PROPOSAL TO ESTABLISH A BACHELOR OF SOFTWARE ENGINEERING DEGREE

FACULTY OF ENGINEERING
UNIVERSITY OF VICTORIA

VERSION 6.0

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1. Executive Summary

This document proposes a new software engineering program at the University of Victoria leading to the degree of *Bachelor of Software Engineering (BSENG)*. This degree program is to be offered jointly by two Departments in the Faculty of Engineering, the Department of Computer Science and the Department of Electrical and Computer Engineering. The cooperation of these departments attests to the true interdisciplinary nature of the software engineering field. The intent is to start the program in September 2003 by admitting students to both first and second year.

The requirements for this new program include 47 courses and mandatory work experience of 16 months. The courses, which are designed to be taken over eight terms, include 38 prescribed courses and nine elective courses. The proposed software engineering curriculum is innovative, attractive, and interdisciplinary.

The proposed software engineering degree program is designed to be accredited by both the *Canadian Engineering Accreditation Board (CEAB)* and the *Computer Science Accreditation Council (CSAC)*. Accreditation by both organizations befits the interdisciplinary nature of this field. Six Canadian software engineering programs have so far been accredited by CEAB [12, 13]. Three programs have been accredited by CSAC and thus meet the standards of the Canadian Information Processing Society [14]. Accreditation ensures that a program meets or exceeds the educational standards set by the accrediting bodies. CEAB, for example, specifies, in broad terms, the minimal program content required in mathematics, basic sciences, engineering science, engineering design, and complementary studies. As an ongoing process, accreditation will help ensure that the program is kept up to date and effective and that the curriculum meets the guidelines of the *Association of Professional Engineers and Geoscientists of British Columbia*.

The proposed new software engineering degree program integrates well with existing programs in the Faculty of Engineering and leverages available resources effectively. The proposed program structure follows the pattern of existing Bachelor of Engineering (BENG) programs at the University of Victoria. In particular, there is a common first year for engineering programs. This was adjusted to accommodate the proposed software engineering program. The new program also allows for transfers from University Colleges and could connect to the existing bridge from colleges into Third Year Engineering.

Full implementation of the proposed software engineering degree program will require a significant number of additional faculty members, including a Director of Software Engineering, in the Department of Computer Science and the Department of Electrical and Computer Engineering. Four faculty positions have already been filled in direct support of the existing Software Engineering Option in the Department of Computer Science and of the Software Engineering Specialization in the Department of Electrical and Computer Engineering. The additional positions will be created with funding from the *Doubling the Opportunity (DTO)* initiative [2].

The administrative structure of the BSENG program consists of six parts: the *Software Engineering Program Board*, the *Software Engineering Program Director*, the *BSENG*

Curriculum Committee, the *BSENG Work Experience Office*, the *Software Engineering Program Office*, and the Faculty of Engineering *Undergraduate Programs Coordination Committee*.

Many sources were consulted during the design of the curriculum of the proposed BSENG program. The IEEE*/ACM Computing Curricula Recommendation 2001* [7], including a draft of the *Software Engineering Volume* [8], was extensively consulted throughout the development of the proposed curriculum. The IEEE/ACM recommendations represent an intensive consultation of computing and software engineering practitioners and educators worldwide. A number of software engineering undergraduate degree programs, which have recently been started in Canada, the United States and other parts of the world, were also examined.

The degree program is built upon the current base of expertise in software engineering research and education in the Departments of Computer Science and Electrical and Computer Engineering. There have been software engineering research projects and courses at the University of Victoria since the late Seventies. The curriculum also draws on the experiences gained in offering a software engineering option and specialization in third and fourth year, since 1998. Over the years, the synergy between teaching and research in software engineering has contributed significantly to the graduate and undergraduate program. Thus, the proposed degree program is a logical next step in the development of software engineering as a discipline at the University of Victoria.

The proposed BSENG degree program meets Objective 12 of the *University of Victoria Strategic Plan* [1] since this high quality program constitutes a timely response to disciplinary and interdisciplinary developments and societal and student needs. This program is a good indication of the University's commitment and contribution to innovation in the information technology sector in British Columbia. Since software engineering is a high priority research area in the Faculty of Engineering, this program also meets Objective 16 by concentrating institutional support on one of the University of Victoria's focus areas.

