studies electronic reports, http://www.washington.edu/admin/factbook/OisAcrobat/2001_timetodeg_college.pdf

their Ph.D. in 2001-2002, the time to degree was significantly less with a range of between 3.75 years and 5.0 years, and an average of 4.25 years.

Figure 3.5: IE Ph.D. Degrees Earned 1998-2002



Ph.D. graduates have gone on to a variety of positions, ranging from private consulting, jobs with industry, and faculty appointments. A complete list of Ph.D. dissertation titles, as well as employment positions received, can be found in Appendix E.1.

Exit Interviews and Alumni Information

When a master's or doctoral student is nearing degree completion, he or she is given an exit interview with the faculty Graduate Program Coordinator. Information is obtained on a variety of subjects including satisfaction with course offerings, whether or not desired educational objectives were reached, and plans for subsequent employment.

Graduating students are also solicited for employment information via the IE Alumni Association. Information provided by alumni is highlighted on the IE website (refer to http://depts.washington.edu/ie/alumni/form.htm).

4.0 Research

Research activities by industrial engineering faculty are making significant impact on a national and international level. Each of the IE faculty members make substantial contributions to research in several areas, including, manufacturing, human interface technology and virtual reality, optimization, reliability and engineering learning. As documented in the 2000/2002 bi-annual report, the IE faculty have written 23 journal articles, 9 books and book chapters, 29 conference papers and given 46 presentations. While many of the grants and contracts are multi-year, in the window of this biennium, the average amount of expenditure (excluding overhead) per faculty was $575,000 per year. The bi-annual report is included in Appendix I.8.

Professor Cindy Atman has been awarded ten million dollars from the National Science Foundation to establish a Center for the Advancement of Engineering Education (CAEE). Professor Atman will lead the new center, which is a collaboration between UW, the Colorado School of Mines, Howard University, Stanford University, the University of Minnesota and several other partners. Her innovative research in engineering education brings recognition to IE, the College, and the UW. Professor Cindy Atman will also continue as the Director of the Center for Engineering Learning and Teaching (CELT), the first Center in the country in a College of Engineering to include research in engineering learning as a major goal. In order to maximize the application of these research findings, CELT also serves as a resource for the College's faculty members and teaching assistants to help them test out new teaching methodologies and technologies. Professor Atman's research has been nationally and internationally recognized, and the National Academy of Engineering and other universities are proposing similar centers using Atman's CELT as a model.

Professor Benita Beamon, who joined IE at the UW in 1999, is the director of the Production Systems Laboratory. Its mission is to provide a knowledge center for production systems analysis and design that will foster cooperation among interested members of the academic community, government, and industry. Both graduate and undergraduate Industrial Engineering students are currently involved with research projects in the lab. Professor Beamon's research focuses on Material Handling Systems and Supply Chain Systems.

Professor Tom Furness is the Center Director of the celebrated Human Interface Technology (HIT) Laboratory. Professor Furness develops state-of-the-art technology and research in virtual reality. He is a pioneer in the development of interfaces between humans and complex machines. The successful development of the HIT Lab has received international acclaim, and is being used as a model for establishment of a HIT Lab in New Zealand, where Dr. Furness also holds a professorship at the University of Canterbury. The HIT Lab was established by Professor Furness in 1989 together with the Washington Technology Center to transform virtual environment concepts and early research into practical, market-driven products and processes. HIT Lab research strengths include interface hardware, virtual environments software, and human factors. The Lab hopes to develop a new generation of human-machine interfaces to provide

solutions to challenges in a variety of domains. The HIT Lab promotes multi-disciplinary research, and consists of 105 people of which 23 are graduate students and 8 are undergraduate students. The HIT Lab has spawned 23 start up companies, and Prof. Furness was featured in Discovery magazine in 1999. Professor Furness annually hosts the Virtual Worlds Consortium composed of 48 companies, which disseminates state-of-the-art research and advances in virtual environments.

Professor Kailash (Kal) C. Kapur's research focuses on customer centered approach for quality and reliability engineering; system design, control and optimization; and integrated quality management system (IQMS), which also includes all the elements of 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 Richard Storch's research focuses on productivity improvement in shipbuilding, addressing areas such as quality control, material management, work organization, and lean manufacturing. His current research projects are in the area of design for production, design expert system development, statistical quality control, applications to dimensional control, and strategic planning for process improvement.

Professor Tony Woo, Director of IE at the University of Washington and John M. Fluke Distinguished Chair in Manufacturing Engineering, is a leader in the area of computational manufacturing. He has published extensively in computational geometry, computing visibility, computer graphics and more broadly computer-aided design and manufacturing. He was a Fulbright Research Scholar, and recipient of three NSF Outstanding Performance Awards. Professor Woo serves an editorial function for nine journals.

