## New Degree Program Proposal for
## a Bachelor of Science in Computer Engineering and Systems (UW Tacoma)

# I. Relationship to Institutional Role, Mission, Program Priorities

The mission of UWT is to serve the educational needs of students in the South Puget Sound region; the Institute of Technology is more particularly charged with addressing the needs of students in the South Sound in the area of technology and more specifically computer science. While the existing programs in Computing and Software Systems (the Bachelor of Science and the recently approved Bachelor of Arts) address these needs for part of the student population and local economy, there continues to be demand for more technical and specialized training in computing. Programs in computer science usually offer a variety of "flavors" of degrees, ranging from generalist to more and more specialized. As the Institution has grown, the need for a Computer Engineering and Systems, CES, degree program that will be accredited by ABET is both a priority for the program and a demand of community.

Compared to the program in Computing and Software Systems, the proposed BS in Computing Engineering and Systems will require 35 additional units of lower division prerequisites. Of the 90 units required for juniors and seniors, 45 will come from the existing CSS curriculum. The remaining 45 units will include new engineering courses and 10 units of electives that could include other CSS courses. As part of their program, seniors will be required to take 10 units of senior design project. The result will be a program tailored to train students in computer engineering and design, with a concentration in digital and real-time systems. The program will build on the existing CSS program but add an engineering component that does not currently exist.

The fall quarter, 2006 marks a new beginning for undergraduate education at the University of Washington, Tacoma. This will be the first time that freshmen are admitted to the University. When freshmen are admitted to the engineering program they will required to take 90 units of lower division preparation courses to prepare themselves for the intensive upper division courses that make up the CES degree program. With the addition of lower division courses at UWT, it will be easier for transfer students who have not met all the prerequisites for the program, but are otherwise qualified for admission, to be admitted and complete their lower division classes in conjunction with taking some of the junior level classes.

# II. Need for the Program

### A. Demand for the program

Engineering education has been a State of Washington priority for UWT since its beginning. In 1988 the HEC Board recommended the creation of branch campuses of UW and WSU to expand both access to 4-year degree programs and the potential for economic development. It proposed development of baccalaureate and master's programs in the liberal arts and professional fields to the legislature. The HEC Board recommendations were adopted without modification when the legislation to create the campus was passed in 1989. The following is an exhibit from that HEC Board recommendation:

*Exhibit 8*
**HECB Recommends Branches Focus**
**on Liberal Arts and Applied Degrees**

| Baccalaureate Degrees | Master's Degrees |
|---|---|
| Business | Business |
| Computer Science | Computer Science |
| Engineering | Engineering |
| Arts & Letters | Arts & Letters |
| Nursing | Education |
| Sciences | Health |
| Social Sciences | Social Sciences |

*Source: HECB, Design for the 21st Century (1988), p. 16*

Also in 1988, the UW independently conducted studies to determine what degree programs should be offered at each of the branch campuses. Based on surveys of prospective employers and students in the Puget Sound Region, the UW report displayed the following table of projected program enrollments for the Tacoma campus:

| **Baccalaureate programs:** |
|---|
| Arts and Sciences (over half of anticipated enrollments), |
| Business (growing to about 20 percent), |
| Engineering (growing to about 12 percent), and |
| Nursing (about 2 percent) |
| **Applied Master's programs:** |
| Engineering (one-fourth of graduate enrollments), |
| Business (about 20 percent), |
| Nursing (about 12 percent), and |
| Teaching (roughly 33 percent). |

*Source: UW Report on Degree program Projections for the proposed Branch Campuses (1988)*

In 1999, the AeA Washington Council Higher Education Task Force performed extensive fact-finding efforts in participation with state government, legislators, public and private college university presidents and administrators, and industry groups. In October of 1999 it released a report entitled <u>The High Technology Industry, State Government and Higher Education Teaming to Build the Workforce of the Future</u>. This report concluded that anecdotal and statistical evidence indicates a technical workforce shortage is pervasive throughout the high technology industry, including most engineering, computer science, and information systems fields. It estimated there is one qualified person available for every eight computer science and engineering positions requiring a four-year degree. The report stated that there was strong support for the creation of an Institute of Technology to provide a single focal point for developing technology degree programs, providing much needed state-of-the-art laboratory resources, research partnerships with industry, and a critical mass of top-flight talent. It also stated that financial resources exist in industry to develop and fund such an institution in partnership with state government.

In 2000, Governor Locke championed the Institute of Technology concept for increasing the baccalaureate and master's level education of computing and engineering professionals, and providing exceptional career opportunities for Washington citizens, especially women and underrepresented groups. The WSA, the AeA, the UW, the Executive Council for a Greater Tacoma, Intel and other South Sound industries joined the governor's office in encouraging the legislature to create the Institute of Technology and locate it at UWT. They helped raise sufficient initial private funding to partner with the state. In 2001 the legislature created the Institute of Technology at UWT and charged it to expand its Computing and Software Systems program and follow that with additional programs.

Computer Engineering being the one most discussed. In a WSA report, Findings of the 2000-2001 Workforce Study, it was stated that the demand for significantly more baccalaureate and masters level professionals in the computer science, engineering, and information fields was critical. The Governor's office plan proposed augmented funding for beginning an engineering program in 2003, but the State's economic situation made that unrealistic. In a WSA report, Findings of the 2003-2004 Workforce Study, it was confirmed that the demand for significantly more baccalaureate and master's professionals in the computer science and engineering fields still existed, and the need for continued growth of educational capacity was re-emphasized.

The Institute of Technology has now graduated approximately 200 BS and MS degreed professionals in Computing and Software Systems. They are employed by many of the leading companies in the Puget Sound, including Microsoft, Intel, and Boeing. The Tacoma-Pierce Country Economic Development Board now views the Institute as a key resource for economic development. The report of a research study the Board commissioned from DCG Corplan Consulting LLC in 2004, Strategy for Leveraging the UWT Institute of Technology to Recruit and Retain Technology Firms in Tacoma-Pierce County, emphasized the importance of the UWT Institute of Technology in developing its strategy for economic development and in creating high paying and rewarding jobs for the residents of Pierce County and South Puget Sound. The Executive Council for a Greater Tacoma is presently exploring strategies to encourage more students to prepare for Institute degree programs, and the Economic Development Board has offered to fund some of that research.

Besides increasing the number of students in its BS in Computing & Software Systems program, the Institute has made progress in expanding its programs through the creation of a BA program in Computing and Software Systems that provides expertise in computer applications and requires a minor in an area of application. The Institute also created a minor in Computing and Software Systems to create strength in applying computers in other professions. The Institute is encouraging the Milgard School of Business to create complementary programs to better serve needs in the Institute and in the School of Business.

During the past several years the Institute has been building both faculty and facilities in anticipation of the creation of engineering degrees. It has reached a point where it is now feasible to launch a BS degree in Computer Engineering & Systems. The Institute's Board of Advisors has encouraged the creation a five-year program in which a student could earn both a BS and an MS in Computer Engineering & Systems. Intel, one of the key industries in the South Sound, and the first contributor to the creation of the Institute of Technology, has been encouraging the Institute to offer an MS program in an Electrical Engineering area, such as Computer Engineering & Systems. Intel has requested a list of equipment needs to which it could make contributions.

Implicit in all this outreach from industry is that demand for students educated in computer science remains high: the Washington State Job Vacancy Survey for April/May, conducted by the Washington State Employment Security Department[1] reports job vacancies of 5,491 for the "Computer and Mathematical" occupation group in April/May 2005, up from 4,080 in October 1994 and 3,840 in May 2004. Computer Software Engineer was listed as the second "top job in demand," trailing only Registered Nurses. Both the need for more graduates trained in this area and the availability of jobs to those so trained is confirmed by the HECB's own State and Regional Needs Assessment which states that "current degree production only meets 67 percent of the need in engineering, software

[1] http://www.workforceexplorer.com/admin/uploadedPublications/5159_JVSApr-May_05.pdf

engineering, and architecture and 56 percent of the need in computer science."[2] Locally, for Pierce County, the report notes that the second-largest county (with 1/10 of the state's population) in the state is gradually shifting from a manufacturing economy to a service economy. The study, while not singling out computer science or information technology as an area of growth for the region, states that "Local planners and stakeholders are focusing strategic planning efforts on attracting high-technology firms."[3] A key part of this strategy will be having a local source for training potential employees in such firms, and the BS in Computing and Engineering Systems answers that need.