Software engineering was identified as a Doubling the Opportunity program area for the University of Victoria in the March 11, 2002 letter to President Turpin from the *Deputy Minister of Advanced Education* [2]. Resources (i.e., staffing, funding, space, *etc.*) for the proposed Bachelor of Software Engineering degree are thus a major component of the University of Victoria plan for the DTO initiative. Positions and funding have been allocated. Space is being assigned in a new engineering building, currently at the design stage.

The structure of this document follows the proposal template specified in the *Guidelines and Procedures for the Submission of New Degree Programs in British Columbia*.

1.1 Background

For more than 30 years, the term "software engineer" has been used so broadly that virtually anyone who has written a line of computer software can call herself or himself a "software engineer." It has been common practice for software vendors to disclaim any responsibility for the consequences of defects in the software that they market. Those who write such software have rarely been held accountable. The result has been the

proliferation of software products that fail frequently and incur significant costs to their users. For software used in safety-critical applications, such as medical, avionics, and automobile control systems, the risks of failure are especially high.

Software engineering is the application of computer science and engineering principles and practices to the design, construction, testing, maintenance, and evolution of software. While the term itself was coined in the late Sixties, it is only recently that software engineering has emerged as an undergraduate discipline in its own right. It is essential to the economic growth and development in the Province of British Columbia that students have the opportunity to study this increasingly critical area and obtain *software engineering degrees* [10].

Today, the documentation, design, development, evolution, and verification of computer software are integral parts of engineering solutions. The focus of the proposed software engineering degree program will be both on the application of engineering methods to software, and on the development of engineering software applications. There will be special emphasis on three themes: (1) the analysis and testing of software for correctness, performance, and usability; (2) the design of software to reduce the costs of maintenance and evolution; and (3) the design of software as part of larger, embedded, and real-time systems.

1.2 Objectives

The major objectives of the proposed program are:

- to satisfy student demand and industry demand for software engineering education in British Columbia;

- to give students a thorough and deep understanding of the specification, development, implementation, testing, maintenance, and evolution of software systems ranging from embedded systems to large information systems;

- to create an innovative program to address the truly interdisciplinary nature of software engineering effectively;

- to build upon the substantial software engineering research and education expertise already present at the University of Victoria; and

- to deploy the quality and strengths of University of Victoria Engineering Faculty into software engineering education.

1.3 Outcomes

The principal outcome of the proposed program will be graduates with a breadth and depth of knowledge of software engineering that combines theory and practice of Computer Science and Engineering. Graduates will also have strong communication skills and be proficient in engineering design, particularly as it applies to software development and software systems. Software engineering graduates will also start companies contributing to the economic growth of British Columbia.

The knowledge and skills that graduates will be expected to acquire during the BSENG program include:

- an understanding of all aspects of software development and the software development process from the early design stages to long-term software maintenance and evolution;
- the ability to construct and evaluate software in the context of physical systems and real-world applications;
- the ability to apply software and engineering design principles to software development and system design including trade-off analyses;
- an understanding of software quality criteria and assurance and the ability to assess the quality of a software system;
- the ability to plan and manage large software projects;
- the ability to work independently and collaboratively;
- an understanding of engineering economics and entrepreneurship in software practice;
- the ability to understand the underlying principles on which physical systems and real-world applications are built on;
- the ability to integrate and participate in the design process of these systems and applications;
- the capability to communicate effectively both orally and in writing; and
- a breadth of background, knowledge, and skills in software engineering, as well as related areas of engineering, computer science, mathematics and complementary studies, that will provide students with a base for life-long learning.

2. Letter of Intent

The *Letter of Intent to Offer a Bachelor of Software Engineering* dated January 16, 2002 is listed as Appendix A of this document. Appendix B lists the comments received from other institutions regarding the Letter of Intent.

3. Curriculum

3.1 Knowledge and Skills

> *Entrepreneurship will become a core skill which all our young people will need to exploit the opportunities emerging from science and technology, culture and communications.*
>
> *Tony Blair, British Prime Minister*

A number of software engineering undergraduate degree programs have recently been started in Canada, the United States and other parts of the world. The proposed program is the first full undergraduate program in Software Engineering to be offered in British Columbia. In that respect, it is the first opportunity for B.C. students to pursue the knowledge and skills required for a career as a software engineering professional in a focussed program of study leading to a *Bachelor of Software Engineering* degree. The

curriculum is also founded on the experiences gained in offering a software engineering option and specialization in third and fourth year since 1998 at the University of Victoria.

