S.07-52

SIMON FRASER UNIVERSITY

Senate Committee on University Priorities
Memorandum

TO: Senate

FROM: John Waterhouse
Chair, SCUP
Vice President, Academic

RE: Proposal for a Bachelor of Applied Science in Mechatronic Systems Engineering (Major, Honors, and Minor) (SCUP 07-18)

DATE: March 2, 2007

At its February 21, 2007 meeting SCUP reviewed and approved the proposal from the Faculty of Applied Sciences for a Bachelor of Applied Science in Mechatronic Systems Engineering (Major, Honors, and Minor).

Motion

That Senate approve and recommend to the Board of Governors, the proposal for a Bachelor of Applied Science in Mechatronic Systems Engineering (Major, Honors, and Minor) offered by the Faculty of Applied Sciences.

encl.

c: M. Saif
F. Golnaraghi

SIMON FRASER UNIVERSITY

MEMORANDUM

To: Senate Committee on University Priorities

From: B. Krane, Chair
Senate Committee on Undergraduate Studies

Subject: Curriculum Revisions
Faculty of Applied Sciences (SCUS 07-07a)

Date: 8 February 2007

Action undertaken by the Senate Committee on Undergraduate Studies at its meeting of 6 February 2007 gives rise to the following recommendation:

Motion:

"that SCUP approve and recommend to Senate the Bachelor of Applied Science in Mechatronics Systems Engineering."

The relevant documentation for review by SCUP is attached.

Mechatronic Systems Engineering
Full Program Proposal

Farid Golnaraghi, Program Director for MSE at Surrey

February 8, 2007

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1. Executive Summary

The School of Engineering Science at Simon Fraser University has embarked on a major initiative to develop new undergraduate and graduate degree programs in Mechatronic Systems Engineering (MSE) to be offered at the SFU Surrey Campus.

It is proposed that the Mechatronic Systems Engineering (MSE) program start at SFU's Surrey campus in Fall 2007. MSE is a multidisciplinary engineering program that integrates mechanical, electronics, control, software, and computer engineering for the design and development of computer-controlled electromechanical products and systems. These systems are used in a range of industries including automotive, manufacturing, robotics, biomedical, aerospace, and consumer products.

Mechatronics "is the synergistic combination of mechanical engineering ('mecha' for mechanisms, i.e., machines that move), electronic engineering ('tronics' for electronics), and software engineering. The purpose of this interdisciplinary engineering field is the study of automata from an engineering perspective to permit the control of advanced hybrid systems. [It] is centred on mechanics, electronics and computing which, combined, make possible the generation of simpler, more economical, reliable and versatile systems." (http://www.answers.com/topic/mechatronics)

Simon Fraser University opened its newest campus in Surrey in September 2002. SFU Surrey currently offers programs in a wide variety of disciplines. The new MSE program is expected to link with the School's existing strengths on the Burnaby campus in microelectronics, telecommunications, intelligent systems, control, and biomedical engineering. It is also intended that the training of MSE students should benefit from the Surrey campus entrepreneurship, management, business, and communication expertise.

Vision Statement: Our goal is to train Mechatronic System engineering students with strong communication and business acumen. Upon completion of their degree, the Surrey MSE graduates will have:

1. A strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering
2. A minimum of one year of related industry work experience through participation in the Engineering Science Co-op Program
3. Enhanced oral and written communication skills through paticipation in the TechOne program
4. Entrepreneurial and business skills and a solid command of the newest technologies

This full proposal describes the proposed MSE undergraduate curriculum course descriptions and overall program requirements for approval by SFU's SCUP and Senate.

2. Introduction

The School of Engineering Science at Simon Fraser University has embarked on a major initiative to develop new undergraduate and graduate degree programs in Mechatronic Systems Engineering (MSE) to be offered at the SFU Surrey Campus starting Fall 2007. Consequently the School has hired three faculty members for its new MSE program, and is currently looking for more candidates to complement its MSE faculty. (http://web.ensc.sfu.ca/website/job_postings/mechatronic)

The first mandate of the School was to develop a full undergraduate curriculum. The new curriculum is a combination of existing and new courses and was approved by the faculty in December 2006. The Notice of Intent was approved by SCUP in January 2007 and appears in Appendix 3.

Credential to be Awarded

BASc (Bachelor of Applied Science)

Location

Surrey

School/Faculty Offering Program

Engineering Science/Faculty of Applied Sciences

Anticipated Program Start Date

September 2007

Description of Proposed Program

The semester-by-semester outline of the new program is given below.

Aims, goals and/or objectives

To produce graduates capable of combining electrical engineering, mechanical engineering and computing. Graduates should also have exceptional communication skills and an understanding of entrepreneurship.

Anticipated contribution to the mandate and strategic plan of the institution

This program will increase the University's graduates in the high-tech sector, thus helping to fulfill the commitments the University has made under the 'Double the Opportunity' initiative. It will also attract students to the Surrey campus, helping to fulfill the University's growth targets for that campus.

Target audience

The program is directed mainly at high-school graduates; however, some students may be accepted into later years of the program via college transfer.

Delivery methods

Courses will be delivered by a combination of lectures and laboratory work. 5.

Linkages between the learning outcomes and the curriculum design, including an indication whether a work experience/work place term is required for degree completion

Developing skill in engineering requires a solid foundation in mathematics and the sciences, together with a mastery of engineering disciplines and the opportunity to apply them in one or more capstone design projects. An essential part of the engineer's education is the application of skills in a work environment, and for this reason a minimum of three Coop semesters is required for completion of the program.

Distinctive characteristics

This program differs from the engineering programs offered on SFU's Burnaby campus, and from all other engineering programs in BC, by its combination of mechanical and electrical engineering to cover the new field of *mechatronics*. It will also be distinctive in its emphasis upon engineering communications, and its strong interactions with students in SFU's business programs.

The program combines basic mathematics, science and TechOne courses available in the Surrey campus with engineering and specialized mechatronics courses. Major efforts were made to take advantage of the Surrey campus strengths including Communication, Business, Management and Entrepreneurship, in the training of the MSE students. Our vision is to train engineering students with strong technical knowledge, excellent communication skills, and an understanding of business; engineers who will develop products that cater to public needs; engineers who can communicate their ideas to non-engineers and in return can understand their requirements and needs; engineers who will ultimately stay in BC and join start-up companies or start their own. The last statement reflects our belief that smaller companies form BC's industrial future, and this will be a focus of SFU's MSE program.

Anticipated completion time in years or semesters

Eight academic semesters, plus at least three Coop semesters.

Enrolment plan for the length of the program

It is anticipated that the majority of students will enter the program by taking the TechOne program with a suitable set of electives, giving a first-year class of about 50 students. A small number of additional students may enter the program via college transfer.

Policies on student evaluation

As per general regulations for the University and the Faculty of Applied Science.

Policies on faculty appointments (minimum qualifications)

Faculty will normally hold a PhD. Eligibility for Professional Engineering Registration is required. Industrial experience is highly valued.