There is presently limited opportunity to realize an engineering education in Washington and especially in the South Sound. Too many of those who may desire to consider pursuing on engineering career are forced to select among their only three choices: an out-of-the-region university, an out-of-the-state university, or no engineering education. For the significant number of place-bound students, no engineering education is the only option. If this state is to realize its desire to be a leader in technology and innovation, it must grease the career paths for it youth, not create roadblocks nor send its talented youth elsewhere to realize their careers.

Tacoma is on the threshold of becoming a four-year campus. It is presently accepting applications for its inaugural freshman class. Approximately 15% of the inaugural freshman class has indicated an intention of studying in the Institute of Technology. If engineering is approved for the campus, that number can be expected to rise consistently over the next few years. There are many place-bound students in the region that are ideally suited to pursue an engineering career. In addition, transfer applications for the Institute this year are up 100% over last year! This is significant and important. These numbers attest to a strong demand for computer science and engineering types of programs in the South Sound, and demonstrate a demand that needs to be supported. The preponderance of community college pre-engineering programs are located in the populace areas of Western Washington. Their enrollments are presently limited only by the lack of four-year university options for their graduates. The staff of the State Board for Community and Technical Colleges shares the view that with an additional four-year engineering option, these programs can grow, and in time thrive.

Clearly it is in the interests of the State to produce more engineers and create an internationally competitive technological and innovative workforce. It is also in the best interests of Washington's citizens to have the opportunity to compete for some of Washington's most challenging and rewarding careers. The demand for this program exists now, and with its existence, the demand can be expected to increase.

In addition to the demand, it is expected that soon after the CES program produces its first graduates, there will be a need for an advanced degree in the field of Computer Engineering and Systems. Program reviewers and industry leaders have stated that for many companies, the preferred degree for new college hires is the master's degree. The Institute does have plans to add the MS program when it is felt that there is sufficient demand.

**B. Support of the Statewide Strategic Master Plan for Higher Education**

---

[2] (October 2005) State and Regional Needs Assessment Report, Higher Education Coordinating Board, 28. Available at www.hecb.wa.gov.

[3] (October 2005) State and Regional Needs Assessment Report, Higher Education Coordinating Board, 71. Available at www.hecb.wa.gov.

The HECB Strategic Master Plan has two goals: providing more opportunities for degrees and helping the state's economy. The proposal for a BS in Computing Engineering and Systems clearly meets both goals. Adding an additional degree program to the offerings of the Institution of Technology will provide students in Tacoma another choice in computer science education. While we initially do not intend the addition of this degree program to increase the absolute number of graduates from the Institute, we do expect the program to attract more students. Also, since the program will specifically help with the third strategy of the Strategic Master Plan of increasing the number of degrees in high-demand fields, and the UW is in agreement with this strategy, it is likely that funding will be increased for the Institute in general and the BS in CES in particular. One of the reasons that programs in computer engineering and systems engineering are high-demand is that they result in immediate benefits for the economy, both because graduates are ready to go into high-technology professions and because this industry creates jobs in its wake. The BS in CES is also a preliminary and necessary step in the development of an MS in Computing and Engineering Systems, thus providing the groundwork for both growth in opportunities for degrees and help for the economy.

## III. Relationship to Other Institutions

Despite the importance of computing to Washington and its economy, presently there are only three universities in Washington that offer ABET[4] accredited BS in Computer Engineering programs.[5 & 6] They are:

- The University of Washington (Seattle campus)
- Washington State University (Pullman campus)
- Gonzaga University (Spokane)

None of these are readily accessible to residents of the South Sound. This continues to adversely impact the ability of the South Sound to be competitive in the present and future economy. In addition to these three engineering programs, DeVry (Federal Way) offers a degree in Computer Engineering Technology.

The UW Seattle program is highly selective, and neither relocation nor commuting is a feasible option for many. DeVry does offer an accredited Computer Engineering Technology program in Federal Way, but technology programs have different curricula and focus on very different career paths than engineers. Engineers are prepared to design systems and technologists to install, maintain, and repair them.

The proposed Computer Engineering & Systems Program is not a duplication of existing programs. The goal of this program is to specifically serve the South Sound community, its industry, and its people, and to serve as a catalyst for innovation and technological growth. This program will produce systems oriented computer engineering professionals who can leverage both hardware and software experience to design optimal engineering solutions. Students will gain hands-on experience in state-

[4] ABET is the recognized U.S. accreditor of college and university programs in applied science, computing, engineering, and technology.

[5] Washington State University offers engineering programs on its Tri-Cities and Vancouver campuses, but Computer Engineering is only available in Pullman.

[6] Seattle University offers a computer engineering specialty in its accredited Electrical Engineering program, and Pacific Lutheran University and Seattle Pacific University offer unaccredited computer engineering programs.

of-the art laboratories and use state-of-the-art hardware and software tools. The Computer Engineering & Systems Program will produce graduates able to:

- apply knowledge of mathematics, science, and engineering to identify, formulate, and solve computer engineering problems;
- use hardware and software tools to analyze, design, develop and test computer-based systems containing both hardware and software components;
- achieve success in graduate programs in computer engineering or a related field;
- continue to develop their knowledge and skills after graduation in order to succeed personally and contribute to society;
- work effectively as a member of a multi-disciplinary development team and undertake leadership roles when appropriate;
- communicate their ideas, both in written and oral forms, so that others can use and build on their work;
- appreciate the importance of ethics in the profession and the need to act in society's best interest.

The Computer Engineering & Systems Program is being designed to inherently incorporate the new ABET 2000 Outcomes Assessment principles. The Computer Engineering & Systems Program will provide unique new opportunities for south sound students and employed residents to prepare and compete for challenging and rewarding positions in Washington's growing computer industry, and it will provide a south sound pool of computer professionals to grow present industry and attract new industry to Washington. The program builds upon the new "Statewide Engineering AS-T Track 2 Major Pathways (MRP) Agreement" to ensure that the program will articulate well with all of the state's Community and Technical Colleges' pre-engineering programs.

Below is a list of the State's Accredited Engineering and Technology programs.

## Accredited Computer Engineering Programs in Washington

**University of Washington** Seattle, WA

Aeronautical and Astronautical Engineering BS [1936]
Chemical Engineering BS [1936]
Civil Engineering BS [1936]
**Computer Engineering BS [1988]**
Electrical Engineering BS [1936]
Forest Engineering BS [1996]
Industrial Engineering BS [1986]
Material Science and Engineering BS [1936]
Mechanical Engineering BS [1936]
Paper Science and Engineering BSForRes [2002]

**Washington State University** Pullman, WA

Biological Systems Engineering BS [1996]
Chemical Engineering BS [1951]
Civil Engineering BS [1936]

**Computer Engineering BS [2002]**
Electrical Engineering BS [1936]
Manufacturing Engineering BS [2002]
Materials Science and Engineering BS [1936]
Mechanical Engineering BS [1936]

**Gonzaga University** Spokane, WA
Civil Engineering BS [1985]
**Computer Engineering BS [2003]**
Electrical Engineering BS [1985]
Mechanical Engineering BS [1985]

## Other Accredited Engineering Programs in Washington

**Seattle University** Seattle, WA
Civil Engineering BSCE [1985]
Electrical Engineering BSEE [1962]
Mechanical Engineering BSME [1962]

**Seattle Pacific University** Seattle, WA
Electrical Engineering BS [1989]
** Note: Offers a BS in Computer Engineering that is not accredited*

**Saint Martin's University** Lacey, WA
Civil Engineering BSCE [1969]
Mechanical Engineering BSME [1994]

**Henry Cogswell College** Everett, WA
Electrical Engineering BS [1994]
Mechanical Engineering BS [2002]

**Walla Walla College** College Place, WA
Engineering BS [1971]

## Accredited Technology Programs in Washington

**Eastern Washington University** Cheney, WA
**Computer Engineering Technology BS [1991]**
Mechanical Engineering Technology BS [1991]

**DeVry University, Federal Way** Federal Way, WA
**Computer Engineering Technology (WA Campus) BS [2005]**
Electronic(s) Engineering Technology (WA Campus) BS [2005]

**Western Washington University** Bellingham, WA
Electronic(s) Engineering Technology BS [1989]
Manufacturing Engineering Technology BS [1989]
Plastics Engineering Technology BS [2001]

## IV. Program description and Curriculum

### BS Degree in Computer Engineering and Systems

**Program Mission**

The Computer Engineering and Systems Program will educate each student to be a responsible and productive computer engineer who can effectively apply emerging technologies to meet future challenges.