The curriculum has been designed to give students a thorough and deep understanding of the specification, development, implementation, testing, maintenance, and evolution of software systems ranging from embedded systems to large information systems. As a balanced engineering curriculum, the courses ensure that students obtain a foundation in mathematics and basic sciences, a broad preparation in engineering design and engineering sciences, and an exposure to non-technical subjects in the form of complementary studies courses. The core of the curriculum consists of software engineering, computer science, electrical engineering, and computer engineering courses.

Since many students are undecided about the discipline of study when they first come to university, the first year in Engineering at the University of Victoria is common to all programs. The first year courses emphasize fundamental skills, such as computer programming, engineering design, basic science, calculus and English. These courses also provide the broad background necessary to allow students to choose from the broad range of engineering and basic science electives. Student advising is a critically important part of Engineering First Year. The primary goals of the two courses on electrical and mechanical systems are to develop engineering design skills and to expose students to a variety of systems.

The second and third year courses develop engineering skills and fundamental knowledge, which are essential for a software engineering degree, including software engineering, computer science, computer engineering, electrical engineering, basic science, business, entrepreneurship, technical writing, and elective complementary studies.

Fourth year continues this skill and knowledge development with an additional four prescribed courses. An engineering curriculum must culminate in a significant design experience which is based on the knowledge and skills acquired in earlier course work and which, preferably, gives students an exposure to the concepts of teamwork. The required capstone project is intended for this purpose. The fourth year of the proposed software engineering degree program also includes five engineering electives. These courses allow the students to specialize and pursue particular interests in greater depth. The final course in this software engineering degree program introduces students to the legal, social, and professional issues that arise in software engineering practice.

The selection of skills and knowledge to be taught in this program was guided by the IEEE/ACM Computing Curricula Recommendation 2001, existing software engineering degree programs, accreditation requirements, and the expertise of the faculty in the Department of Computer Science and the Department of Electrical and Computer Engineering. The result is a balanced state-of-the-art curriculum.

Work experience is a mandatory component of the degree program. This is critical to providing students the opportunity to practise and apply knowledge and skills acquired throughout this software engineering program.

In summary, the knowledge and skills that graduates will be expected to acquire during the BSENG program include but are not limited to:

- an understanding of all aspects of software development and the software development process from the early design stages to long-term software maintenance and evolution;
- the ability to construct and evaluate software in the context of physical systems and real-world applications;
- the ability to apply engineering design principles to software development including trade-off analyses;
- an understanding of software quality criteria and assurance and the ability to assess the quality of a software system;
- the ability to plan and manage large software projects;
- the ability to work independently and collaboratively;
- an understanding of engineering economics and entrepreneurship in software practice;
- the ability to understand the underlying principles on which physical systems and real-world applications are built on;
- the ability to integrate and participate in the design process of these systems and applications;
- the capability to communicate effectively both orally and in writing; and
- a breadth of knowledge and skills in software engineering, as well as related areas of engineering, computer science, mathematics and complementary studies, that will provide students with a base for life-long learning.

3.2 Course Requirements

The requirements for this new BSENG program include 47 courses and mandatory work experience of 16 months. The courses, which are designed to be taken over eight terms, include 38 prescribed courses and nine elective courses.

The proposed program structure follows the pattern of the existing BENG programs at the University of Victoria. Most of the courses are prescribed in any engineering degree program. The prerequisite structure is well defined. A balanced distribution of basic science, mathematics, engineering science, engineering design, and complementary studies is required. An engineering program must culminate in a significant design experience and, hence, the capstone project in fourth year. This project is usually one term, but can also be extended to two terms. Moreover, two different projects can be undertaken for full credit in the two fourth-year terms. Over half of the required core courses have a laboratory component, which involves substantial projects.

The main part of the software engineering core is a sequence of eight courses (labeled SE1-SE8 below). These courses are designed to be taken in order to provide a coordinated development of the student's software engineering expertise. All courses in this series will include a laboratory component.

The program has been designed to take advantage of existing courses and expertise in the Faculty of Engineering. New courses are introduced only as necessary for the academic structure of the proposed program, but many existing courses will be redesigned to

accommodate this new degree program. The tables below show that the program specifies twelve new courses (i.e., WE, SYSDYN, SAS, BUS1, BUS2, CTRL, SEC, IKM, CON, CSCW, WMC, and CAP). Eight of these are part of the required core and four courses are engineering electives. Courses SE3 to SE8 are new courses, but replace existing SENG courses. Existing courses which require adjustments include SE1, SE2, MECHSYS, ELECSYS, CAS, DD, OSDC, ARCH, CBSE, and SOCIAL. To accommodate the additional BSENG students, new sections will have to be created for selected existing courses (e.g., SE1 and SE2).