Professor Joyce Yen's research field is stochastic programming. This branch of Operations Research focuses on resource allocation and decision-making under uncertainty. The aim is to incorporate information about random outcomes when evaluating potential solutions. Prof. Yen's research projects have included airline crew scheduling under uncertainty, telecommunications network design given random demands, and air traffic management resource management with weather and other sources of randomness.

Professor Zelda Zabinsky's research focuses on global optimization, with both theoretical and applied aspects. One application area is the optimal design of stiffened composite panels with manufacturing constraints. The research is making a significant impact on the aerospace industry, and a software design tool is in use at Boeing for optimal design studies of aircraft composite wings and fuselage. Prof. Zabinsky is also working on research in supply chain optimization and air traffic management. She has also worked on applications of Operations Research in manufacturing, production, transportation, health care and forestry.

Professors Yen and Zabinsky recently received a grant from the Boeing Company for $918,738 to investigate "Air Traffic Flow Management Under Temporary Constraints." Their research team of two Ph.D. students and one master's student have been developing optimization methodologies to tackle the logistical problems faced in air traffic management given an inherent system uncertainty.

The IE faculty have been successful in obtaining research funding, even before the recent $10 million award to Prof. Atman for CAEE. The research funding comes from a variety of sources, including governmental agencies, such as the National Science Foundation, the U.S. Navy and the Office of Naval Research; and industrial sponsors, such as the Boeing Company, GE, Microsoft, Microvision, Physio-Control, Flow International Corporation, Ford Motor Company, and others. A large percentage of IE's funding comes from the National Science Foundation, which is a competitive source, and attests to the recognition of the faculty.

IE faculty have been promoting scholarship, including nine books and book chapters. Several highlights of books and book chapters are included here. Professor Kailash Kapur is one of the country's leading scholars in the area of quality and reliability, and his book, Reliability in Engineering Design, is in its 19th printing and has been translated into several languages. Professor Richard Storch's book, Ship Production, is sought after by shipyards and the U.S. Navy. Professor Tony Woo's work on the comparison of 3D data sets was awarded first prize by the ASEE magazine PRISM, in the special issue on counter-terrorism. Professor Zelda Zabinsky had two chapters appear in the Encyclopedia of Optimization on global optimization and applications. Professor Cindy Atman co-authored Risk Communication: A Mental Models Approach in 2001.

The faculty publish in many prestigious journals, including the transactions of such societies as the American Society of Mechanical Engineering (ASME), Institute of Electrical and Electronic Engineers (IEEE), Institute of Industrial Engineers (IIE), and the Society of Naval Architecture and Marine Engineering (SNAME). Other peer-reviewed journals publishing IE faculty research include: Design Studies, International Journal of Engineering Education, International Journal of Human-Computer Interaction, International Journal of Production Research, International Journal of Systems Science, Journal of Ship Production, Production Planning and Control, and Mathematical Programming. Professor Benita Beamon received an award for Most Outstanding Paper of 1999 from the journal *Logistics Information Management*.

IE faculty serve as editors or on editorial boards for seventeen journals. These include *ASME Journal of Manufacturing Science and Engineering; Computer Aided Design; Computers and Industrial Engineering; IIE Transactions; International Journal of Computational Geometry and Applications; International Journal of Computer Applications in Technology; International Journal of Information Technology; International Journal of Modeling and Simulation; Journal of Engineering Education; Journal of Global Optimization; Journal of Marine Science and Technology; Journal of Ship Production; Presence, Teleoperations and Virtual Environments; Quality Engineering; SME Journal of Manufacturing Processes and Visual Computer; SME*

Journal of Manufacturing Systems; Virtual Reality Journal; and *Visual Computer*. Faculty also serve as reviewers for the above journals, as well as other journals.

The IE faculty are also active in research conferences. Professor Tony Woo hosted two NSF conferences locally. Professor Zelda Zabinsky was the Program Chair for the International INFORMS Conference in June 2001. Professor Richard Storch is on the international program committee and regular contributor to the International Conference on Computer Application in Shipbuilding (ICCAS) and the International Federation of Information Processing, Working Group 5.7 in Advances in Production Management Systems. Professor Tom Furness hosts the Virtual Worlds Consortium workshop held semiannually at the HIT Lab. This workshop is attended by industrial partners and professional scientists and engineers from the UW community. Additionally, the HIT Lab is active in international conferences and frequently provides tutorials and exhibits at the SIGCHI and SIGGRAPH conferences. Students (especially doctoral students) are encouraged to present their results in a technical conference during their time at the UW, as well as publish in peer-reviewed journals.