**Program Objective**

The objective of the Computer Engineering and Systems Program is to produce graduates able to:

- apply knowledge of mathematics, science, and engineering to identify, formulate, and solve computer engineering problems;
- use hardware and software tools to analyze, design, develop and test computer-based systems containing both hardware and software components;
- achieve success in graduate programs in computer engineering or a related field;
- continue to develop their knowledge and skills after graduation in order to succeed personally and contribute to society;
- work effectively as a member of a multi-disciplinary development team and undertake leadership roles when appropriate;
- communicate their ideas, both in written and oral forms, so that others can use and build on their work;
- appreciate the importance of ethics in the profession and the need to act in society's best interest.

**Curriculum**

The curriculum was designed with the strategies of:

- minimizing the number of new courses that will need to be offered;
- sharing curricula with the BS in CSS, particularly in the junior year, to allow students a better opportunity to explore their choice of degree;
- using CSS concentration courses to serve as part of the required CES curriculum;
- running the CES program in a cohort model to allow the program to be cost effectively launched with a minimum of 20 students;
- organizing the new courses so as to be able to use local expertise to initially expand the faculty;
- leveraging CSS laboratories located in Cherry Parks to minimize the new facility costs.

The resultant curriculum is as follows:

- Computer Science Fundamentals
  - TCSS 305 Programming Practicum
  - TCSS 342 Data Structures
- Electrical Engineering Fundamentals
  - TCES 215 Electrical Circuits *(new course)*
  - TCES 312 Electronics & Analog Systems *(new course)*
- Computer Systems

- TCSS 371 Machine Organization
  - TCSS 372 Computer Architecture
  - TCSS 422 Computer Operating Systems
- Math / Theory
  - TCSS 321 Discrete Structures I
  - TCES 323 Linear Systems and Transforms *(new course)*
  - TCES 450 Probability and Statistics with Numerical Methods *(new course)*
- "Soft Skills"
  - TCSS 360 Software Development and Quality Assurance Techniques
  - TCSS 325 Computers, Ethics, and Society
- Computer Engineering
  - TCES 230 Introduction to Logic Design *(new course)*
  - TCES 413 Advanced Digital System Design *(new course)*
  - TCSS 465 Embedded Real-Time Systems
  - TCES 480 Senior Design Project I *(new course)*
  - TCES 481 Senior Design Project II *(new course)*
- Breadth Electives
  - 10 Credits (May include 5 credit-hours of Internship)

Rigorous engineering programs typically have few elective choices or else require more than 180 hours. This curriculum is particularly tight since it includes core courses in both computer science and electrical engineering. Most of the elective choices are in the lower division humanities and social sciences.

## Description of New Courses

Although the Computer Engineering & Systems curriculum is built primarily on existing UWT courses, there are eight required engineering courses that are not presently offered.

**TCES 215 - Electrical Circuits**
*5 Credits / Prerequisites: Physics II, Calculus II*
Introduction to electrical engineering. Basic circuit and systems concepts. Power and Energy. Mathematical models of components. Kirchoff's laws. Resistors, sources, capacitors, inductors, and operational amplifiers. Solution of first and second order linear differential equations associated with basic circuit forms. Analysis of circuits with sinusoidal signals. Laboratory Required.

**TCES 230 – Introduction to Logic Design**
*5 Credits / Prerequisites: Intro to Programming, Physics II*
Boolean algebra and logic simplification techniques. Design of combinational logic networks for decoders, encoders, multiplexers, and demultiplexers. Design of sequential logic devices including flip-flops, registers, and counters. Analysis of devices used to build logic networks, including open-collector, three-state devices, CMOS, and programmable logic devices. Use of tools for schematic capture and circuit simulations. Introduction to state machines. Laboratory required.

**TCES 312 – Electronics & Analog Systems**
*5 Credits / Prerequisites: TCES 215, Differential Equations*
Electronic devices, semiconductors, bipolar devices, amplifiers, analog circuits, analog/digital conversions, filters, noise, operational Amplifiers, signal shaping, discrete feedback amplifiers, and frequency analysis and response. Laboratory required.

**TCES 323 –Linear Systems & Transforms**
*5 Credits / Prerequisites: TCES 312*
Circuit analysis techniques for networks with both independent and dependent sources. Network topology. Natural and forced response for RLC circuits. Complex frequency, poles and zeros. Introduction to Fourier series, Fourier, Laplace and z-transforms. Introduction to the discrete Fourier Transform and the Fast Fourier Transform (FFT) algorithm.

**TCES 413 – Advanced Digital System Design – 5 Credit hours**
*5 Credits / TCSS 372, TCES 312*
Design techniques using combinational and sequential logic synthesis and optimization, state machines, discrete components, gates, LSI, and programmable logic, interfacing, memory systems, digital communication including serial/parallel & synchronous/asynchronous architectures, hardware description languages, and hardware simulators. Emphasis on reconfigurable logic for design and implementation. Automated development systems and procedures are used throughout design. Laboratory required.

**TCES 450 - Probability and Statistics with Numerical Methods– 5 Credit hours**
*5 Credits / Differential Equations, Discrete Structures I*
Basic concepts of probability and statistics with emphasis on models used in science and engineering. Probability models for statistical estimation and hypothesis testing. Confidence limits. One- and two-sample inference, simple regression. Least squares solutions to data fitting problems, and numerical solution techniques applicable to large-scale engineering/science problems.

**TCES 480 – System Design Project I**
*5 credits / Prerequisites TCES 413, Corequisites: TCSS 465*
Under faculty supervision, each student or team prepares a plan for a senior design project. This plan includes project definition, project requirements, preliminary design, and work schedule. Requirements and design shall address human factors, safety, reliability, maintainability, and customer cost. Oral and written reports are required. This course has a significant writing component.

**TCES 481 – System Design Project II**
*5 credits / Prerequisites: TCES 480*
Continuation of TCES 490, students construct, test, and demonstrate their senior design projects. Formal oral and written reports documenting the project are required. This course has a significant writing component.

**TCES 4XX – Electives**
*5 credits / Prerequisites: as needed*
Electives will be added to the curriculum as needed. Two courses that have been suggested are: data communications and robotic system design.

External reviewers of this program in addition to IAB reviewers have pointed out the importance of making sure graduates have good communication skills. That is why both of the senior design classes require significant writing and presentation components. Although students are required to take 10 units of English composition as freshmen and sophomores, engineers need additional training in technical communications. The senior design project is meant to give engineering students practice in both written and oral communication that will prepare them work in industry and to pursue graduate studies in a technical field.

It should be noted that some of the new courses may be attractive as electives for students in other programs. In particular, TCES 230, Introduction to Logic Design, and TCES 450, Probability and Statistics with Numerical Methods, could reasonably be taken by students in other science fields.