Program Resources

This will be a new program, additional to the engineering options currently offered at the Burnaby campus, so no activities will be reduced or eliminated when it starts up. To mount the program, approximately 15 full-time CFL faculty will be required, the first three of whom have already been hired. In addition, the program will require 8 support staff, some clerical, some technical. The total space requirement, including laboratories and faculty offices, will be 2,282 square meters. Equipping the laboratories will require one-time start-up costs of $750,000-$1,000,000. In steady-state, the program will have an operating budget of $180,000/year

Policies on program assessment

Like all SFU programs, the program will be externally reviewed at seven-year intervals. In addition, the program will be reviewed at least every six years by the Canadian Engineering Accreditation Board, or

CEAB.

Level of support and recognition from other post-secondary institutions, (including plans for admissions and transfer within the British Columbia post-secondary education system) and relevant regulatory or professional bodies, where applicable

The program will apply for recognition and accreditation from the CEAB the year before its first students are due to graduate. The program will work with BCCAT to facilitate articulation with appropriate programs at college level.

Evidence of student interest and labour market demand

Recent surveys (from across Canada and US) indicate that the demand for Mechanical Engineering is on the rise, to the point that a number of Canadian Mechanical Engineering departments cannot meet the demand. Engineering Science has a solid reputation in the community and the Mechatronic Systems Engineering program will allow it to extend its offerings to combine Mechanical Engineering with its established strength in Electronic Engineering.

Related programs in your own or other British Columbia post-secondary institutions.

Although there are other British Columbian and Canadian programs described as 'mechatronics', notably at UBC, all these programs, with the possible exception of Waterloo's, are based in pre-existing mechanical engineering departments which already have an established culture. These programs tend to offer a mechanical engineering curriculum with the addition of a few electrical engineering courses, or one or two courses labeled mechatronics. By contrast, there was no mechanical engineering program at SFU, and the proposed program is being built from the ground up as mechatronics for students interested in truly pursuing mechatronics. For this reason, the program will be unique in British Columbia.

The following sections include program and course descriptions. All courses listed have been approved by SCUS. Course descriptions for newly-approved courses are attached.

3. Program Overview

The proposed curriculum comprises eight academic semesters, starting Fall 2007. It includes a blend of existing and new courses designed specifically for the MSE students. All courses are to be offered in the Surrey campus, except for the Introduction to MEMS course that requires access to the "clean rooms" only available at the Burnaby campus.

The program listing as it will appear in the 20007/08 calendar is is shown next, where <u>underlined</u> courses represent new engineering courses specifically designed for the MSE program.

<u>Semester One (Fall)</u>

CHEM 120-3 (B-sci) in Surrey or **CHEM 121-4 (B-Sci)** General Chemistry and Laboratory I in Burnaby

MATH 151-3 Calculus I*

CMPT 128-3 Introduction to Computing Science and Programming for Engineers*

PHYSICS 140-4 Studio Physics – Mechanics and Modern Physics*

TECH 114-3 (B-Soc) Technology in Everyday Contexts

TECH 106-3 Spatial Thinking and Communicating

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

9 credit hours

Semester Two (Spring)

MATH 232-3 Elementary Linear Algebra*

MATH 152-3 Calculus II*

PHYSICS 141-4 Studio Physics – Optics, Electricity and Magnetism*

Cmpl I-3 first complementary elective[1]

ENSC 182-3 Mechatronics Design I*

TECH 101-3 (W) Communication, Teamwork and Collaborative Process

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

[1]must be an approved course. A pre-approved list of complementary studies courses is available from the School of Engineering Science.

19 credit hours

Semester Three (Fall)

ENSC 281-3 Statics and Strength of Materials*

MATH 251-3 Calculus III*

ENSC 231-3 Engineering Materials

Cmpl II-3 second complementary elective[1]

ENSC 220-3 Electric Circuits 1*

MATH 310-3 Introduction to Differential Equations*

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

18 credit hours

Semester Four (Summer)

ENSC 282-3 Kinematics and Dynamics of rigid bodies and Mechanisms*

ENSC 283-3 Introduction to Fluid Mechanics*

ENSC 226-4 Electronic Circuits *

PHYSICS 231-3 Physics Laboratory II*

ENSC 380-3 Linear Systems*

MACM 316-3 Numerical Analysis I

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

19 credit hours

Semester Five (Spring)

ENSC 382-3 Machine Design*

ENSC 381-3 Systems modeling and simulation*

ENSC 331-3 Introduction to MEMS*

ENSC 329-4 Introduction to Digital Logic*

PHYSICS 344-3 Thermal Physics*

ENSC 311-3 The Business of Engineering I: Fundamentals*

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

[1]must be an approved course. A pre-approved list of complementary studies courses is available from the School of Engineering Science.

19 credit hours

Semester Six (Fall)

ENSC 384-4 Mechatronics Design II*[2]

ENSC 383-4 Feedback Control Systems*[2]

ENSC 332-4 Microprocessors and Interfacing*

ENSC 387-4 Introduction to Electromechanical Sensors and Actuators*[2]

ENSC 312-3 The Business of Engineering II: Applications and Commercialization*

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

[2] Strongly recommended to be taken concurrently

19 credit hours

Semester Seven (Spring)

ENSC 489-4 Computer Aided Design and Manufacturing*

ENSC 451-4 Real Time and Embedded Systems*

ENSC 441-3 Capstone Design Technical Project I*

ENSC II-4 first Engineering elective[3]

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

[3] chosen from a list of ENSC-approved courses. With permission of the undergraduate curriculum committee chair, students may replace one engineering science elective with either a directed study or a special project laboratory course. Special Topics courses that have been approved by the undergraduate curriculum committee chair and the director may be counted here.

15 credit hours

Semester Eight (Fall)

ENSC 484-4 Industrial Control Systems*

ENSC III-4 second Engineering elective[3]

ENSC IV-4 third Engineering elective[3]

ENSC 407-1 Engineering Laws and Ethics

ENSC 442-3 Capstone Design Technical Project II*

[3] chosen from a list of approved electives. With permission of the undergraduate curriculum committee chair, students may replace one engineering science elective with either a directed study or a special project laboratory course. Special Topics courses that have been approved by the undergraduate curriculum committee chair and the director may be counted here.

16 credit hours

Additional Requirements for Honors

ENSC 498-3 Engineering Science Thesis Proposal (H)

ENSC 499-9 Engineering Science Undergraduate Thesis (H)

Total 144 credit hours (G); 156 credit hours (H)

4. New Courses Developed for this Proposal

The following courses have been developed specifically for the Mechatronics program, and were approved by the Senate Committee on Undergraduate Studies on February 6, 2007.