The BSENG curriculum development process is described in the *Software Engineering Degree Program: Executive Summary* [5]. The BSENG curriculum is detailed in two course description documents, a calendar entry document, and the tables below. Appendix D lists short, calendar-style course descriptions for all courses of the proposed software engineering degree program [3]. For detailed course outlines please refer to the 75-page document *Software Engineering Degree Program: Detailed Course Descriptions* [4]. For an overview of the proposed First Year of Operations please consult the *Bachelor of Software Engineering Calendar Entry* [15].

In the tables below, the first two columns list the unique identifier and the course subject, respectively. The last two columns list the status of a course and a reference to an existing or related course, where

>   E – denotes an existing course requiring no modification;

>   M – denotes an existing course likely requiring modification over time; and

>   N – denotes a new course.

First Year

The existing BENG programs at the University of Victoria have a common first year. The first year in the Computer Science programs is quite different. The first year of the BSENG shown in the following two tables is similar to the existing BENG first year, but can also serve as preparation for computer science degrees. This approach ensures maximal flexibility for students to change programs during or even after first year with minimal additional course work. SE1 and SE2 are new sections of two existing computer science courses (i.e., CSC 110 and CSC 115/CSC160).

TERM 1A	SUBJECT		EXISTING
SE1	Fundamentals of Programming	M	CSC 110
MECHSYS	Mechanical Systems	M	MECH 141
LA	Linear Algebra	E	MATH 133
CALC1	Calculus I	E	MATH 100
PHYS	Physics	E	PHYS 125

TERM 1B	SUBJECT		EXISTING
SE2	Object Oriented Design and Methodology	M	CSC 115 or CSC160
ELECSYS	Electrical Systems	M	ELEC 199
WE	Web Engineering	N	None
CALC2	Calculus II	E	MATH 101
CHEM	Chemistry	E	CHEM 150
ENGL	English	E	ENGL 115

Second Year

The discrete mathematics components in second year are essential for several software engineering courses. Ideally these courses would be taught in first year, but, in order to achieve a common first year, these courses are assigned to second year.

TERM 2A	SUBJECT		EXISTING
SE3	Software Development and Architecture	N	Note 1
CAS	Computer Architecture and Assembly Language Prog.	M	CSC 230
PS	Introduction to Probability and Statistics	E	STAT 260
SYSDYN	System Dynamics	N	None
DS1	Discrete Mathematics I	E	MATH 122
TECHWRT	Technical Writing	E	ENGR 240

TERM 2B	SUBJECT		EXISTING
SE4	Systems Programming and Middleware	N	Note 1
ALG1	Algorithms and Data Structures	E	CSC 225
HCI	Human Computer Interfaces	E	SENG 310
SAS	Signals and Systems	N	ELEC 260/310
DS2	Discrete Mathematics II	E	MATH 222
BUS1	Economics and Entrepreneurship	M	ENGR 280

Note 1: Courses *SE3-SE8* are new but in fact in combination replace existing SENG 265, 330, 365, 420, 440 and 465.

Third Year

The third year of the program permits two basic science electives and one complementary study elective to allow each student to broaden his or her knowledge. The two business components in second and third year are essential for software engineering practice.

TERM 3A	SUBJECT		EXISTING
SE5	Requirements Engineering and Formal Specification	N	Note 1
DD	Digital Design	M	CSC 355 or CENG 355
OSDC	Introduction to Operating Systems	M	CSC 360
CTRL	Control Systems	N	ELEC 360 or MECH 435
BSC5	Basic Science Elective	E	various
BUS2	Planning and Management	N	None

TERM 3B	SUBJECT		EXISTING
SE6	Software Evolution	N	Note 1
AFL	Foundations of Computer Science	E	CSC 320
DB	Databases	E	CSC 370
SEC	Security Engineering	N	Note 2
BSC6	Basic Science Elective	E	various
CST5	Complementary Studies Elective	E	various

Note 2: The new course *SEC* replaces the existing course *SENG 424: Reliability*. Due to staff shortages, SENG 424 has never been offered in the existing programs.