**Comparison of Institute Baccalaureate Degree Programs and Sample Schedule**

The following chart provides a comparison of the BS in CES with the BS in CSS and the BA in CSS. The CES program does require that students take 3 quarters of Calculus for Engineers/Scientists and 3 quarters of Calculus Based Physics, rather that the one quarter of each required for CSS.
The second chart is a recommended four-year schedule for students entering the program as freshmen. It uses the present scheduling of existing courses, and proposes times for the new courses. The program is designed for full time students, but efforts will be made to allow part-time students to make continual progress toward the degree. It should be emphasized that whereas this schedule utilizes existing offerings, the extra demand that this curriculum imposes will require scheduling additional sections in some cases.

**Comparison of Institute Baccalaureate Degree Programs**

| | | BS in Computing & Software Systems | BA in Computing & Software Systems | BS in Computer Engineering & Systems |
|---|---|---|---|---|
| Lower Division: | Program | English Composition (10 hrs) | | (10 hrs) |
| (90 hrs) | Prerequisites: | Humanities (10 hrs) | | (10 hrs) |
| | | Social Sciences (10 hrs) | | (10 hrs) |
| | | Calculus for Engr/Sci (5 hrs) | | (15 hrs) |
| | | Statistics (5 hrs) | | |
| | | Calculus based Physics (5 hrs) | | (15 hrs) |
| | | Object Oriented Comp Prog (10 hrs) | | (10 hrs) |
| | | | | Chemistry or Biology (5 hrs) |
| | | | | Linear Algebra (5 hrs) |
| | | | | Differential Equations (5 hrs) |
| | | | | 215 Electrical Circuits (5 hrs) |
| | Electives: | (35 hrs) | | (0 hrs) |
| Major Core: | Fundamentals: | 305 Programming Practicum | 305 Programming Practicum | 305 Programming Practicum |
| | | 342 Data Structures | 342 Data Structures | 342 Data Structures |
| | Systems: | 371 Machine Organization | 371 Machine Organization | 371 Machine Organization |
| | | 372 Computer Architecture | | 372 Computer Architecture |
| | | 422 Computer Operating Systems | | 422 Computer Operating Systems |
| | Math / Theory: | 321 Discrete Structures I | 321 Discrete Structures I | 321 Discrete Structures I |
| | | 322 Discrete Structures II | | 323 Linear Sys & Transforms |
| Technical | | 343 Design & Analysis of Algorithms | | 450 Prob, Stats, with Num. Methods |
| | "Soft Skills": | 360 Software Dev & QA Techniques | 360 Software Dev & QA Techniques | 360 Software Dev & QA Techniques |
| | | 325 Computers, Ethics, & Society | 325 Computers, Ethics, & Society | 325 Computers, Ethics, & Society |
| | Engineering: | | | 230 Intro to Logic Design |
| | | | | 312 Electronics & Analog Systems |
| | | | | 413 Advanced Digital System Design |
| | | | | 480 Senior Design Project I |
| | | | | 481 Senior Design Project II |
| Concentration: | Major Electives | 5 CSS Courses in BS list | 4 CSS Courses in BS/BA list | 465 Embedded Real-Time Systems |
| | Requirements: | (2 Max from Intern, Indep Study) | (2 Max from Intern, Indep Study) | |
| Breadth: | Free Electives and/ or Minor: | 15 hrs Electives | 20-30 hrs Formal Minor | 10 hrs Electives |
| | | | 10-20 hrs Electives | (May include 5 hrs of Internship) |

| FRESHMAN YEAR | | | | |
|---|---|---|---|---|
| Course No. | Title | Fall | | |
| | Calculus I *(MTH 124)* | 5 | | |
| | English Composition I | 5 | | |
| | Social Science | 5 | | |
| | | | | |
| | | | Winter | |
| | Calculus II *(MTH 125)* | | 5 | |
| | Physics I *(PHY 121)* | | 5 | |
| | English Composition II or Tech writing | | 5 | |
| | | | | |
| | | | | Spring |
| | Calculus III *(MTH 126)* | | | 5 |
| | Physics II *(PHY122)* | | | 5 |
| | Humanities | | | 5 |
| | | | | |
| | **TOTAL UNITS** | **15** | **15** | **15** |

| SOPHOMORE YEAR | | | | |
|---|---|---|---|---|
| Course No. | Title | Fall | | |
| | Differential Equations | 5 | | |
| TCSS 142 | Programming I *(CSE 142)* | 5 | | |
| | Physics III *(PHY 123)* | 5 | | |
| | | | | |
| | | | Winter | |
| TCSS 143 | Programming II *(CSE 143)* | | 5 | |
| | Linear Algebra | | 5 | |
| | Chemistry or Biology (with lab) | | 5 | |
| | | | | |
| | | | | Spring |
| | Social Science or Humanities | | | 5 |
| | Humanities or Social Science | | | 5 |
| TCES 215 | Electrical Circuits *(EE 215)* | | | 5 |
| | | | | |
| | **TOTAL UNITS** | **15** | **15** | **15** |

| JUNIOR YEAR | | | | |
|---|---|---|---|---|
| Course No. | Title | Fall | | |
| TCSS 305 | Programming Practicum | 5 | | |
| TCES 230 | Intro to Logic Design | 5 | | |
| TCSS 321 | Discrete Structures I | 5 | | |
| | | | | |
| | | | Winter | |
| TCSS 342 | Data Structures | | 5 | |
| TCSS 371 | Machine Organization | | 5 | |
| TCES 312 | Electronics & Analog Systems | | 5 | |
| | | | | |
| | | | | Spring |
| TCSS 372 | Computer Architecture | | | 5 |
| TCSS 360 | Software Engr & Quality Assurance | | | 5 |
| TCES 323 | Linear Systems and Transforms | | | 5 |
| | | | | |
| | **TOTAL UNITS** | **15** | **15** | **15** |

| SENIOR YEAR | | | | |
|---|---|---|---|---|
| Course No. | Title | Fall | | |
| TCSS 422 | Computer Operating Systems | 5 | | |
| TCES 413 | Advanced Digital System Design | 5 | | |
| TCSS 325 | Computers, Ethics, & Society | 5 | | |
| | | | | |
| | | | Winter | |
| TCSS 465 | Embedded Real-Time Systems | | 5 | |
| | Restricted Elective (May be Internship) | | 5 | |
| TCES 480 | Senior Project I | | 5 | |
| | | | | |
| | | | | Spring |
| TCES 450 | Probability & Stat with Num Methods | | | 5 |
| | Restricted Elective | | | 5 |
| TCES 481 | Senior Project II | | | 5 |
| | | | | |
| | **TOTAL UNITS** | **15** | **15** | **15** |

+ Restricted Electives requires adviser approval.

Courses in italics are UW Seattle reference numbers

## V. Infrastructure Requirements

The BS in Computer Engineering and Systems program can be launched with a modest investment. However, if the program is launched with an initial target of twenty to thirty juniors per year, clearly some additional resources will be needed in the first year and more will need to be added in the second year. In addition, lower division math and science courses will need to be added at UWT to provide for our new UWT four-year students.

Eight new courses need to be developed and offered by the faculty over then next two years. Courses similar to these are offered at other universities. It is believed that one new senior faculty, a visiting professor, and several part-time lecturers, working in local industry, might meet the initial needs. Intel presently employs many engineers with Masters and PhD degrees, such as Dr. DiBene, who are qualified to teach CES courses, and has offered to help identify some who may be good fits. In addition, there is an ongoing search for faculty to help staff the Computer Engineering and Systems program.

The Institute has already developed laboratories with most of the facilities needed to begin offering the program. It is the policy of the Institute that equipment and facilities acquired by the institute with funds provided by the State and donors belong to the Institute, not its individual programs. Therefore, all laboratories and equipment within the prevue of the Institute will be available for use by students in the CES program in addition to students in its other Institute programs. There is presently capacity and much of the test equipment and supplies needed to provide the laboratory experimentation and undergraduate research.