ENSC 182: Mechatronics Design I

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC182

ENSC 226: Electronic Circuits

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC226

ENSC 231: Engineering Materials

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC231

ENSC 281: Statics and Strength of Materials

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC281

ENSC 282: Kinematics and Dynamics

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC282

ENSC 283: Introduction to Fluid Mechanics

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC283

ENSC 311: The Business of Engineering I

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC311

ENSC 312: The Business of Engineering II

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC312

ENSC 329: Introduction to Digital Logic

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC329

ENSC 331: Introduction to MEMS

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC331

ENSC 332: Microprocessors and Interfacing

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC332

ENSC 381: Systems Modelling and Simulation

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC381

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ENSC 382: Machine Design

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC382

ENSC 384: Mechatronics Design II

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC384

ENSC 441: Capstone Design Project I

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC441

ENSC 442: Capstone Design Project II

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC442

ENSC 451: Real-Time and Embedded Systems

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC451

ENSC 484: Industrial Control Systems

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC484

Appendix 1: Descriptions of All Courses in the MSE Program

YEAR 1 – Semester 1

CHEM 120-3

Atomic and molecular structure; chemical bonding; thermochemistry; elements; periodic table; gases liquids, solids, and solutions. This course includes a laboratory component. Quantitative/Breadth-Science.

MATH 151-3 Calculus I

Designed for students specializing in mathematics, physics, chemistry, computing science and engineering. Logarithmic and exponential functions, trigonometric functions, inverse functions. Limits, continuity, and derivatives. Techniques of differentiation, including logarithmic and implicit differentiation. The Mean Value Theorem. Applications of Differentiation including extrema, curved sketching, related rates, Newton's method. Antiderivatives and applications. Conic sections, polar coordinates, parametric curves.

CMPT 128-3 Introduction to Computing Science and Programming for Engineers

An introduction to computing science and computer programming, suitable for students wishing to major in Engineering Science or a related program. This course introduces basic computing science concepts, and fundamentals of object oriented programming. Topics include: fundamental algorithms and problem solving; abstract data types and elementary data structures; basic object-oriented programming and software design; elements of empirical and theoretical algorithmics; computation and computability; specification and program correctness; and history of computing science. The course will use a programming language commonly used in Engineering Science.

PHYSICS 140-4 Studio Physics – Mechanics and Modern Physics

A general calculus-based introduction to mechanics taught in an integrated lecture-laboratory environment. Topics include translational and rotational motion, momentum, energy, gravitation, and selected topics in modern physics.

TECH 114-3 (B-Soc) Technology in Everyday Contexts

Introduces the role of technologies in an increasingly complex world. Explores the nature and evolution of technology. Provides first-hand experience with a variety of computer, communication and engineering technologies and assesses the impact and consequences of technology on both the individual and societal levels. Themes examined in this course focus on the use of technologies in situated applications and everyday contexts, giving students experience in relating the achievements of technology to human needs.

TECH 106-3 Spatial Thinking and Communicating

Introduces the world of 3D thinking, representation and communication, with a focus on spatial thinking. Provides the foundational skills and knowledge needed to understand, create, and use computer-generated 3D representations. Covers the technical bases of representing 3D environments, as well as cognitive science

theories of visual thinking.

YEAR 1 – Semester 2

MATH 232-3 Elementary Linear Algebra

Matrix arithmetic, linear equations, and determinants. Real vector spaces and linear transformations. Inner products and orthogonality. Eigenvalues and eigenvectors.

In addition to regularly scheduled lectures, students registered in this course are encouraged to come for assistance to the Algebra Workshop (Burnaby), or Math Open Lab (Surrey).

MATH 152-3 Calculus II

Riemann sum, Fundamental Theorem of Calculus, definite, indefinite and improper integrals, approximate integration, integration techniques, applications of integration. First-order separable differential equations. Sequences and series, series tests, power series, convergence and applications of power series. Complex numbers.

PHYSICS 141-4 Studio Physics – Optics, Electricity and Magnetism

A general calculus-based introduction to electricity, magnetism and optics taught in an integrated lecture-laboratory environment. Topics include electricity, magnetism, simple circuits, optics and topics from applied physics.

Cmpl 1-3 credits - First Complementary Elective Course

ENSC 182-3 Mechatronics Design I

First year project course designed to provide students with a first exposure to the challenges of project organization. Students are responsible for designing and constructing a mechanical robot optimized to solve a particular chosen task. The engineering challenges of the project are expected to focus half on mechanical design and half on control algorithm design and implementation.

A full course description accompanies this proposal, and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC182

TECH 101-3 (W) Communication, Teamwork and Collaborative Process

Teaches essential skills for negotiating first-year coursework successfully. Covers the principles, practice and understanding of effective communication, research, critical thinking and teamwork needed within both face-to-face and virtual environments. Presents opportunities to practice and develop communication and interpersonal skills, and make that expertise transferable from the classroom to the workplace. (Equivalent to ENSC 101 with additional topics on project management, teamwork and presentational skills.)

YEAR 2 – Semester 1

ENSC 281-3 Statics and Strength of Materials

Covers basic concepts of mechanics, vectors. Statics of particles. Rigid bodies and force systems, equilibrium of rigid bodies. Analysis of trusses and frames. Distributed forces, centroids and moments of inertia. Friction. Internal shear and bending moments in beams. Strength of Material: Introduction to mechanical response of materials and stress-strain relationships. Behaviour of prismatic members in tension, compression, shear, bending and torsion. Stress and strain transformations. Virtual work and energy methods.

A full course description is attached, and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC281

MATH 251-3 Calculus III

Rectangular, cylindrical and spherical coordinates. Vectors, lines, planes, cylinders, quadric surfaces. Vector functions, curves, motion in space. Differential and integral calculus of several variables. Vector fields, line integrals, fundamental theorem for line integrals, Green's theorem.

ENSC 231-3 Engineering Materials

Materials, their structures, properties and performance; crystal structures and instruments for structure determination; polymers, ceramics, and composites; quality control and reliability.

This is equivalent to the existing Burnaby-campus course ENSC 330-4 (without the lab). A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC231

Cmpl II-3 credits - Second Complementary Elective Course

ENSC 220-3 Electric Circuits 1

This course will cover: fundamental electrical circuit quantities, and circuit elements; circuits laws such as Ohm law, Kirchoff's voltage and current law, along with series and parallel circuits; operational amplifiers; network theorems; nodal and mesh methods; analysis of natural and step response of first (RC and RL), as well as second order (RLC) circuits; real, reactive and rms power concepts.

MATH 310-3 Introduction to Differential Equations

First-order differential equations, second- and higher-order linear equations, series solutions, introduction to Laplace transform, systems and numerical methods, applications in the physical, biological and social sciences.

YEAR 2 – Semester 2

ENSC 282-3 Kinematics and Dynamics of Rigid Bodies and Mechanisms

Planar and 3D motions kinematics and kinetics of rigid bodies and mechanisms; linkages, gears, cams; Synthesis and analysis of mechanisms; Consideration of the static and dynamic forces in machines; Vibration analysis, response to shock, motion and force transmissibility, vibration isolation.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC282

ENSC 283-3 Introduction to Fluid Mechanics

Physical properties of fluids and fundamental concepts in fluid mechanics. Hydrostatics. Conservation laws for mass, momentum and energy. Flow similarity and dimensional analysis as applied to engineering problems in fluid mechanics. Laminar and turbulent flow. Engineering applications such as flow measurement, flow in pipes and fluid forces on moving bodies.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC283

ENSC 226-4 Electronic Circuits

Introduces the basic electronic components, amplifiers, diodes, and oscillators. Fundamentals of logic design.