Fourth Year

The fourth year of the program permits five engineering electives and one free elective to allow each student to focus his or her studies in the area of most interest.

TERM 4A	SUBJECT		EXISTING
SE7	Embedded Systems	N	Note 1
NET	Computer Networks	E	CSC 450 or CENG 460
Elective	A course taken from the engineering electives listed below		Tables A and B
Elective	A course taken from the engineering electives listed below		Tables A and B
Elective	A course taken from the engineering electives listed below		Tables A and B
Free Elect.	A free elective taken from any Faculty		Any course

TERM 4B	SUBJECT		EXISTING
SE8	Software Quality Engineering	N	Note 1
CAP	Capstone Design Project	N	SENG 499
RT	Real-Time Systems	E	CSC 460 or CENG 455
Elective	A course taken from the engineering electives listed below		Tables A and B
Elective	A course taken from the engineering electives listed below		Tables A and B
SOCIAL	Social and Professional Issues	N	ENGR 498 or SENG 400

Engineering Electives

Students can choose courses from the following two tables of core engineering electives for the five slots of fourth year engineering electives. To satisfy accreditation requirements, at least three of these courses must come from Table A. The remaining two courses may be chosen from Table A or Table B. However, with permission of the BSENG Program Director, most other courses with prefixes CSC, CENG, and ELEC may also be used to satisfy this elective requirement. The sixth or free elective course may be selected at any level and from any Faculty, including the Faculty of Engineering.

Engineering Electives Table A

YEAR 4	SUBJECT		EXISTING
CAP	Capstone Design Project (to allow two-term projects)	E	SENG 499
FTC	Fault-tolerant Computing	E	CSC 454
ALG2	Algorithms and Data Structures 2	E	CSC 326
ALG3	Analysis of Algorithms	E	CSC 425
CG	Computer Graphics	E	CSC 405
MMS	Multimedia Systems	E	SENG 410 or CSC 461
IKM	Information and Knowledge Management	N	None
NC	Network-centric Computing	M	SENG 450
DC	Distributed Computing	M	SENG 462 or CSC 462
MICRO	Microprocessor Systems	M	CENG 355
CSA	Computer Systems and Architecture	E	CENG 450
AI	Artificial Intelligence	E	CENG 420
PATREC	Pattern Recognition	E	ELEC 485
ROBOT	Robotics	E	ELEC 426 or MECH 430
ERGO	Ergonomics	E	SENG 412

Engineering Electives Table B

YEAR 4	SUBJECT		EXISTING
ARCH	Software Architecture	M	SENG 422
CBSE	Component Based Software Engineering	N	Topics course
CC	Compiler Construction	E	CSC 435
PL	Programming Languages	E	CSC 330
CON	Concurrency	N	None
CSCW	Computer Supported Collaborative Work	N	None
DSP	Digital Signal Processing	M	ELEC 310
COM	Communications	M	ELEC 350
MCOM	Mobile Communications	E	ELEC 456
WMC	Wireless and Mobile Computing	N	None
NUM	Numerical Methods	E	CSC 340
NA1	Numerical Analysis I	E	CSC 349A
NA2	Numerical Analysis II	E	CSC 349B
ORLP	Operations Research: Linear Programming	E	CSC 448A
ORSIM	Operations Research: Simulation	E	CSC 448B
MIN	Data Mining	N	None
SP	Software Process	E	SENG 470
AOOP	Advanced Object Oriented Design	E	SENG 430
MSD	Management of Software Development	E	SENG 472

The following table summarizes the components and the contributions of the key disciplines to the proposed software engineering degree program.

BSENG COMPONENT	NUMBER OF COURSES
Software Engineering	12
Engineering	7
Computer Science	6
Mathematics	6
Basic Science	4
Complementary Studies Electives	7
Engineering Electives	5
Total	47

3.3 Program Structure and Class Size

The program itself will have no additional specialties, minors or majors. Students will however still be able to pursue the *Software Engineering Option* within a Computer Science degree or a *Software Engineering Specialization* within a Computer Engineering degree.

The program size is expected to be 75 students per year. As for other programs in the Faculty, class size will vary depending on the level and whether the course is shared with other programs. Class size typically ranges from 150 – 175 in first year to 15 – 60 in fourth year electives. The student to faculty and student to teaching assistant and/or laboratory instructor ratios will be similar to existing programs.