A specific concern is the laboratory space for the two-quarter, senior design project classes. A facility needs to be created for use by students working on their projects. Ideally, this facility would have no scheduled classes and would be available throughout the day for student project use. There are currently two rooms in the Cherry Parkes facility and one in the Pinkerton facility that would satisfy this need.

As the Institute’s programs grow in number and size, additional equipment and supplies will be required. Intel, one of the Institutes strong supporters, has been a great help in funding Institute equipment in the past, and has expressed a willingness to help with this. In addition, UWS Electrical Engineering offered to help us acquire equipment equivalent to theirs where savings could be occurred with only per unit extra charges.

Technician support for the new program will be provided by having one of the two technicians currently assigned to CCS work part time for the CES program. This should not cause and problems for the CCS program because the facilities that the technician will be supporting will for the most part be those shared with CSS.

As the CES and CSS programs grow, the challenge will be to develop additional laboratories as enrollments increase beyond the ability to share the CSS laboratories.

## VI. Faculty and Administration

Faculty expertise is available to provide leadership for this program. The Institute already has expertise in Electrical Engineering. Professor Larry Crum, Project Manager Larry L. Wear (former professor and Chair of ECE, Cal State Chico), Adjunct Joseph T. DiBene (Principle Engineer, Senior Silicon Architect, Intel Corp.) and Director & Professor Orlando Baiocchi have PhD's in Electrical Engineering, Lecturer Don McLane has a Masters degree in Electrical Engineering, and Assistant Professor Sam Chung has a Bachelors degree in Electronics (Electrical Engineering). Dr. Crum has extensive background in development and leadership of computer engineering programs. He has served as Chair of a Computer Engineering Program that offered BS and MS degrees in Computer Engineering, and served a Chair of a Computer Science & Engineering Department that offered BS, MS, and PhD degrees in Computer Science & Engineering. Dr. Wear started the Computer Engineering Department at Chico, has served as Chair of both ECE and Computer Science departments, and has extensive teaching experience in Computer Science and Electrical/Computer Engineering. Dr. DiBene has extensive research and development experience in the semiconductor field. Dr. Baiocchi was a Professor and Chair of ECE departments in both California and North Dakota. He was also the Dean at SUNYIT where he started the Electrical and Computer Engineering programs. Both Dr. Crum and Mr. McLane have significant computer engineering industrial experience. Both Dr. Wear and Dr. DiBene have recent industry and consulting experience in the electrical and computer engineering fields.

Tables 1, shown below, list the faculty and administration that will be needed to start the program, Table 1, and to maintain the program during year five, Table 2.

**Table 1: Faculty and Administration- at program startup**

| **Faculty** | | | | |
|---|---|---|---|---|
| **Name** | **Degree** | **Rank** | **Status** | **% Effort in Program** |
| Larry Crum | Ph.D. | Prof. | ½ Time | 100% |
| Larry Wear | Ph.D. | Prof. | Full Time | 40% |
| Orlando Baiocchi | Ph.D. | Prof. | Full Time | 10% |
| Sam Chung | Ph.D. | Asst. Prof. | Full Time | 10% |
| Don McClain | MS | Lecturer | Full Time | 50% |
| J. Ted DiBene | Ph.D. | Lecturer | Part Time | 10% |
| | | | **Total Faculty FTE** | 1.7 |
| **Administration** | | | | |
| Larry Wear | Ph.D. | Prof. | Full Time | 60% |
| Open | BS | Lab Supervisor | ½ Time | 100% |
| Open | MS | Prog. Admin. | Full Time | 10% |
| Chris Rails | MS | Advisor | Full Time | 10% |
| | | | **Total Staff FTE** | 1.3 |

**Table 2: Faculty and Administration- for year five**

| **Faculty** | | | | |
|---|---|---|---|---|
| **Name** | **Degree** | **Rank** | **Status** | **% Effort in** |

| | | | | Program |
|---|---|---|---|---|
| Larry Crum | Ph.D. | Prof. | ½ Time | 100% |
| Orlando Baiocchi | Ph.D. | Prof., Inst. Director | Full Time | 10% |
| Sam Chung | Ph.D. | Asst. Prof. | Full Time | 10% |
| Don McClain | MS | Lecturer | Full Time | 50% |
| J. Ted DiBene | Ph.D. | Lecturer | Part Time | 10% |
| Open | Ph.D. | Assoc. Prof | Full Time | 100% |
| Open | Ph.D. | Asst. Prof. | Full Time | 100% |
| Open | Ph.D. | Prof | Full Time | 100% |
| | | | **Total Faculty FTE** | **4.3** |
| **Administration** | | | | |
| Larry Wear | Ph.D. | Prof. | Full Time | 100% |
| Open | BS | Lab Supervisor | Full Time | 100% |
| Kathi Gibbons | BS | Advisor | Full Time | 100% |
| Alina Urbanec | MS | Prog. Admin. | Full Time | 10% |
| Chris Rials | MS | Lead Advisor | Full Time | 10% |
| | | | **Total Staff FTE** | **3.2** |

## VII. Students

### A. Pathways to CES Program

Pre-engineering programs are offered by most or all of our partner community colleges. Students in these programs take the articulated Associate of Science Degree curriculum, which includes the lower division requirements in the CES program. The options for these students to take upper division majors in four-year universities in western Washington are limited. The staff at the SBCTC estimates that there are at least 50 students with a GPA of 3.0 each year that can’t complete their degree in western Washington, as they desire. It is anticipated that at least 20 students will matriculate into the Computer Engineering & Systems program for its first class.

In addition to transfer students, the program expects to attract freshmen to the program when it is opened. The University of Washington, Tacoma will have its first freshman class starting fall semester 2006. At the time of this writing, approximately 190 students have been accepted into the freshman class with 20 of these having declared Computing and Software Systems as their major. Since the CSS program has attracted over 10% of the freshman class, it seems reasonable to expect that the proposed Computer Engineering and Systems program will be able to attract at least 5% of the class. Therefore, we expect about 10 freshmen to choose CES as their major.

Table 3 shows the expected number of students in the program over its first five years.

**Table 3: Student Enrollment Targets**

| Year | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Headcount** | 20 | 40 | 60 | 70 | 80 |
| **FTE** | 15 | 30 | 45 | 55 | 65 |

| | | | | | |
|---|---|---|---|---|---|
| **Program Graduates** | 0 | 10 | 15 | 20 | 25 |

**B. Diversity and Outreach Initiatives**

One of the primary missions of the Institute of Technology and the CSS program is to serve the educational needs of the South Sound region. The Institute's mission statement underscores the imperative that the program "proactively support a diverse population of current and future students, with emphasis on non-traditional and underrepresented students." Institute advising and outreach staff actively reach out to and recruit populations that are historically under-represented in science and math disciplines, including women. These efforts will continue, and in fact we hope that the additional educational option will enhance the program's appeal to these groups.

Recent UWT developments with respect to diversity include appointment of a Director for Diversity, and allocation of space on campus to provide infrastructure for services to students and to the campus community. Short-term grant funding is supporting a part-time staff person. All of these are important efforts to develop appropriate on-campus support systems for diverse student, faculty, and staff populations.

The University of Washington Tacoma has anti-discrimination policies that are reprinted in the University Handbook and disseminated to students, faculty, and staff on all three campuses. The University does not discriminate on the basis of race, color, creed, religion, national origin, gender, sexual orientation, age, or Vietnam-Era veteran status.