The IE faculty have supported undergraduate research. These faculty/student collaborations are discussed in section 3.1.

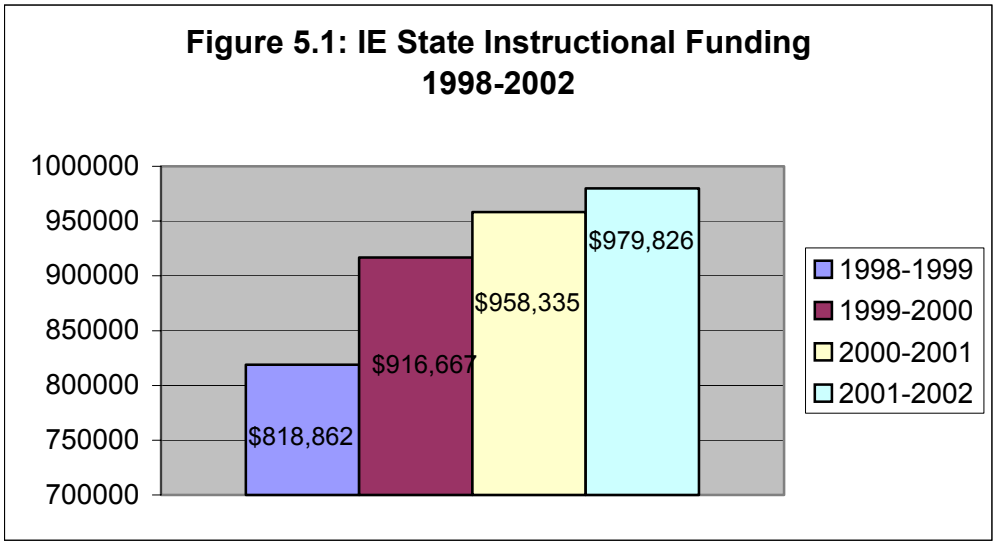
Industrial Engineering is a very diverse field, and consequently IE faculty encourage interdisciplinary research. The IE faculty have collaborated with many other departments on research, in research funding, advising of students and in publications. Departments such as Aeronautics and Astronautics, BioEngineering, Chemical Engineering, Civil and Environmental Engineering, Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering are strongly represented in collaborative research with IE faculty. Also represented are College of Architecture, College of Education, College of Oceans and Fisheries, School of Medicine, School of Public Health, Psychology and Technical Communications.

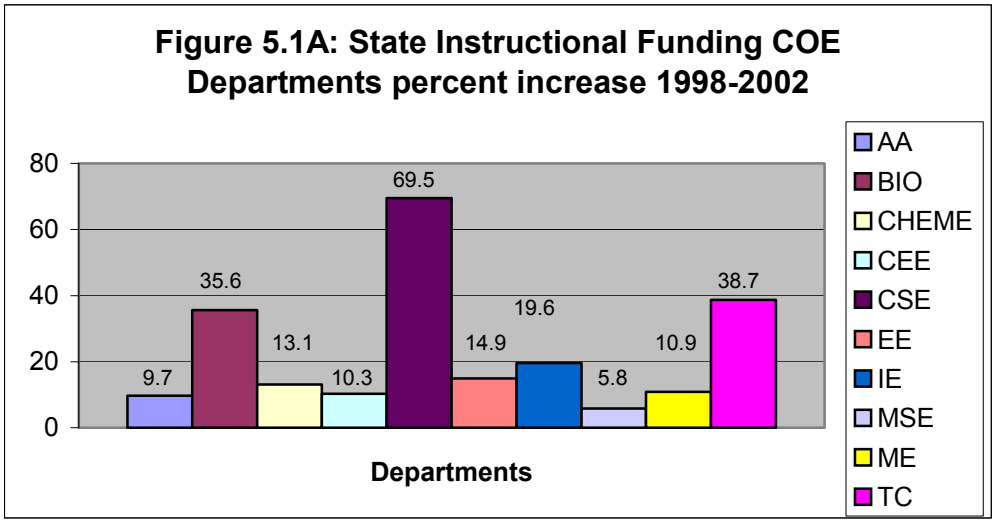
5.0 Resources

Industrial Engineering is funded from state allocations, grant and contract awards, self-sustaining revenue, and gift funds.