3.4 Research Expectations

There have been software engineering research projects and courses at the University of Victoria since the late 1970's. The synergy between teaching and research in software engineering at the University of Victoria is exemplary. Undergraduate students participate in software engineering research projects and often continue as graduate students. Examples are Margaret-Anne Storey and Ken Wong, who started as undergraduates in computer science, became—as undergraduates—involved in software engineering research projects, and obtained their M.Sc. and Ph.D. degrees. Today they are software engineering professors at the Universities of Victoria and Alberta, respectively.

As an undergraduate program, the BSENG degree program will be primarily course based. However, many courses will include significant projects and all students will be required to complete a capstone design project. These projects will provide an opportunity for faculty to share their research expertise with students and, in many instances, for students to undertake research-related activities.

4. Learning Methodologies

4.1 Learning Environment

The learning environment will be similar to existing Electrical and Computer Engineering and Computer Science programs as the proposed BSENG program makes substantial use of existing courses. The learning environment is multifaceted and consists of classroom instruction, laboratory tutorials and projects, the capstone design project, and the mandatory work experience.

Advising is an important component throughout the proposed degree program. The Software Engineering Program Director ensures appropriate advising for BSENG students. The BSENG student advising team includes:

- The Software Engineering Program Director

- One faculty member from the Department of Computer Science

- One faculty member from the Department of Electrical and Computer Engineering

- The BSENG Program Office

- The BENG Programs Office

The BENG Programs Office advises first year students, who are in the common engineering first year. The BSENG Program Office is expected to advise mostly 2nd, 3rd, and 4th year BSENG students.

The Director also handles concerns and appeals regarding the BSENG program. Student concerns regarding a particular course shall, in the first instance, be handled by the course instructor, second by the Software Engineering Program Director, third by the appropriate Department Chair, and fourth by the Associate Dean or the Dean of Engineering.

4.2 Learning Methods

Experiential Learning—Work experience is mandatory for the existing BENG and optional for the existing Computer Science degree programs. The proposed BSENG has a mandatory work experience. The minimum total length of the work experience is 16 months. The requirement can be completed with the acquisition of an aggregate of at least 16 months of full time work periods. The shortest period of full time work recognized towards the aggregate is one month, but periods could range from 1 to 16 months, thus giving students ample flexibility. Under special circumstances students may be able to complete a portion of the work experience utilizing periods of half time work coupled with half time study. However, accumulations of "casual" work hours may not be applied to the completion of the work experience. Approval of special arrangements will be at the discretion of the Director of the BSENG Program and the Executive Director of Co-operative Education or their designates. Challenges or transfer of credit for up to eight months of the work experience are also permitted in the case of extensive relevant work experience *prior* to entering the program or appropriate work terms completed at a certified post-secondary institution. Regardless of the extent of prior work

experience, at least eight months of the work experience must be completed while the student is registered at the University of Victoria.

In addition to the above work experience, most courses include laboratory components, assignment, and projects emphasizing experiential learning. All students are required to complete a four-month capstone design project that can be extended to eight months.

Employability Skills—The proposed BSENG program covers a broad range of materials from theory to practice. The emphasis is on providing students with the necessary skills for careers as software engineers and the background for life-long learning required to succeed in the fast moving world of engineering and technology. The emphasis is not directly on skills for specific jobs, but clearly much of the course materials combined with the mandatory work experience will make graduates of this program eminently employable [10].

Lectures, Labs, and Tutorials—Courses will be primarily delivered in the on-site lecture mode. Labs and tutorials will form part of the course when appropriate. Labs can either be 'structured' (i.e., a sequence of experiments is executed with prescribed methods in a specific time slot) or 'non-structured' (i.e., substantial software development assignments and projects are carried out by the students using facilities provided by the University, but not in a specific time slot or under specific time constraints). However, for both lab types, progress and success is measured against specified performance requirements.

5. Faculty

Full implementation of the proposed software engineering degree program will require a significant number of additional faculty members, including a Director of Software Engineering, in the Department of Computer Science and the Department of Electrical and Computer Engineering. Four faculty positions have already been filled in direct support of the existing Software Engineering Option in the Department of Computer Science and of the Software Engineering Specialization in the Department of Electrical and Computer Engineering. The additional positions will be created with funding from the *Doubling the Opportunity (DTO)* initiative [2].