This course combines elements of the existing courses ENSC 225-4 Microelectronics I and ENSC 325-4 Microelectronics II. A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC226

PHYSICS 231-3: Physics Laboratory II

Introductory physics laboratory with experiments chosen from mechanics, heat, optics, electricity, magnetism, properties of matter, atomic and nuclear physics, along with lectures on the use of computers for data acquisition and data analysis in the physics laboratory. The course consists of a weekly combination of a three hour lab and one hour lecture.

ENSC 380-3: Linear Systems

The objectives of this course are to cover the modeling and analysis of continuous and discrete signals using linear techniques. Topics covered include: a review of Laplace transforms; methods for the basic modeling of physical systems; discrete and continuous convolution; impulse and step response; transfer functions and filtering; the continuous Fourier transform and its relationship to the Laplace transform; frequency response and Bode plots; sampling; the Z-transform.

MACM 316-3 Numerical Analysis I

A presentation of the problems commonly arising in numerical analysis and scientific computing and the basic methods for their solutions.

YEAR 3 – Semester 1

ENSC 382-3 Machine Design

Review of stress and strain in solids, superposition, energy theorems, theories of failure, elastic and inelastic analysis of symmetrical bending, torsion of circular members, and virtual work. Adequacy assessment and synthesis of machine elements with a focus on the design process. Static failure of ductile and brittle materials, fatigue analysis of structures. Topics include the design of welds, bolted connections, springs and shafts. Solution strategies include both analytical and finite element methods.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC382

ENSC 381-3 Systems modeling and simulation

Introduction to systems modeling and analysis. Application to engineering systems including: Mechanical, Electrical, Thermal, and Fluid Systems. Allows the student to acquire, in a time-efficient and uncomplicated manner, knowledge in the formation and construction of dynamic models. The simulation models that the student will design in this course accommodate these analyses, with the construction of realistic hypotheses and elaborate behavior models.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC381

ENSC 331-3 Introduction to MEMS

An introduction to micro-electro-mechanical systems, covering thin-film processing technologies, bulk and surface micromachining, and MEMS applications.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC331

ENSC 329-4 Introduction to Digital Logic

Conveys the essential principles of digital logic systems which are the building blocks of many electronic systems including computer systems. These principles form the basis of the electronics component of the mechatronics curriculum and therefore a good understanding of the material is crucial.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC329

PHYS 344-3 Thermal Physics

Heat, temperature, heat transfer, kinetic theory, laws of thermodynamics, entropy, heat engines, applications of thermodynamics to special systems, phase transitions.

ENSC 311-3 The Business of Engineering I – Fundamentals

Provides fundamentals of the business, management and entrepreneurial concepts important to Canadian engineers who manage projects, run businesses, or need to decide on the most efficient method for accomplishing a task. Topics include the Canadian business environment, theories of management thought, forms of ownership, corporate structure and growth, the process of management - planning, organization theory, motivation, control and communication. Additional topics include financial accounting, rates of return, taxes, cost-benefit analysis, marketing, financing methods, and business plan.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC311

YEAR 3 – Semester 2

ENSC 384-4 Mechatronics Design II

Interweaves mechanisms, electronics, sensors, and control strategies with software and information

technology to examine the demands and ideas of customers, and find the most efficient, cost-effective method to transform their goals into successful commercial products. Most of the term is devoted to a significant design project in which student groups work independently and competitively, applying the design process to a project goal set by the faculty coordinator.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC384

ENSC 383-4 Feedback Control Systems

This course provides an introduction to the analysis, design, and applications of continuous-time, linear control systems. Topics include transfer function representations of open and closed loop systems, time domain specifications and steady state error, time and frequency response, and stability criteria. It includes a treatment of methods for the analysis of control systems based on the Root Locus and the Nyquist criterion, and their use in the design of PID and lead-lag compensation. Laboratory exercises and the use of computer-aided design tools are included in this course.

ENSC 332-4 Microprocessors and Interfacing

Covers basic microcomputer architecture, design and analysis of address decoders and memory systems, design and analysis of assembly language programs and microcomputer system design.

A full course description is attached and may also be found at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC332

ENSC 387-4 Introduction to Electromechanical Sensors and Actuators

Provides an introduction to the theory and application of sensors and actuators for electromechanical, computer controlled-machines and devices. Topics include operating principles, design considerations, and applications of analog sensors, digital transducers, magnetic circuits, stepper motors, continuous-drive actuators, and drive system electronics. Component integration and design considerations are illustrated through examples selected from applications of machine tools, precision machines, robotics, aerospace, and transportation. Laboratory exercises strengthen the understanding of component performance, system design and integration.

ENSC 312-3 The Business of Engineering II – Commercialization

Offered in conjunction with ENSC384 (Mechatronics Design II). Concepts covered include project management skills such as budgeting, scheduling earned value analysis as well as facilitation, communication and negotiation. Students will experience what it is like to be part of a diverse project team while working on a specific project. The business topics covered in ENSC 311 are reinforced in this course. These topics include financial accounting, rates of return, taxes, cost-benefit analysis, marketing, financing methods, and business plan.

A full course outline is attached and is also available at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC312

YEAR 4 – Semester 1

ENSC 489-4 Computer Aided Design and Manufacturing

Survey of methods for computer aided design and manufacturing (CAD/CAM), including experience with basic systems in the laboratory component of the course. The student will be introduced to computer integrated manufacturing and flexible manufacturing systems concepts. The use of finite element modelling and analysis will be presented through examples from thermal studies as well as mechanical stress analysis. Issues in constructing and using integrated CAD/CAM in a produciton environment will be discussed. Emphasis will be on the use of such techniques in light industry, particularly related to electronics manufacturing. A manufacturing cell, consisting of several robots and computer control systems, will be available for for student projects.

ENSC 451-4: Real Time and Embedded Control Systems

Focuses on implementation and design of embedded computer control systems used in mechatronics and other applications. Many of these systems are real-time in nature, meaning that the computer system must discern the state of the world and react to it within stringent response-time constraints. Upon completion of the course, the student will have a basic understanding of how to design, build and integrate hardware and software for an embedded control application. Hands-on experience will be gained by performing laboratory experiments and doing an embedded computer control project on a mechatronic system.

A full course outline is attached and is also available at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC451

ENSC 441-3 Capstone Design Technical Project - I

Students will combine their technical, marketing, and entrepreneurship knowledge to conceive, and design a product. Also includes project documentation and project management. At the end of the term a comprehensive report is required.