Measures at UWT to promote nondiscrimination, equity, and diversity include:

- Including the University of Washington non-discrimination statement on all position announcements
- Advertising faculty and relevant staff positions in minority publications and distributing the position announcements to lists of minority and woman candidates maintained by the University of Washington Graduate School
- Using informal collegial and professional networks to help faculty identify potential minority and female candidates for student, staff, and faculty positions
- Making personal contact with potential faculty candidates, encouraging them to apply and answering any questions they might have, and using additional campus-wide financial resources through the Provost’s office to ensure competitive offers and attractive recruitment packages for candidates from under-represented groups
- Holding applicant events where potential students can meet with faculty and professional staff and learn about the proposed program and its admission process
- Stating clearly the anti-discrimination policies in all application packets

Procedures proposed to retain students from under-represented groups include:

- Inviting ethnic organizations information sessions and meetings
- Working to provide emergency financial assistance to students in crisis
- Targeting students of color and other under-represented groups in the recruitment process, and providing information on financial aid and scholarships
- Using Student Affairs staff to link students experiencing academic or personal difficulties with appropriate resources
- Providing information on financial aid, scholarships, and TA opportunities to students from under-represented groups

As an example of the outreach programs the Institute has conducted, during the spring quarter 2006 an open house information session was held for the Korean community. The even was very successful. Approximately 75 people attended; the attendees included prospective students, family and community representatives. During the session the degree programs were explained along with the admission requirements. Advisors were available to answer individual questions and tours were given of the Institutes laboratory and computing facilities. Based on the apparent success of this event, more are being planned starting in the fall quarter 2006.

## IX. Accreditation

It is expected that engineering programs be accredited. The program created following the guideline established by the Accreditation Board for Engineering and Technology. Dr. Baiocchi and Dr. Wear are both trained ABET program evaluators and Dr. Wear has been on two accreditation teams that have used the ABET 2000 criteria for accreditation. In addition, Dr. Wear directed the successful accreditation efforts for both an electrical/ electronic engineering program and a computer engineering program. Dr. Baiocchi led accreditation efforts for engineering programs at both the University of North Dakota and SUNYIT. Dr. Crum led the development of an accredited computer engineering program at Wright State University and managed it through two accreditation reviews. He was a member of the IEEE Computer Society committee that advised ABET on the original computer engineering accreditation standards. He has also been a member of several accreditation visit teams and led an accreditation visit team for the Computer Science Accreditation Board, which partners with ABET in accreditation.

Since the Computer Engineering program has been laid out with accreditation in mind, meeting ABET's requirements, although time consuming, should not be difficult. ABET requires that a degree program have graduates before receiving accreditation, therefore there will be ample time to make any adjustments needed to satisfy the accreditation requirements prior to an accreditation visit.

## X. Program Assessment

The proposed program is an engineering program and as such needs to be accredited by the Accreditation Board for Engineering and Technology (ABET). In 2000 ABET changed the focus of its accreditation process so the program educational objectives and student educational outcomes became the driving forces of the process. To meet the ABET accreditation requirements our program must be built on a sustainable assessment process.

Knowing from the beginning that assessment was critical to the programs success, we have designed the program and curriculum with assessment in mind. The following paragraphs describe how we will assess the program and student educational outcomes.

### A. Program and Course Assessment Plan

Based on the University's mission, the Institute of Technology's mission, and with input for our advisory board, the following objective was established for the program.

The objective of the Computer Engineering and Systems program is to produce graduates able to:

- apply knowledge of mathematics, science, and engineering to identify, formulate, and solve computer engineering problems;
- use hardware and software tools to analyze, design, develop and test computer-based systems containing both hardware and software components;
- achieve success in graduate programs in computer engineering or a related field;
- continue to develop their knowledge and skills after graduation in order to succeed personally and contribute to society;
- work effectively as a member of a multi-disciplinary development team and undertake leadership roles when appropriate;
- communicate their ideas, both in written and oral forms, so that others can use and build on their work;
- appreciate the importance of ethics in the profession and the need to act in society's best interest.

To verify that a program that meets its objective, it is necessary to constantly evaluate and, if necessary, improve the program. To that end, CES has developed a Program Improvement Process that is repeatable and manageable. The process is executed once each year, but there is a different set of inputs each year. The CES Program Improvement Process is depicted in the Figure 1 shown below.

The process in Figure 1 begins each year with a review of the assessment tool(s) that will be used to gather that year's data. Based on past results, the faculty may choose to update or replace a given assessment tool. When the assessment tool has been chosen, data is gathered from one or more of the sources (employers, IAB, alumni, students, and faculty). The data are then reviewed by the faculty to determine what, if any, changes should be considered. If needed, a Change Improvement Plan is developed. Based on the plan, changes are implemented.