Anticipating ten filled positions in support of the software engineering program by July 1, 2003, there will be sufficient Faculty resources to start first and second year of the proposed degree program in September 2003. Further positions will be allocated in support of the software engineering program under subsequent years of DTO funding to start the third and fourth year of the degree program.

In addition to the positions above, several other faculty members are involved in software engineering research and education. A number of other members of the Faculty of Engineering have interests related to software engineering or teach courses that will be in direct support of the program.

Research and teaching profiles for the faculty members noted above can be accessed via the Department home pages (i.e., www.csc.uvic.ca and www.ece.uvic.ca).

6. Program Consultations and Evaluation

The program is built upon the current base of expertise in software engineering research and education in the Departments of Computer Science and Electrical and Computer Engineering at the University of Victoria. There are at present six faculty members whose research is specifically in the area of software engineering. A software engineering program option and specialization have been offered since 1998 in the Faculty of Engineering. The proposed program is thus a logical next step in the development of software engineering as a discipline at the University of Victoria.

6.1 Consultation

Many sources were consulted during the design of the curriculum of the proposed BSENG program. The IEEE/ACM[1] Computing Curricula Recommendation 2001 [7], including a draft of the Software Engineering Volume [8], was extensively consulted throughout the development of the proposed curriculum. The course descriptions of this IEEE/ACM recommendation were a critical source for the design of the BSENG program.   The IEEE/ACM recommendations represent a fully intensive consultation of computing and software engineering practitioners and educators worldwide.

A number of software engineering undergraduate degree programs, which have recently been started in Canada, the United States and other parts of the world, were also consulted during the development of the proposed BSENG curriculum. The following table lists some of the specific software engineering programs which were consulted. University of Waterloo's *Bachelor of Software Engineering (BSE)* [11] is probably the program most closely related to the proposed University of Victoria BSENG program. In particular, the Waterloo program is also jointly offered by the School of Computer Science and the Department of Electrical and Computer Engineering, but the two units are in different faculties.

INSTITUION	WEB SITES
Butler University	http://www.butler.edu/cs/
California Polytechnic Institute	http://ceng-web.calpoly.edu/computer_sci.html
Carleton University	http://www.carleton.ca/cu/ed4life/brochures/soft_eng.html
Concordia University	http://www.cs.concordia.ca/programs/ugrad/soen/soen.html
Drexel University	http://www.ece.drexel.edu/ECE/software.html
Lakehead University	http://www.lakeheadu.ca/~engwww/soft/tech_sched.html
McMaster University	http://www.cas.mcmaster.ca/cas/undergraduate/SEprogrammes.html http://www.eng.mcmaster.ca/Engineering1/interested/eng1.html
Milwaukee School of Engineering	http://www.msoe.edu/eecs/se/
Monmouth University	http://www.monmouth.edu/academics/ugprograms/seug.asp

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[1] The Institute of Electrical and Electronics Engineers (IEEE) and the Association of Computing Machinery (ACM) are the principal worldwide organizations for computing professionals.

Rochester Institute of Technology	http://www.se.rit.edu/degrees.php
University of Calgary	http://www.eng.ucalgary.ca/students/programs/student_software.htm
University of Ottawa	http://www.uottawa.ca/academic/info/regist/crs/0203/gngEN/gng-eng11.htm#4
University of Texas at Dallas	http://www.utdallas.edu/dept/eecs/se.html
University of Waterloo	http://www.softeng.uwaterloo.ca/
University of Wisconsin	http://www.uwplatt.edu/~se/
University of Western Ontario	http://www.engga.uwo.ca/electrical/default.htm

6.2 Evaluation

The program has been subject to the normal review process at the University of Victoria and was approved for submission by the *Senate Committee on Planning*.

Other British Columbia Institutions—Other British Columbia Institutions had the opportunity to comment upon the *Letter of Intent* in the normal manner through the *Degree Program Review Committee (DPRC)*. Comments received from DPRC are listed in Appendix B.

Institutions Outside of British Columbia—As noted, the programs at 16 universities, including eight in Canada, were reviewed during curriculum development. Software Engineering curriculum and accreditation have been topics of ongoing discussion at the national meetings of the Deans of Engineering and the Chairs of Computer Science for several years. University of Victoria representatives were active participants in these discussions.

External academic consultants—In May 2002, the Chair of the BSENG Curriculum Committee presented the proposed BSENG degree program to several leading academics at the *IEEE/ACM International Conference on Software Engineering (ICSE 2002)*.