A full course outline is attached and is also available at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC441

ENSC II-4 first Engineering elective

YEAR 4 – Semester 2

ENSC 484-4 Industrial Control Systems

Examines modern industrial control systems and applications. Topics include: review of industrial sensors and actuators; computer interfacing; ladder logic and programmable logic controllers; industrial computer and programming methods; industrial networks; human-machine interfaces; supervisory control and data acquisition (SCADA); manufacturing execution systems; and enterprise-wide integration.

A full course outline is attached and is also available at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC484

ENSC 442-3 Capstone Design Technical Project - II

Students will apply their technical, marketing and entrepreneurship knowledge to develop a product earlier designed in ENSC 441, then present and be able to sell it to a panel of engineers, business and investment community.

A full course outline is attached and is also available at:

http://fas.sfu.ca/ucc/Papers/2006/2006-86/ENSC442

ENSC II-4 second Engineering elective

ENSC 1-4 third Engineering elective

ENSC 407-1 Engineering Laws and Ethics

This course uses lectures, case studies and group discussions to increase awareness and understanding of the legal and ethical responsibilities of professional engineers. Students exercise their skills as critical thinkers and persuasive writers.

Simon Fraser University
school of engineering science

Preapproved Complementary Electives

Source: http://web.ensc.sfu.ca/undergraduate_program/courses/comp_post06

Complementary Studies Electives and Breadth (Hum/Soc) Requirements

All Engineering Science students are required to complete 2 courses (6 credits) of Complementary Studies - Cmpl I-3 and Cmpl II-3. To comply with the rules of the Canadian Engineering Accreditation Board (CEAB), at least one of these two courses (or 3 credits) must deal with the central issues, methodologies and thought processes of the humanities and social sciences. Also, students admitted to SFU from Fall 2006 onward are required to take courses to fulfill the B-Soc (Breadth-Social Science) and B-Hum (Breadth-Humanity) requirements. The normal requirements are 6 credits (or 2 courses) each of B-Soc and B-Hum.

For students in the Computer Engineering, Electronic Engineering, Engineering Physics, and System Engineering options, the university has agreed to reduce the total credits required in B-Soc and B-Hum courses to 9 (or 3 courses), with at least one course (3 credits) in each category. Since ECON 103-3 is a B-Soc course, these students will use Cmpl I-3 and Cmpl II-3 to satisfy the rest of the B-Soc and B-Hum requirements. Note that one of Cmpl I-3 and Cmpl II-3 must be in the Central Issue, Methodology, and Thought Process category as required by CEAB

For students in the Biomedical Engineering option, the university has agreed to further reduce the total credits required in B-Soc and B-Hum courses to 6 (or 2 courses), with at least one course in each category. Since GERO 300-3 is a required complementary elective course in the Biomedical Engineering curriculum, and it is both a designated B-Soc course as well as a course in the Central Issue, Methodology, and Thought Process category, it means Biomedical students must use the remaining free complementary elective to satisfy the B-Hum requirement. This course needs not be a course in the Central Issue, Methodology, and Thought Process category as required by CEAB

For a complete list of certified designated B-Hum and B-Soc courses, please click here. The subset that also meets CEAB expectations of a complementary studies elective are provided below. They are divided into the "Central Issues, Methodology and Thought Processes" and "Other" categories. This is the list where Cmpl I-3 and Cmpl II-3 should be chosen from. Failure to do so may result in delay in graduation. If you are unsure,

please consult your advisor. Before contacting your advisor, you may want to first study the section on Valid Combinations of Cmpl I-3 and Cmpl II-3 at the end of this page If you plan to take courses outside the pre-approved list, please consult the chair of the Undergraduate Curriculum Committee.

A. Courses on Central Issues, Methodology and Thought Processes

All students must take at least one course in this category.
Note: these course have been deemed to cover ideas and techniques that are in the ``mainstream" of the humanities. Courses intented to teach specific skills (such as ENGL 214-3 and FPA 120-3), that don't contain sufficient ``analysis" (such as BISC 003-3), or are too focussed on a specific application (such as KIN 140-3 and CRIM 151-3) are generally not acceptable in this category.

Archaeology

ARCH 100-3 Ancient Peoples and Places
ARCH 131-3 Human Origins
ARCH 223-3 The Pre-history of Canada
ARCH 272-3 Archaeology of the Old World
ARCH 273-3 Archaeology of the New World

Criminolgy

CRIM 101-3 Introduction to Criminology

Economics

ECON 102-3 Twentieth Century Economics
ECON 105-3 Principles of Macroeconomics

Education

EDUC 230-3 Introduction to the Philosophy of Education

English

ENGL 101-3 Introduction to Fiction
ENGL 102-3 Introduction to Poetry
ENGL 103-3 Introduction to Drama
ENGL 104-3 Introduction to the Essay as Literature

Geography

GEOG 100-3 Human Geography
GEOG 102-3 World Problems in Geographical Perspective

GEOG 162-3 Canada
GERO 300-3 Introduction to Gerontology

History

HIST 101-3 Canada to Confederation
HIST 102-3 Canada Since Confederation
HIST 105-3 Western Civilization from the Ancient World to the Reformation Era
HIST 106-3 Western Civilization from the Reformation Era to the 20th Century
HIST 151-3 The Modern Middle East
HIST 225-3 20th Century Europe

Humanities

HUM 102-3 Classical Mythology
HUM 201-3 Great Texts in the Humanities I
HUM 202-3 Great Texts in the Humanities II
HUM 230-3 Introduction to Religious Studies

Latin American Studies

LAS 140-3 Cultural Heritage of Latin America
LAS 200-3 Introduction to Latin American Issues

Philosophy

PHIL 100-3 Knowledge and Reality
PHIL 120-3 Introduction to Moral Philosophy
PHIL 150-3 History of Philosophy I
PHIL 151-3 History of Philosophy II
PHIL 300-3 Introduction to Philosophy

Political Science

POL 100-3 Introduction to Politics and Government
POL 151-3 The Administration of Justice

Psychology

PSYC 100-3 Introductory Psychology I
PSYC 102-3 Introduction to Psychology II
PSYC 106-3 Social Issues

Sociology and Anthropology

SA 100-4 Perspectives on Canadian Society

SA 101-4 Introduction to Anthropology
SA 150-3 Introduction to Sociology

Women's Studies

WS 101-3 Introduction to Women's Issues in Canada
WS 102-3 Introduction to Western Feminisms

B. Courses in the "Other" Category

Communication

CMNS 110-3 Introduction to Communication Studies

Contemporary Arts

FPA 111-3 Issues in the Fine and Performing Arts
FPA 136-3 The History and Aesthetics of Cinema I
FPA 140-4 Music in the 20th Century
FPA 147-3 Introduction to Electroacoustic Music

Criminolgy

CRIM 131-3 Intro. to the Crim. Justice System -- A Total System Approach
CRIM 135-3 Introduction to Canadian Law and Legal Institutions

Performing Arts

FPA 147-3 Introduction to Electroacoustic Music

Valid Combinations of Cmpl I-3 and Cmpl II-3

(a) for Computer Engineering, Electronics Engineering, Engineering Physics, Mechatronic Systems Engineering, and System Engineering students