Financial Support from the University

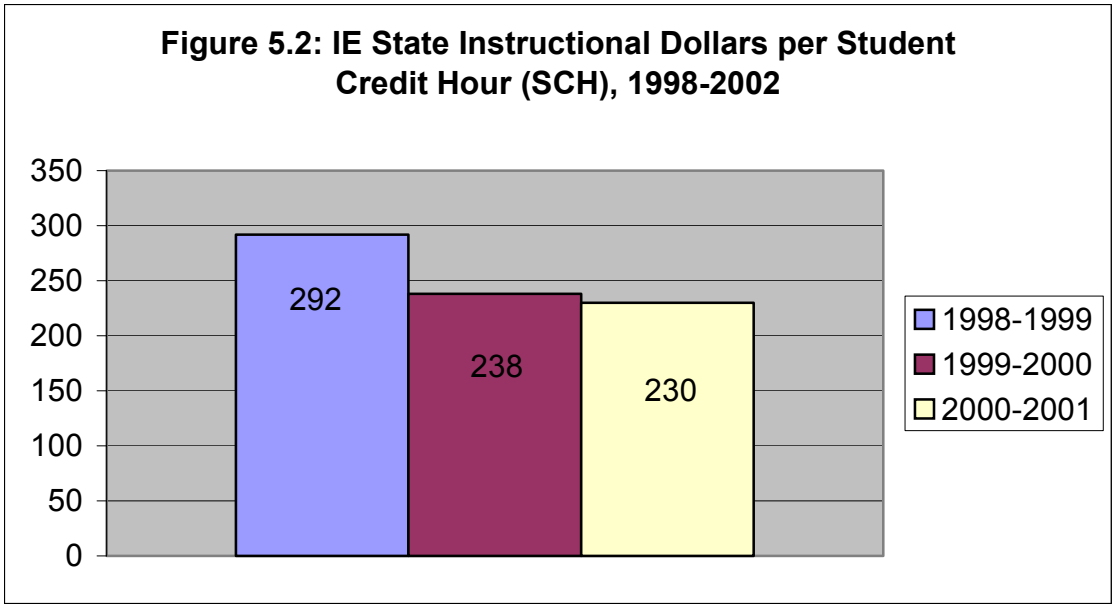
IE receives a state budget allocation each biennium. State instructional funding for IE increased 19.65% from 1998-1999 to 2000-2001 as shown in Figure 5.1.[14] IE's state instructional dollars increased beyond the cost of living adjustments (of 2-4%) due to the awarding of permanent TA positions, which increased the budget by $91,868. Increases by all departments and units in the College of Engineering are shown in Figure 5.1A.



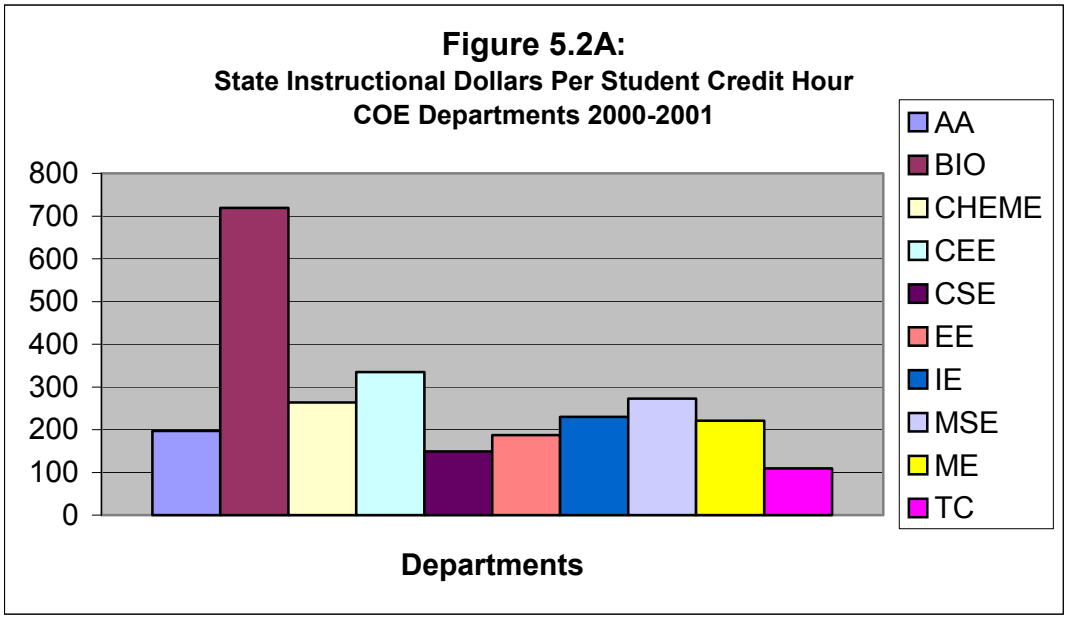


[14] The data in this section comes from the academic profiles of the University Fact Book.