6.3 Accreditation

Canadian Engineering Accreditation Board (CEAB) and the Computer Science Accreditation Council (CSAC)—Accreditation is designed to ensure that a program meets or exceeds the educational standards set by the accrediting bodies. CEAB for example specifies, in broad terms, the minimal program content required in mathematics, basic sciences, engineering science, engineering design, and complementary studies. The CSAC guidelines are similar.

The program has been constructed to meet both the CEAB and CSAC guidelines. We will apply for accreditation as soon as permitted (i.e., the year the first group of students graduate from the program). We will also discuss the program with the accreditation bodies and take advantage of pre-reviews that might be available.

Our assessment of the proposed program relative to CEAB course content criteria is shown in the following table. One AU (Accreditation Unit) corresponds to one lecture hour and 0.5 AU for each lab or tutorial hour.

BSENG SUBJECT AREA	Minimum AUs	Estimated AUs
Mathematics	195	402
Basic Sciences	225	300
Complementary Studies	225	278
Engineering Sciences	225	470
Engineering Design	225	446
Engineering Sciences and Design together	900	916
Total AUs in BSENG Program	1,800	1,896

Other aspects of the curriculum content criteria relate to laboratory experience, the roles of professional engineers in society, and approaches to independent learning. We anticipate these criteria will be readily satisfied by the proposed BSENG program.

CEAB and CSAC accreditation considers such issues as program leadership; the quality of the students, staff and faculty; laboratories; facilities including computing resources; library resources; and program governance. These have been considered in the program resource and management structure including the creation of the position of Director of Software Engineering [6].

As an ongoing process, accreditation will help ensure that the program is kept up to date and effective and that the curriculum content meets the guidelines of the *Association of Professional Engineers and Geoscientists of British Columbia.*

Over the last two years, six Canadian software engineering programs (i.e., Calgary, Concordia, Lakehead, McMaster, Ottawa, and Western Ontario) were accredited by CEAB [12, 13]. CEAB expects to evaluate ten other software engineering programs for possible accreditation within the next three years [13]. Three programs (i.e., Calgary, Saskatchewan, and Western Ontario) have been accredited by CSAC and thus meet the standards of the Canadian Information Processing Society [14].

6.4 Letters of Support

Appendix C lists letters in support of the BSENG degree program at the University of Victoria from leaders of the information technology sector in British Columbia and elsewhere.

7. Admission and Transfer

The BSENG degree program at the University of Victoria is designed to be a direct entry undergraduate program. Because the first year is the same for all engineering programs, students can complete first year and then choose among the software engineering, computer science, electrical engineering, computer engineering, and mechanical engineering programs. Students must declare this program as a major no later than the end of their second year of study.

The proposed software engineering program also allows for transfers from University Colleges and could connect to the existing bridge from colleges into Third Year Engineering. The Faculty of Engineering has well established transfer processes.

Work experience challenge based on appropriate prior employment will be permitted. Course challenge based on prior learning will not be permitted, but transfer credit for equivalent courses from other post-secondary institutions will be. This is consistent with current practice in the Faculty of Engineering.

8. Administrative Structure

The administrative structure document [6] outlines the mechanisms that implement the principles of equal sharing and joint management by the Department of Computer Science and the Department of Electrical and Computer Engineering in the Faculty of Engineering. It also secures the unique identity of the new program while ensuring that the operation and authority of the two home departments and their administrative structures remain intact.

The implementation of these principles is accomplished through the introduction of the following administrative structures: the *Software Engineering Program Board*, the *Software Engineering Program Director*, the *BSENG Curriculum Committee*, the *BSENG Work Experience Office*, the *Software Engineering Program Office*, and the *Faculty of Engineering Undergraduate Programs Coordination Committee*.

Introducing a new interdisciplinary program, such as the BSENG program, is a balancing act. All programs in the Faculty of Engineering are important. The BSENG program should not grow to the detriment of other programs. A key overall objective is to offer high-quality programs across the entire Faculty of Engineering.

In summary, the administrative structure provides effective mechanisms for faculty and staff to deliver high-quality software engineering programs. Thus, students in the proposed University of Victoria Bachelor of Software Engineering program can concentrate on acquiring knowledge and skills through the balanced state-of-the-art BSENG curriculum.

References

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Appendix A: Letter of Intent

Appendix B: Comments from other institutions on the LOI

Appendix C: Letters in Support of BSENG Program

Appendix D: Calendar Course Descriptions