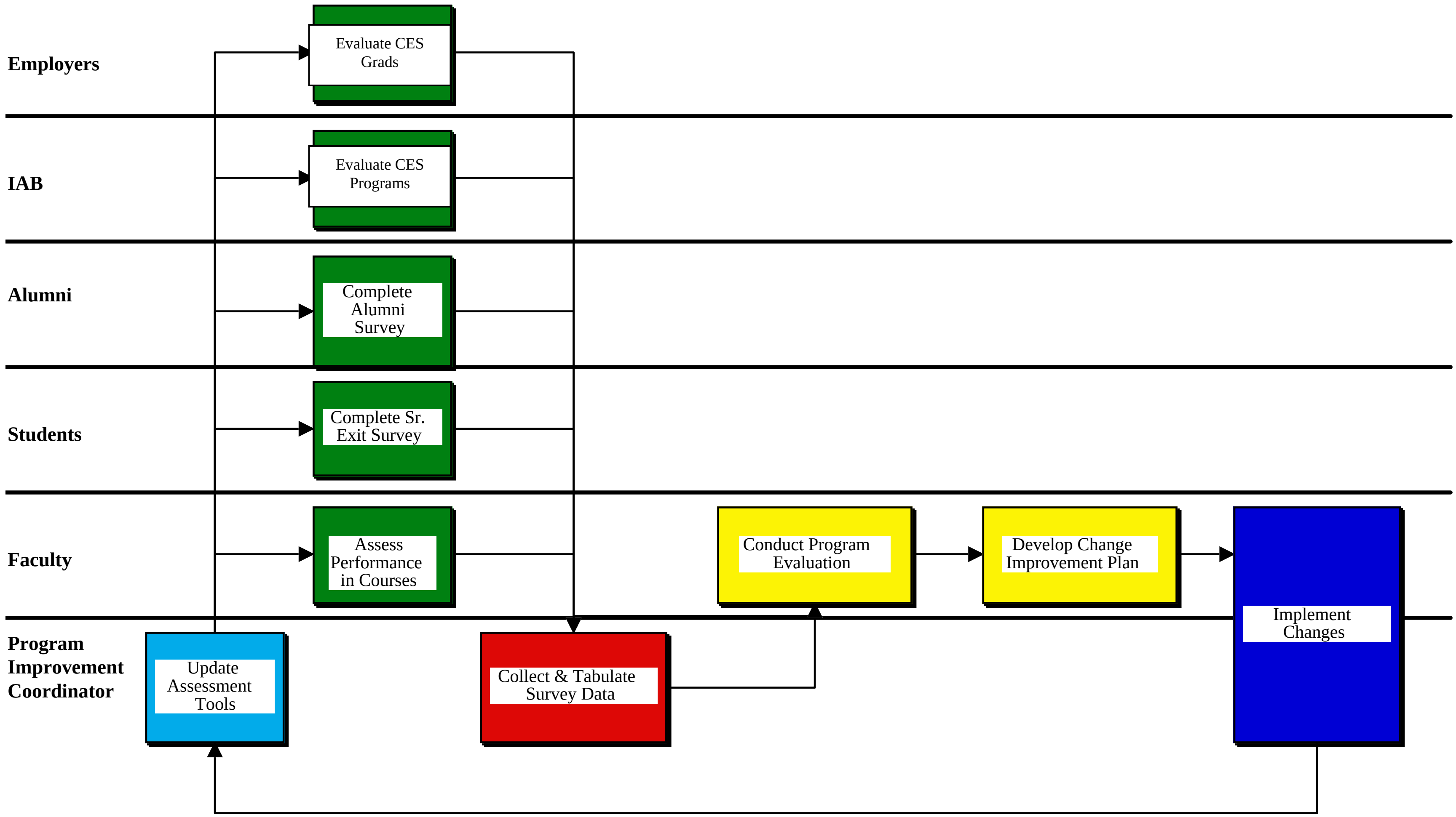


**Figure 1: CES Program Improvement Process**

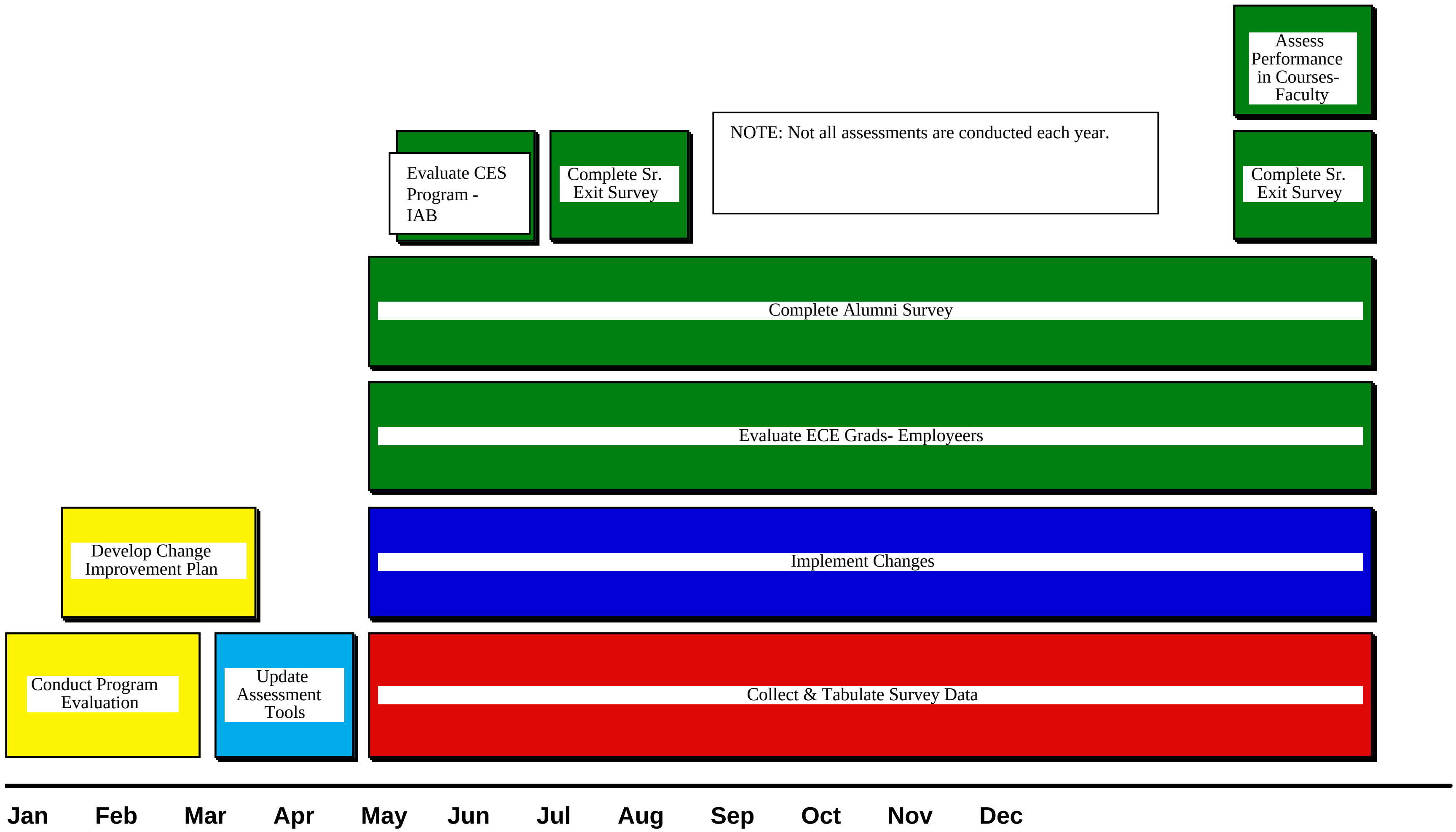


**Figure 2: Timeline for CES Program Improvement Process Activities**

The timeline for the program improvement activities is shown in Figure 2. As can be seen, each January and February change plans are developed, if needed; changes are implemented during the following year. Alumni data collection via the web page survey actually happens continuously throughout the year. Other data collection activities, such as employer surveys and senior exit surveys, take place at specific times.

The six-year cycle of assessment activities is shown below in Table 4. As shown, senior exit surveys are the only form of assessment that takes place each year. The other assessment methods are distributed throughout the six-year cycle so that assessment activities are not excessive in any one year. The faculty feels that this distribution makes the assessment activities manageable over a period of years.

**Table 4: Six Year Assessment Cycle**

| Year | Alumni Surveys | Senior Exit Surveys | Faculty Course Assessment | IAB Recommenda-tions | Employer Surveys |
|---|---|---|---|---|---|
| 1 | 1-2 yr grads | X | | X | |
| 2 | | X | X | | |
| 3 | 3-7 yr grads | X | | | X |
| 4 | | X | | X | |
| 5 | 8+ yr grads | X | X | | |
| 6 | | X | | | |

The process described about will be used when the program has reached "steady state." For the first few years a modified version will be used. During the startup phase, Senior Exit surveys and Faculty Course Assessments will be will be conducted each year. The IAB will also be consulted on any proposed changes to the program during this time. After graduates have been in the field for two years, Alumni and Employer Surveys will be added to the process. After the first ABET accreditation visit, the assessment process will be in steady state and the process described in the preceding paragraphs will be followed.

Determining that each student has met all of the elements of the Program Educational Objective cannot be fully determined until after graduation and the graduates' ability to function as an engineer can be evaluated. Student educational outcomes, on the other hand, can and should be measured by the time the student graduates. The following section describes how that will be done for CES students.

## B. Student Educational Outcomes Assessment Plan

ABET has defined a set of educational outcomes that all graduates of engineering programs must meet. That set is shown below:

a) An ability to apply knowledge of math, science and engineering
b) An ability to design and conduct experiments as well as to analyze and interpret data
c) An ability to design a system, component, or process to meet desired needs
d) An ability to function on multi-disciplinary teams

e) An ability to identify, formulate and solve engineering problems
f) An understanding of professional and ethical responsibilities
g) An ability to communicate effectively
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context
i) A recognition of the need for, and an ability to engage in, life-long learning
j) A knowledge of contemporary issues
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

For the CES Program we have defined an assessment plan that will ensure that all graduates have successfully met each of the outcomes.

The assessment plan for student education outcomes uses both direct and indirect forms of assessment. Indirect assessment relies on a student exit survey that enables us to collect data on how well students feel they have met the educational outcomes. Students are asked a series of questions related to each outcome, a)-k). Responses are on a scale of 1 to 5 where a response of 1 indicates the student feels poorly prepared to meet the objective and a response of 5 indicates the student feel very well prepared to meet the objective. The faculty has decided that the average response should be 3.75 or greater and if it is not, there is a problem that should be examined.

Although indirect assessment can provide useful data, ABET has stated that outcome assessment must not rely solely on indirect assessment. Because of this, we have developed a direct form of assessment that is embedded in individual classes. This form of direct assessment requires that students demonstrate an ability to perform specific tasks in certain relevant courses. Table 5 below shows the classes in chick the a)-k) outcomes will be measured. If a student does not satisfactorily demonstrate the ability to achieve the outcome, he or she will fail the course.