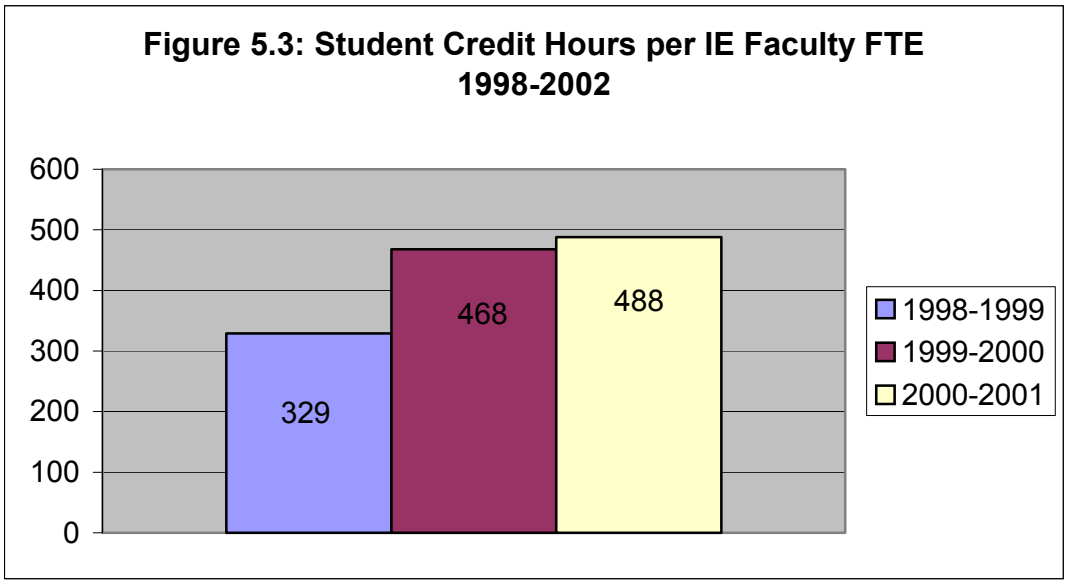
State instructional dollars per Student Credit Hour (SCH) in IE is decreasing as the number of Student Credit Hours taught by the IE faculty continue to increase. State instructional dollars per SCH decreased from $292 in the 1998-1999 school year to $230 for 2000-2001 (see Figure 5.2).



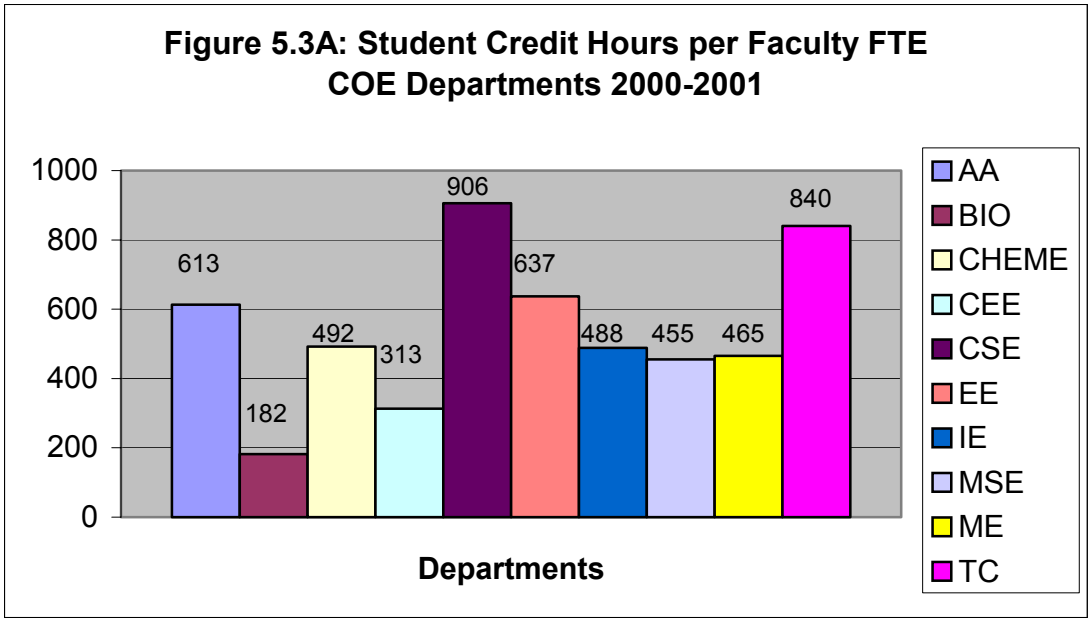
When comparing state instructional dollars per Student Credit Hour to other COE departments, IE falls in the middle at $230 per SCH. These figures were arrived at by dividing state instructional dollars by total SCHs taught (see Figure 5.2A).