Scenario 1:

	Central Issues, Methodology and Thought Processes	Others
B-Soc	Cmpl I	
B-Hum	Cmpl II	

Scenario 2:

	Central Issues, Methodology and Thought Processes	Others
B-Soc	Cmpl I	
B-Hum		Cmpl II

Scenario 3:

	Central Issues, Methodology and Thought Processes	Others
B-Soc		
B-Hum	Cmpl I	Cmpl II-3

Scenario 4 :

	Central Issues, Methodology and Thought Processes	Others
B-Soc		
B-Hum	Cmpl I Cmpl II	

(b) for Biomedical Engineering Students

Scenario 5:

	Central Issues, Methodology and Thought Processes	Others
B-Soc	GERO 300	
B-Hum	Cmpl II	

Scenario 6:

	Central Issues, Methodology and Thought Processes	Others
B-Soc	GERO 300	
B-Hum		Cmpl II

Updated August 2006

Appendix 2: WQB Analysis

The UCITF has accepted that ENSC students in all existing options except Biomedical Engineering can replace the requirement to take two B-Hum and two B-Soc courses with the requirement that they take three, with at least one in each category. (Biomedical students need only take one from each category.) Once the Mechatronics program has been approved, we will apply to the UCITF for the waiver of a single B-Hum or B-Soc course.

The WQB requirements can then be satisfied as follows:

Requirement	First Course	Second Course
B-Hum	CMPL I	CMPL II or waiver
B-Soc	TECH 114	CMPL II or waiver
B-Sci	CHEM 120	PHYS 140
W	TECH 101	ENSC 441
Q	MATH 151	MATH 152

ENSC 441 is in the process of being put forward for a W designation. It is expected that this can be achieved before the first students take the course in Fall 2010.

Appendix 3: Notice of Intent (Approved by SCUP, Jan 10, 2007)

Notice of Intent

Notice of Intent: Mechatronics Program

Farid Golnaraghi, Program Director for Mechatronic Systems Engineering, School of Engineering Science

December 12, 2006

Credential to be Awarded
BASc (Bachelor of Applied Science)
Location
Surrey
School/Faculty Offering Program
Engineering Science/Faculty of Applied Sciences
Anticipated Program Start Date
September 2007
Description of Proposed Program
The semester-by-semester outline of the new program is given below.

Aims, goals and/or objectives

To produce graduates capable of combining electrical engineering, mechanical engineering and computing. Graduates should also have exceptional communication skills and an understanding of entrepreneurship.

Anticipated contribution to the mandate and strategic plan of the institution

This program will increase the University's graduates in the high-tech sector, thus helping to fulfill the commitments the University has made under the `Double the Opportunity' initiative. It will also attract students to the Surrey campus, helping to fulfill the University's growth targets for that campus.

Target audience

The program is directed mainly at high-school graduates; however, some students may be accepted into later years of the program via college transfer.

Content

Proposed Mechatronics Curriculum V10 (Surrey Campus) [1]
December 7, 2006

Courses and Typical Schedule
Semester One (Fall)

CHEM 120-3 in Surrey or CHEM 121-4 General Chemistry and Laboratory I in Burnaby
MATH 151-3 CALCULUS I*
CMPT 128-3 Introduction to Computing Science and Programming for Engineers*
PHYSICS 140-4 Studio Physics – Mechanics and Modern Physics*
TECHONE 114-3 Equivalent to ENSC 100*
TECHONE 101-2 Equivalent to ENSC 204-1 Graphical Communication for Engineering – with additional material including of design software such as "Solid Works"*

29.

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

1[redacted]dit hours

Semester Two (Spring)

MATH 232-3 ELEMENTARY LINEAR ALGEBRA*
MATH 152-3 CALCULUS II*
PHYSICS 141-4 Studio Physics – Optics, Electricity and Magnetism*
Cmpl I-3 first complementary elective[1]
ENSC 182-3 Mechatronics Design I*
TECHONE 100-3 Equivalent to ENSC 101 with additional topics on project management, teamwork and presentational skills*

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.
[1]must be an approved course. A pre-approved list of complementary studies courses is available from the School of Engineering Science.

19 credit hours

Semester Three (Fall)

ENSC 281-3 Statics and Strength of Materials*
MATH 251-3 CALCULUS III*
ENSC 231-3 Engineering Materials – Equivalent to ENSC 330-4 (without the lab)
Cmpl II-3 second complementary elective[1]
ENSC 220-3 Electric Circuits 1*
MATH 310-3 INTRODUCTION TO DIFFERENTIAL EQUATIONS*
*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.

1[redacted]dit hours

Semester Four (Summer)

ENSC 282-3 Kinematics and Dynamics of rigid bodies and Mechanisms*
ENSC 283-3 Introduction to Fluid Mechanics*
ENSC 226-4 Electronic Circuits * **
PHYSICS 231-3 Physics Laboratory II*
ENSC 380-3 Linear Systems*
MACM 316-3 NUMERICAL ANALYSIS I

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.
** ENSC 225-4 Microelectronics I and ENSC 325-4 Microelectronics II are combined to form Electronic Circuits in the proposed program

19 credit hours

Semester Five (Spring)

ENSC 382-3 Machine Design*
ENSC 381-3 Systems modeling and simulation*
ENSC 331-3 Introduction to MEMS*
ENSC 329-4 Introduction to Digital Logic*
PHYSICS 344-3 Thermal Physics*
ENSC 311-3 The Business of Engineering I: Fundamentals*

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.
[1]must be an approved course. A pre-approved list of complementary studies courses is available from the School of Engineering Science.

[redacted]19 credit hours

Semester Six (Fall)

30.

ENSC 384-4 Mechatronics Design II*[2]
ENSC 383-4 Feedback Control Systems*[2]
ENSC 332-4 Microprocessors and Interfacing*
ENSC 387-4 Introduction to Electromechanical Sensors and Actuators*[2]
ENSC 312-3 The Business of Engineering II: Applications and Commercialization*

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.
[2] Strongly recommended to be taken concurrently

19 credit hours

Semester Seven (Summer)
ENSC 489-4 Computer Aided Design and Manufacturing*
ENSC 451-4 Real Time and Embedded Systems*
ENSC 441-3 Capstone Design Technical Project I*
ENSC II-4 first Engineering elective[3]
ENSC 305-1 Project Documentation

*should be taken in the designated semester; consequences of deviating from this schedule are the responsibility of the student.
3 chosen from ENSC 424, 425, 426, 427, 428, 429, 450, 481, 483, 488, 489, 495. With permission of the undergraduate curriculum committee chair, students may replace one engineering science elective with either a directed study or a special project laboratory course. Special Topics courses that have been approved by the undergraduate curriculum committee chair and the director may be counted here.