**Table 5: Direct Outcome Assessment Mechanism**

| Outcome | Course | Outcome Pass/Fail Criteria |
|---|---|---|
| **a)** | **TCES 323** | Homework and examinations must demonstrate each student's ability to analyze circuits by:<br>• applying Kirchhoff's Laws and the concepts of energy and power<br>• solving for currents, voltages, and powers in circuit elements, mainly by hand calculations, using complex frequency concepts, linear algebra and calculus, including differential equations, as needed.<br>To pass this course, students must receive an average grade of C- or higher on homework assignments, and examinations. |
| **b)** | **TCES 481** | Students must demonstrate their ability to design and conduct experiments, and analyze experimental data by :<br>• Writing a Product Test Plan that defines what parameters will be tested<br>• Describing the procedures that will be used to take the needed measurements<br>• Listing all equipment and software that will be required to perform the tests<br>• Describing how test data will be analyzed.<br>To assure that students in teams successfully demonstrate their ability to meet this outcome, each student must take complete responsibility for testing at least one of the project's specifications<br>To pass this course, students must receive an average grade of C- or higher on the testing assignments. |
| **c)** | **TCES 312** | Students must demonstrate their ability to design and verify assigned specifications in:<br>• A Zener diode voltage regulator with power dissipation constraints<br>• A bias circuit for a bipolar or field-effect transistor with specified worst-case current limits<br>• A single-stage amplifier with specified gain, gain stability, frequency response, output swing capability and input impedance.<br>• A multistage negative feedback amplifier with specifications similar to but tighter than those in the single-stage amplifier.<br>To ensure that students' work is really their own, design documentation must include:<br>• A schematic of the final design<br>• A narrative description of the first-pass design process<br>• A spreadsheet printout of the value of each of the specifications for each iteration of the design process showing the migration from the first-pass design to the final one<br>To pass this course, students must receive an average grade of C- or higher on the design assignments. |

| | | |
|---|---|---|
| | **TCES 413** | Students must demonstrate their ability to design and verify assigned specifications by designing, constructing, testing and demonstrating a single board microcomputer that can perform audio frequency data acquisition as well as serial communication with another device.<br>The instructor will assess each student's ability to achieve this outcome by evaluating the student's semester-long individual design and implementation project.<br>Since the project's implementation uses a modular 'build and test' approach, a student will not receive a grade of C- or better unless he or she does produces a working system that includes at least a CPU with ROM, an input port with DIP switches, and an output port with LEDs. |
| **d)** | **TCES 480** | Each student must actively participate in a series of team-based writing and presentation assignments. The evaluation of these team-based assignments includes the following aspects:<br>• Research – Collaborative research and formulation of project concepts and plans<br>• Presentation – A team-based presentation that describes the project concept and plan. Students are graded both on the overall presentation, and on their individual contributions.<br>• Documents – Three collaboratively generated documents: concept, requirements, and design<br>• Participation – The instructor's evaluation of each individual student's successful and constructive participation in the group activities.<br>To pass this course, students must receive an average grade of C- or higher on team-based assignments. |
| **e)** | **TCES 480**<br>**TCES 481** | Students must demonstrate their ability to:<br>• Identify a problem by successfully completing a concept document for a project<br>• Formulate a solution by successfully completing the technical requirements document for a project<br>• Solve a problem by successfully completing all design documents needed to build a project.<br>To pass these courses students must receive an average grade of C- or higher on each of the following assignments: the Product Concept Document (TCES 480), the Technical Requirements Document TCES 480), and the final design documents (TCES 481) |
| **f)** | **TCSS 325** | Students are required to submit a written memo on a reading assignment concerning professional ethics.<br>A score of 7 out of 10 on this memo assignment is the minimally acceptable achievement of proficiency. Students not achieving this proficiency will be required, at the discretion of the instructor, to perform remedial work until proficiency is achieved. |

| | | |
|---|---|---|
| **g)** | **TCSS 480** | Students must demonstrate their ability to communicate effectively by:<br>• Giving one or more oral status reports<br>• Submitting documents that are a part of the normal product development cycle.<br>To assure that students in teams demonstrate satisfactory completion of this outcome:<br>• Each student must give at least one oral status report during the semester.<br>• Each student must be responsible for one or more of the following documents: project concept, technical requirements, preliminary design, and project plan.<br>To pass this course students must receive a grade of C- or higher on both the written and oral assignments. |
| **h)** | **TCSS 325** | Students are required to submit a written memo on a reading assignment concerning the effects of engineering on society in a global context. The article may focus on such issues as war and weapons of mass destruction, environmental pollution, international bribery, and energy.<br>A score of 7 out of 10 on this memo assignment is the minimally acceptable achievement of proficiency. Students not achieving this proficiency will be required, at the discretion of the instructor, to perform remedial work until proficiency is achieved. |
| **i)** | **TCES 480** | Students must demonstrate their ability to engage in life-long learning by:<br>• Researching and evaluating current articles in their field of study for homework assignments<br>• Showing proper documentation of sources used for their research<br>The aggregation of grades for these assignments will demonstrate whether or not the student has satisfied outcome i). To pass this course, students must receive an average grade of C- or higher on these selected assignments |
| **j)** | **TCSS 325** | Students are required to submit a written memo on a reading assignment concerning contemporary issues such as overseas outsourcing for engineering designs, the Columbia accident, or the energy crisis.<br>A score of 7 out of 10 on this memo assignment is the minimally acceptable achievement of proficiency. Students not achieving this proficiency will be required, at the discretion of the instructor, to perform remedial work until proficiency is achieved. |
| **k)** | **TCSS 465** | For both homework assignments and laboratory projects, students must demonstrate their ability to use modern engineering tools by:<br>• Applying PSpice or similar tool to design, analyze and simulate computer interface circuits.<br>• Applying Altera MAX+PLUS II or similar Computer-Aided Engineering (CAE) software tools to design, analyze and simulate digital circuits.<br>To pass this course students must receive an average grade of C- or higher on homework assignments involving CAE tools. |

The combination of direct and indirect assessment described above will ensure that all students will demonstrate mastery of each educational outcome by the time of graduation

## XII. Budget

The projected program expenses and revenues are shown in Table 6.

**Table 6: Projected Program Expenses and Revenues**

| **Program Expenses** | | | | | |
|---|---|---|---|---|---|
| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year N (Full Enrollment)** |
| **Administrative Salaries (# FTE) Benefits @ # %** | $92,870 | $92,870 | $163,150 | $163,150 | $163,150 |
| **Faculty Salaries (# FTE) Benefits @ # %** | $190,238 | $278,223 | $389,889 | $444,618 | $545,922 |
| **TA/RA Salaries (# FTE) Benefits @ # %** | $8,550 | $12,825 | $16,335 | $17,335 | $21,335 |
| **Clerical Salaries (# FTE) Benefits @ # %** | $10,040 | $10,040 | $66,022 | $131,445 | $202,055 |
| **Other Salaries (# FTE) Benefits @ # %** | | | | | |
| **Financial Aid specific to the program** | | | | | |
| **Contract Services** | | | | | |
| **Travel** | $5,000 | $10,000 | $12,000.00 | $16,000 | $20,000 |
| **Goods and Services** | $5,000 | $25,000 | $35,000 | $46,000 | $66,000 |
| **Equipment** | $65,000 | $40,000 | $60,000 | $50,000 | $70,000 |
| **Lease or Acquisition (attach form iii.a)** | | | | | |
| **Other (itemize)** | | | | | |
| **Indirect (if applied to the program)** | $48,293 | $62,100 | $96,062 | $113,019 | $142,988 |
| **Total Costs Per Year** | $424,991 | $531,058 | $838,458 | $981,567 | $1,231,450 |
| **Costs Per FTE Student Per Year** | $28,332.73 | $17,702 | $18,632 | $17,847 | $18,945 |
| **Total Costs** | | | | | $4,007,523 |
| **Program Revenues** | | | | | |
| General Fund: State Support | $241,228 | $291,900 | $632,627 | $522,572 | $687,909 |
| Tuition and Fees (total) | $108,000 | $155,051 | $225,011 | $349,692 | $439,533 |
| Corporate Grants/Donations | $50,000 | $65,000 | $65,000 | $75,000 | $75,000 |
| Internal Reallocation* | $8,000 | $8,000 | $8,000 | | |
| Other Fund Source (Specify) | | | | | |
| **Total Revenue** | | | | | $4,007,523 |

*The CES program will use the services of a program advisor from the CSS department for the first three years until demand justifies a full time person to service the CES students.