Student Credit Hours per IE faculty FTE continue to rise, from 329 student credit hours per faculty FTE in 1998-1999, to 488 Student Credit Hours in 2000-2001 (see Figure 5.3). The result is increased teaching loads for faculty.

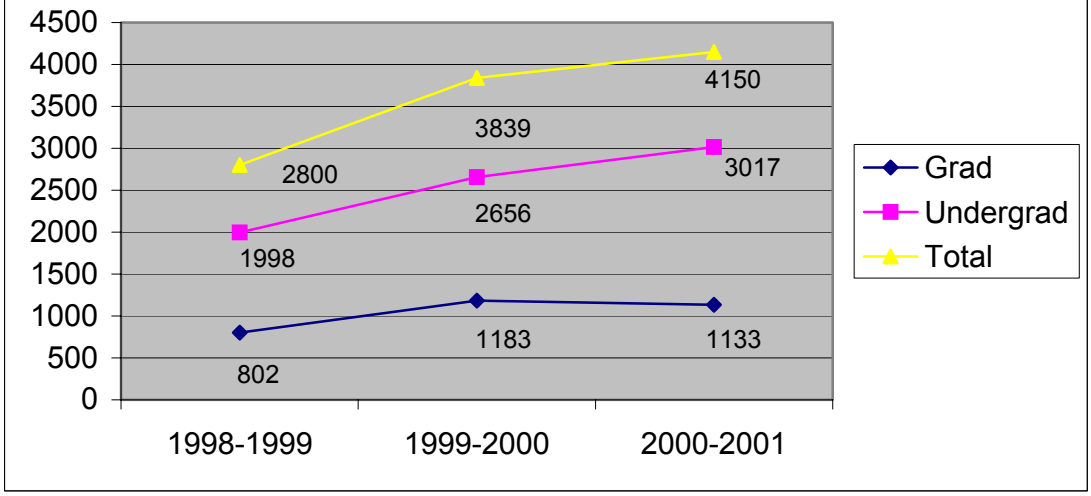


IE falls in the middle of Student Credit Hours per faculty FTE compared to other COE departments (see Figure 5.3A).



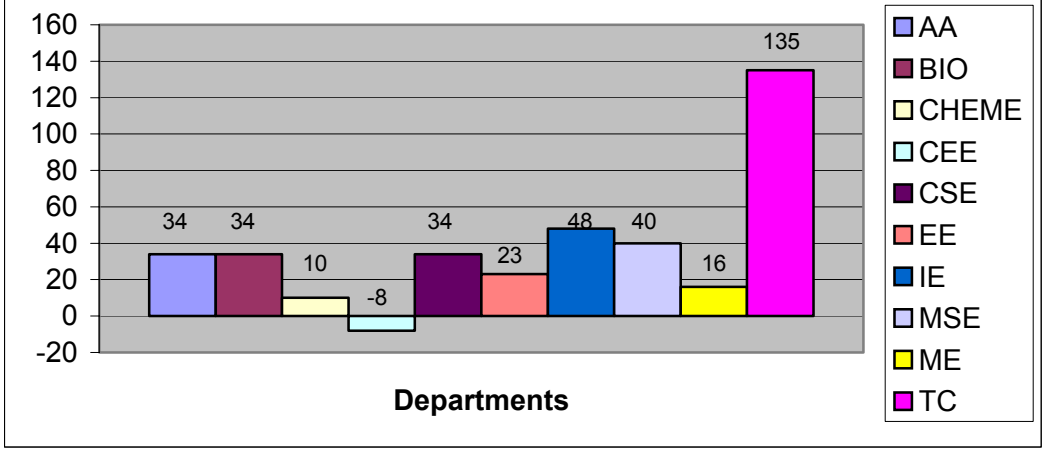
The number of Student Credit Hours taught per year in IE has increased from 2800 in 1998-99 to 4150 in 2000-2001 (see Figure 5.4). The shift of ENGR courses 250 and 315 to INDE courses may account for some of the increase in undergraduate SCHs.

Figure 5.4: IE Student Credit Hours 1998-2002



The percentage of increase in Student Credit Hours per faculty FTE within COE departments is shown in Figure 5.4A.