16 credit hours

Semester Eight (Fall)

ENSC 484-4 Industrial Control Systems*
ENSC III-4 second Engineering elective[3]
ENSC IV-4 third Engineering elective[3]
ENSC 406-2 Engineering Ethics, Law and Professional Practice
ENSC 442-3 Capstone Design Technical Project*

3 chosen from ENSC ENSC 424, 425, 426, 427, 428, 429, 450, 481, 483, 488, 489, 495. With permission of the undergraduate curriculum committee chair, students may replace one engineering science elective with either a directed study or a special project laboratory course. Special Topics courses that have been approved by the undergraduate curriculum committee chair and the director may be counted here.

17 credit hours

Additional Requirements for Honors
ENSC 498-3 Engineering Science Thesis Proposal (H)
ENSC 499-9 Engineering Science Undergraduate Thesis (H)
Total 146 credit hours (G); 158 credit hours (H)

Delivery methods

Courses will be delivered by a combination of lectures and laboratory work.

Linkages between the learning outcomes and the curriculum design, including an indication whether a work experience/work place term is required for degree completion

Developing skill in engineering requires a solid foundation in mathematics and the sciences, together with a mastery of engineering disciplines and the opportunity to apply them in one or more capstone design projects. An essential part of the engineer's education is the application of skills in a work environment, and for this reason a minimum of three Coop semesters is required for completion of the program.

Distinctive characteristics

[redacted]program differs from the engineering programs offered on SFU's Burnaby campus, and from all other engineering programs in BC by its combination of mechanical and electrical engineering to cover the new field of *mechatronics*. It will also be distinctive in its emphasis upon engineering communications, and its strong interactions with students in SFU's business programs.

Anticipated completion time in years or semesters

Eight academic semesters, plus at least three Coop semesters.

Enrolment plan for the length of the program

It is anticipated that the majority of students will enter the program by taking the TechOne program with a suitable set of electives, giving a first-year class of about 50 students. A small number of additional students may enter the program via college transfer.

Policies on student evaluation

As per general regulations for the University and the Faculty of Applied Science.

Policies on faculty appointments (minimum qualifications)

Faculty will normally hold a PhD. Eligibility for Professional Engineering Registration is required. Industrial experience is highly valued.

Program Resources

[redacted]This will be a new program, additional to the engineering options currently offered at the Burnaby campus, so no activities will be reduced or eliminated when it starts up. To mount the program, approximately 15 full-time CFL faculty will be required, the first three of whom have already been hired. In addition, the program will require 8 support staff, some clerical, some technical. The total space requirement, including laboratories and faculty offices, will be 2,282 square meters. Equipping the laboratories will require one-time start-up costs of $750,000-$1,000,000. In steady-state, the program will have an operating budget of $180,000/year

Policies on program assessment

Like all SFU programs, the program will be externally reviewed at seven-year intervals. In addition, the program will be reviewed at least every six years by the Canadian Engineering Accreditation Board, or CEAB.

Level of support and recognition from other post-secondary institutions, (including plans for admissions and transfer within the British Columbia post-secondary education system) and relevant regulatory or professional bodies, where applicable

The program will apply for recognition and accreditation from the CEAB the year before its first students are due to graduate. The program will work with BCCAT to facilitate articulation with appropriate programs at college level.

Evidence of student interest and labour market demand

[redacted]t surveys (from across Canada and US) indicate that the demand for Mechanical Engineering is on the rise, to the point that a number of [redacted]ian Mechanical Engineering departments cannot meet the demand. Engineering Science has a solid reputation in the community and the Mechatronics program will allow it to extend its offerings to combine Mechanical Engineering with its established strength in Electronic Engineering.

Related programs in your own or other British Columbia post-secondary institutions.

This program is unique in British Columbia.

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[1] The Electrical and advanced control courses were prepared by Mehrdad Moallem Incoming Faculty ENSC (Surrey)

Appendix 4: Initial 2005 Program Proposal for Mechatronic Systems Engineering at SFU-Surrey

Original 2005 Proposal

MECHATRONIC SYSTEMS ENGINEERING AT SFU-SURREY

MEHRDAD SAIF

PREAMBLE. The *Doubling the Opportunity* (DTO) initiative has resulted in some exciting changes in the Faculty of Applied Science in the last couple of years. In particular, School of Engineering Science has been going through some rapid expansion of its undergraduate as well as graduate programs.

Amongst many challenges posed by the DTO, perhaps the greatest has to do with recruitment of highly qualified students. One effective approach to increasing the enrollment while maintaining the traditionally high quality of engineering students, is through offering new and exciting engineering degree programs. In this regard, the School of Engineering Science is about to offer a new joint degree option with the School of Kinesiology in Biomedical Engineering at the Burnaby Campus. The School is also proposing to offer a Mechatronic Systems Engineering (MSE) degree program at SFU-Surrey. The following is a brief proposal for offering graduate and undergraduate degrees in MSE at SFU-Surrey.

1. WHAT IS MECHATRONICS ENGINEERING?

Engineers traditionally have been trained in distinct disciplines, yet many engineered products such as automobiles, planes, robots, computer's disk drive, and manufacturing systems owe their operation on proper integration and harmonious functioning of many subsystems from many disciplines such as electrical, mechanical and computer engineering. As such, in the last decade or two, the need for training engineers with a broader range of expertise than just one engineering discipline has been recognized. One such effective program of study is called **Mechatronics**. One definition of this term is: "*Mechatronics is the synergistic combination of precision mechanical engineering, electronics control, and systems thinking in the design of products and manufacturing processes.*"[1]

2. BACKGROUND AND RATIONALE

The original vision of the School of Engineering Science was to offer a wide array of engineering programs at SFU. Much like many other universities in Canada and U.S., SFU originally had a plan for a Faculty of Engineering. The plan was to offer programs in three distinct "*Cores*" in engineering.

October 2004.

[1]R. Comerford, *Mecha... What?*, **IEEE Spectrum**, pp. 46-49, August 1994.

35.

Core A, which was implemented first, was to cover Electronic/Electrical Engineering. This Core basically was to offer state of the art programs in electronics, telecommunications, and computer engineering. Core B, named at the time "*Automation*", was to offer a state of the art program which would draw upon expertise in Core A as well as certain topics in mechanical engineering, industrial engineering, industrial electronics and controls. Core B, was to cover electromechanical systems, computer aided design and manufacturing, as well as robotics and control. Essentially, Core B Group was to offer the Mechatronics program. Finally, Core C was to deal with process technology, biochemical and biotechnology processes. Therefore, the overall vision of engineering at SFU was that we would offer niche and state of the art programs in electrical, mechanical, industrial, biomedical and chemical engineering areas without the traditional barriers within these disciplines. Unfortunately, the original vision of engineering at SFU never materialized and only Core A, with some small elements of Core B were put in place. As it turned out, only two faculty members with mechanical engineering degrees were hired into the Core B, after which expansion of this program, and for that matter, any other program in engineering, stopped. Due to the fact that only Core A was fully implemented, for close to twenty years the School has really been an electrical and computer engineering department smaller in size than many established electrical engineering departments at other Canadian universities. At present, majority of School's faculty still are electrical engineers.