Figure 5.4A: Percentage of SCH Increase 1998-2002



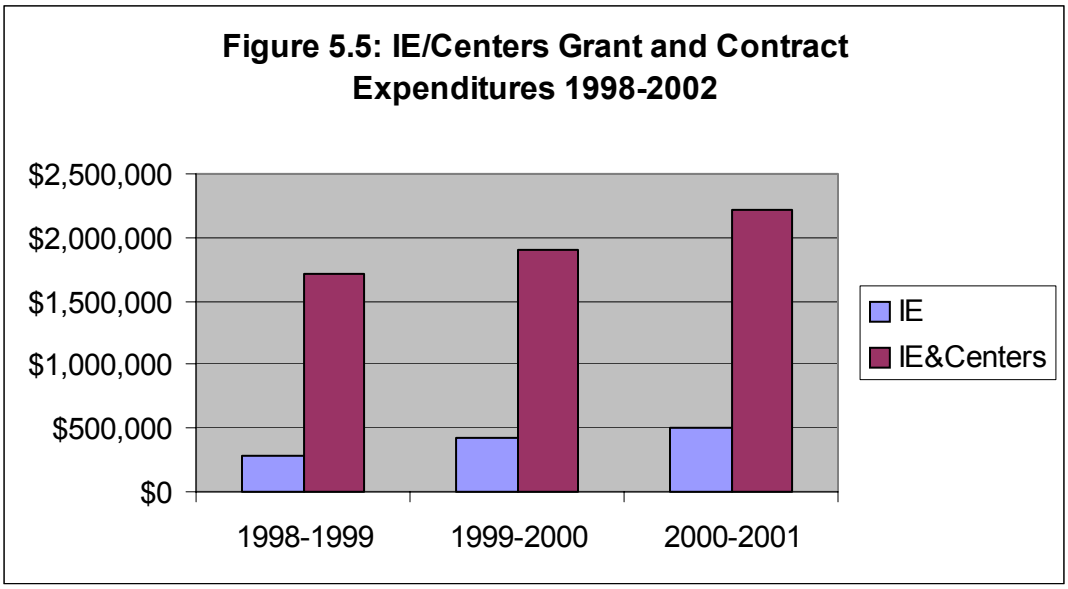
Budget Reductions

As with other departments, IE has sustained budget reductions due to State mandated cuts and seed money for the University Initiatives Fund. A challenge for IE has been to creatively take advantage of opportunities to garner additional resources.

Grant and Contract Awards

The University Fact Book provides a common framework to explore the similarities and differences between units and departments. However, the Fact Book is limiting in reflecting a true picture of departments.

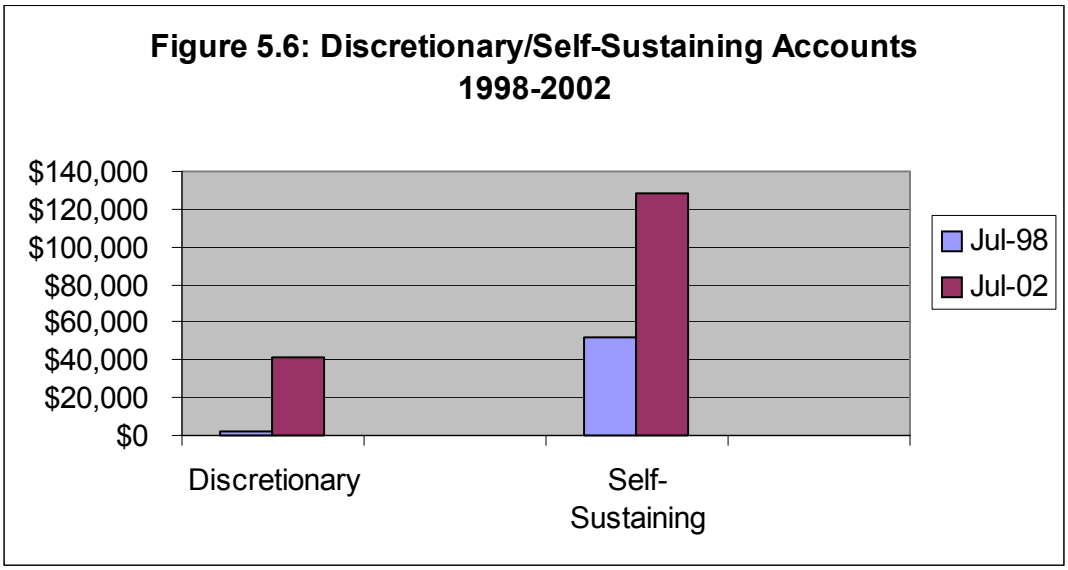
Although IE grant and contract expenditures continue to increase each year, the two COE centers in which IE faculty serve as directors have their own organizational codes. Therefore, grant and contract awards to the Human Interface Technology Lab (averaging $1.7 million per year since 1998) and the Center for Engineering Learning and Teaching (just awarded a $10 million NSF grant) are not reflected in IE's total. Including these figures provides a more accurate picture of IE faculty productivity.



The creation of independent centers may be a creative model to garner additional resources since state funds are not sufficient to achieve IE's goals. The IE faculty is discussing the establishment of a Logistics Center.

Gifts and Self-Sustaining

Faculty have sought out opportunities to increase IE's gift and self-sustaining dollars. Gifts from companies and private donors have increased. Faculty have participated in programs such as Education at a Distance for Growth and Excellence (EDGE) to secure additional self-sustaining dollars. See Figure 5.6.



Assistantships

The number of assistantship opportunities in IE has increased. In Autumn 1998 IE was able to offer 3 teaching assistantships and 8 research assistantships. In Autumn 2002 that number increased to 7 teaching assistantships and 13 research assistantships.

Equipment and Facilities

IE wrote a successful Minor Modifications proposal and received $100,000 from the College to remodel existing space in 1999. A new undergraduate computing lab was established. The large size of a new room (EGA 153) and an increase in temporary money during the biennium allowed IE to retire the eight outdated computers that comprised the undergraduate lab and purchase 18 new ones running NT and networked to a laser printer.

The former undergraduate lab, MEB 106, was transformed into a meeting area for TAs and students. TAs can meet with up to four students in cubicles for office hours or computer demonstrations, and in larger groups at a conference table with white board. The goal is to create a more interactive area for TAs to work with students.

The Manufacturing Research Laboratory and graduate computer lab are in MEB, room B14, which now houses 23 cubicles for research and teaching assistants, as well as 16 computers, a Mac and scanner all networked to a laser printer.

Just completed is a new IE Student Resource Center, MEB 105, a community space for undergraduate and graduate students to work on joint projects.

New Initiatives

In an era of declining state support, IE has been entrepreneurial in seeking additional resources and reducing costs through strategic financial planning. IE endeavors to maximize success with the resources available and secure new resources. The College of Engineering has been supportive as evidenced by the following:

- A 1999 proposal for permanent teaching assistants was received favorably by the College and four new positions were allocated at $91,868 per biennium.

- A Minor Modifications proposal to the College to consolidate, remodel and equip new and existing student computer facilities garnered $100,000 in 1999.

- A successful computer support proposal of $75,000 gave IE the ability to hire permanent computer support staff and upgrade student computer facilities in 2000.

- The College has provided start-up packages for new faculty.

- A proposal to the University's Graduate School for recruitment support increased IE's allocation by 40% for 2001-02, giving IE $21,098 and an advantage in recruiting outstanding TA and RA candidates.

6.0 Planning for the Future

Industrial Engineering at the University of Washington is working towards the goal of achieving national and international prominence in IE education and research. IE has been maintaining quality fundamentals in education and research, while strategically expanding research and technical electives consistent with the size of the faculty.

This program review and self-study has presented an opportunity to reflect on our strengths and challenges, summarized here.

Strengths:

1. Diverse collegial faculty with international reputations.
2. Solid undergraduate program providing a set of fundamentals in IE.
3. Respected graduate program with talented students and close to target in size.
4. Internationally recognized centers.
5. Connections with local industry.
6. Strong sense of IE identity and community among graduate and undergraduate students.

Challenges:

1. Increase visibility of IE at the Univ. of Washington and regionally.
2. Increase the quality and quantity of undergraduate students.
3. Increase research funding.
4. Seek alternatives to increase faculty size.

Discussions on strategic actions and priorities are on-going to address our challenges. As an example of one step is the introduction of a new INDE 101 course, to aid in increasing visibility as well as attracting quality undergraduate students. The IE faculty is also pursuing multi-disciplinary research projects to increase funding of research and graduate students. A possibility is to create a Center which would include IE-specific research interests, as well as multi-disciplinary interests. We are also pursuing several educational initiatives to assist with a self-sustaining budget as well as increasing the student population. Development of certification and professional programs is underway. During the 1998-1999 strategic planning period, a short-term (5 year) action plan was established with nine categories. While we have accomplished steps in all of the areas (see Appendix I.9), many of these issues are on-going. The nine areas are summarized here:

1. Improve the undergraduate program.
2. Improve the graduate program.
3. Attract a steady stream of high caliber students.
4. Improve the teaching skills of the faculty.
5. Strengthen research as a department.
6. Continue to integrate research and teaching.
7. Secure a stable, predictable and adequate budget.
8. Increase faculty size and develop faculty strengths.
9. Attain departmental status.

As a community of faculty, staff, and students, we are actively working on all of these areas. The IE faculty are conscious of building a departmental culture that includes a respectful team approach, interdisciplinary views, and high quality education and research.

To conclude this self-study, the IE faculty feel that we are making tremendous progress in all aspects of our educational and research mission. The program review process provides us an excellent opportunity to obtain suggestions from a wide audience of internal and external sources. We look forward to the suggestions of all who read this document.