The fact that the original model of the engineering school was never materialized resulted in the School's decision for narrowing down the original idea of the Core B or the Automation Engineering and offering a degree option with some elements of mechanical design but still a greater emphasis on the electrical and electronic subject matters. The new option was renamed to be the Systems Engineering Option. Thus, the current Systems Option is naturally geared towards the electrical and electronics and is very thin on the mechanical side. At the undergraduate, graduate as well as research, the School has a weakness in this respect. At the undergraduate level there are not sufficient offering of courses in mechanical engineering and at the graduate level, there is no critical mass. Over the years, there have been numerous discussions and debates about the short comings facing this Group and degree option. However, the answer to these problems has always been clear: the Group/Program requires a large amount of resources to expand in a serious manner. Addition of one or two faculty members will not fully address the problems faced by the faculty in the Systems Group and the degree option.

Nevertheless, despite all of this, the School of Engineering Science has run a very small, highly successful and in demand engineering program from within the Faculty of Applied Science. Currently, Engineering Science offers

a BASc degree with four options: 1) Electronics, 2) Computer, 3) Systems, and 4) Engineering Physics. Of these, only Systems Engineering option has very little elements of mechanical engineering in it, and is our version of a mechatronics degree program which we have successfully been running for the past many years. Although this option never received its full complement of the faculty and resources, it has been a very popular program with the students. It is noteworthy to mention that other universities, such as Waterloo, UVic, and UBC have recently started or planning to offer similar programs.

We feel that the current situation with the DTO has presented a rare opportunity to SFU's Senior Administrators to strengthen and further expand engineering at SFU. Currently, of the 236 DTO slots available to SFU, the University has decided to allocate 182 slots to computer science like areas. This is a huge number even before the downturn in demand for computer science occurred. We propose rather than trying to meet these numbers through creative counting measures or through derivative programs, the University should re-allocate the numbers, and expand engineering at the Burnaby Campus through the biomedical engineering program and a full fledge MSE at the Surrey Campus.

3. MSE AT SFU-SURREY

The School currently has a great faculty strength in the areas of electronics, telecommunication, computer engineering, and Control/Robotics and offers excellent undergraduate degree programs in these areas at the Burnaby campus. In addition, jointly with the School of Kinesiology, and drawing upon their strength as well, the School will soon launch an undergraduate degree program in Biomedical Engineering (BME). Mechatronics is an excellent example of a multidisciplinary engineering and in its core requires an integrated and concurrent mastery of mechanical, electronics, control, software, and computer engineering subjects. Unfortunately, the School has never had the necessary critical mass in some of these subjects (in particular mechanical and control expertise) to offer a full fledge mechatronics program.

The latest trend across engineering faculty in Canada and the United States indicate that the total engineering enrollment at various universities is either steady or slightly on the rise. However,there are shifts in enrollment within the faculty. In particular, enrollment in computer engineering and particularly computer science are generally down, whereas the demand for mechanical engineering has risen drastically. Also other areas such as civil engineering has seen slight improvement in the demand. As an example, at the most recent National Deans of Engineering and Applied Science (NCDEAS), McGill, UBC, U of Alberta, plus a number of other universities all reported that they had many more applicants to the mechanical

engineering program this year than previous years. University of Waterloo recently introduced a degree program in mechatronics and in its first year they had many more qualified applicants than the 100 students they had planned to accept.

Based on the above background, the School of Engineering Science is proposing to offer a different yet complimentary engineering degree program at SFU-Surrey. It is proposed to set up an MSE degree program at SFU-Surrey. Surrey campus is an excellent location for this option. It is anticipated that with existing engineering strength and the presence of School of Computing, Business, Interactive Arts and Technology at Surrey, MSE will find a natural home there and that there will be a great deal of collaboration between the faculty from these schools in research as well as curriculum design. Wearable computing is an example of one research area that the SIAT, MSE and Computing faculty could collaborate effectively at Surrey.

Given the fact that engineering programs often have the first one to one and a half year in common, students can enter the SFU-Surrey and enroll in the MSE program and finish their degree there, or after 1 to 1.5 years they can transfer to the Burnaby campus and finish their degree program in one of the other five degree options available at the main campus. Similarly, students who start in one of the five options at the main campus can transfer to Surrey and complete their degree in MSE there. At the same time, it is anticipated that there will be senior and junior level courses on both campus that are not offered on the other campus. Therefore, it is expected that students on one campus will be taking elective courses at the other campus and thus there will be a bidirectional flow of students between the two campuses.

Along with the undergraduate program, the graduate program in MSE will be implemented at Surrey. At the moment, School of Engineering Science offers one or two courses in mechanical engineering. With hiring of more faculty members with expertise in mechatronics and mechanical engineering, the situation at the graduate level is expected to change drastically. A greater number of graduate level courses will be offered and the current few faculty members will finally have additional colleagues to collaborate with. Similarly it is expected to finally see a critical mass of graduate students in mechatronics. All in all, addition of new mechatronics faculty, graduate courses and students will all be good news for the current System's Group and its graduate program in Intelligent Systems and Control at the main campus as well.

4. Anticipated Enrollment

Initially, the plan is to take 50 undergraduate students in the MSE program each year. At this rate, and given the fact that the our B.A.Sc. programs typically take close to five years to complete, it is expected that the program in steady state will have 250 students in it. Additionally, the program should have somewhere between 50-75 graduate students in the steady state.

5. Resource Requirements

In this section, we shall present a rough estimate of resources required to run the proposed MSE at Surrey.

5.1. Faculty and Staff.

- Facutly– As was mentioned before MSE is a multidisciplinary program and at its core, it requires faculty with expertise in mechanical, electronics, control, software, and computer engineering subjects. Thus, a minimum number of faculty is required to offer this program. Based on the proposed enrollment and using the NCDEAS national mean (of 24.245 $\frac{WFTE}{FTEProf}$) the proposed program at Surrey requires 15 full time faculty.

- Again based on the NCDEAS national mean (of $102.26\frac{WFTE}{Secretary}$ and $94.46\frac{WFTE}{Technician}$) it is anticipated that 8 support staff are needed.

5.2. **Space Requirements.** In order to come up with an estimate of the need for space we have used the figures used by Ontario government for allocation space to universities depending on their programs. The Ontario standards were apparently downgraded by the BC Government for use in BC. The following is based on the engineering numbers.

- Faculty (including support) offices: $15 faculty \times 19.9m^2 = 298.5m^2$
- Faculty research space–$15 \times 23m^2 = 345m^2$
- Research Space for grad students – $50 \times 11.5m^2 = 575m^2$
- Graduate office space– $50 \times 5.3m = 265m^2$
- Support staff space – $8 \times 17.3m^2 = 138.4m^2$
- Undergrad lab space – $4 years \times 3 courses \times 2 hrs \times 50 students \times 0.55m^2 = 660m^2$

Total Space $= 2281.9m^2$

5.3. **Laboratory and Office Equipment.** Apart from the above and an operating cost, a one time support for setting up various laboratories would also be required. This could be anywhere from $750,000–1000,000.

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