Electrical and Computer Engineering Department Strategic Plan

by

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**And the Professoriate of the
Electrical and Computer Engineering Department**

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This document is based on the ECE professoriate reflection and self-evaluation, on the assessment of our undergraduate programs in electrical engineering and computer engineering by our accreditation agency, ABET, on the review of our department and undergraduate programs by the Dean of CEPS, on the review of the graduate program by the Dean of the Graduate School, and by the ECE-Industrial Advisory Board and the ECE-Student Advisory Board.

Vision

To be recognized internationally for education and research in Electrical and Computer Engineering.

To realize this vision, the Department shall foster:
- A faculty committed to its students' educational success;
- The enhancement of breadth and depth of its undergraduate education;
- Graduate programs that prepare students to conduct research and solve complex engineering problems;
- Innovation and creativity of students, staff and faculty;
- Internationally recognized research programs with strong support from professional constituencies;
- Demonstrable leadership, service, and outreach in advancing engineering professionalism to meet society's needs;
- Educational and research partnerships with agencies, universities, and industries;
- Highly successful alumni who contribute to the profession in the global society.

Mission

The Mission of the Department is to foster and advance knowledge in Electrical and Computer Engineering.

The mission involves:
- Teaching courses in Electrical and Computer Engineering, and related fields, at the Bachelor's, Master's and Doctoral levels;
- Advancing knowledge through research and scholarship;
- Serving the State and Nation by making the Department's intellectual resources available to industry and government agencies.

The undergraduate EE and CE programs shall provide a firm foundation in electrical and computer engineering theory and practice, with a mix of laboratory and design experiences. The programs shall also foster teamwork and project management skills.

The graduate ECE program shall lead to the degrees of Master of Science in Electrical Engineering and the Doctor of Philosophy in Electrical Engineering. Research and scholarship are core components of the Department's mission and they directly impact undergraduate and graduate education. Success in obtaining funds to procure equipment and support research efforts is therefore an essential objective for the Department.

Department Strengths
Metrics for determining Departmental Strengths include a history of long-term collaborative research, positive feedback from stakeholders, unique faculty knowledge base, and attainment of successful continuous improvement strategies.
- Core Strengths in Signal Processing, Control and Embedded Systems Engineering, Sensor Systems, and Applied Electromagnetics
- Faculty Directly involved with Hands-on Laboratory Experiences

- Programs at the MS and PhD Levels with Opportunities for Research Funding
- Fully-online Graduate Certificate Programs in Wireless Systems and Ubiquitous Computing
- Active Industrial and Student Advisory Boards

Departmental Challenges

- Research Productivity and Collaborative Effort
- Diversity of the Active Research Portfolio
- Undersubscribed EE and CE Undergraduate Programs
- Undersubscribed Graduate Program
- Visibility to Industry and the Public
- Diversity in Program Students and Faculty

Departmental Opportunities

- Ubiquitous Computing
- Biomedical Engineering
- Navitas Program
    - Undergraduate and the Pre-Masters Program
- Articulation Agreements with CCSNH

Departmental Threats

- Three Senior Faculty who are of retirement age
- Small Number of Female Faculty (we have one)
- Lack of Faculty in Computer Engineering

Strategic Objectives

- Expand Inter-/Multi-disciplinary Educational Opportunities to Increase Under-graduate and Graduate Enrollment
- Increase External Funding by Establishing Inter-/Multi-disciplinary Research Teams
- Improve Industrial Collaboration and Entrepreneurship
- Promote On-Line Education to Increase Student Enrollment in Graduate Programs

Preface

Expanding our educational mission into Ubiquitous Computing, Communications and Biomedical Engineering will respond to the complex demands of society for humanitarian and economic progress by leveraging the strength of our expertise and our facilities. Furthermore, these educational thrust have been known to be areas of interest for female students.

It is our intent to build on the existing faculty in each area with new faculty lines and affiliations and collaboration with other departments on campus.

    Presently, the ECE Department has three full professors (all in their 60s), four-associate professors, three assistant professors (of which one is a female), two lecturers and an Adjunct.

    Beyond expansion of inter-/multi-disciplinary educational and research programs through new faculty and affiliate faculty, the Department will develop articulation agreements with two- and four-year institutions to expand its undergraduate pool in numbers and diversity.

    The ECE faculty advocate for three education and research program enhancements that we feel would meet the needs of state and country and upon successful implementation increase external research funding, increase student numbers in both electrical engineering and computer engineering, draw more females into our programs, and improve our relationships with our industrial partners. The articulation agreements and on-line courses will foster improvement in our student numbers.
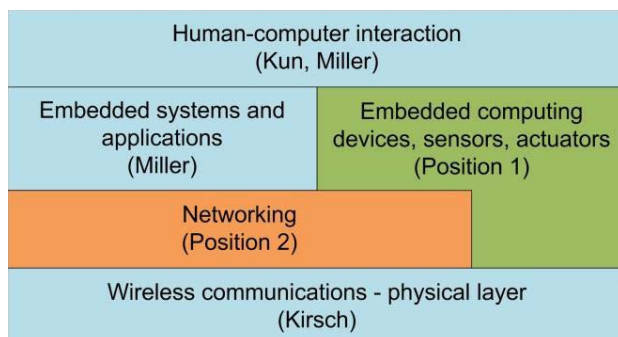
Action Plan

Expand Faculty Positions in Ubiquitous Computing and Communications

    We have entered the third era of modern computing. This era is defined by computing devices that are embedded in everyday objects and become part of everyday activities. These devices are also connected to other devices or networks in an effort to gather or share information. Ubiquitous Computing and communications is a multidisciplinary field of study that explores the design and implementation of such embedded, networked computing devices. The field is young but it is developing fast and appears to have unstoppable momentum.

    Presently, three UNH ECE faculty are involved in research and teaching on topics in Ubiquitous Computing and Communications. Professor Tom Miller works on embedded system design and application development and on human-computer interaction for mobile devices. Associate Professor Andrew Kun works on human-computer interaction design for mobile devices and desktop multi-touch interfaces. Associate Professor Nicholas Kirsch works on Wireless Communications systems that enable networks for mobile devices.

    Professors Miller and Kun have been successful in attracting funding for work that focuses on application development and human-computer interaction for Ubiquitous Computing and utilizes networking technologies. Professor Kirsch has secured funding for work on physical layer communications to increase connectivity in widely varying conditions. Professors Miller, Kun and Kirsch feel that there is potential for jointly conducting grant-funded research that would explore Ubiquitous Computing and Communications systems more thoroughly than their individual efforts currently allow. However, this potential would be significantly strengthened by the addition of two new members to the ECE faculty or possibly: one in Embedded

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Systems and one in Networking (see figure).

Embedded Systems Position (this position has been approved, and we have identified finalists for that position)*:* This new faculty member will focus on embedding computing devices, sensors and actuators into our environment. The embedded systems will enable applications and human-computer interactions of interest to Professors Miller and Kun, and will allow Professor Kirsch to explore interactions between different networking technologies and embedded technologies. The faculty member is to bring expertise in a number of areas such as:

- Embedded computing devices,
- Embedded sensors, and sensor networks,
- Embedded actuators,
- Energy harvesting and power management for embedded systems,
- FPGA-based design,
- RFID.

Networking position: An additional faculty member would focus on issues related to computer networks. This networking expert would tie in Professor Kirsch's work on the physical layer to the application layer research of Professors Miller and Kun. A simplistic view of Ubiquitous computing is for the devices to view network connections as always present. Similarly, a naïve physical layer view of networking traffic is that there is constant demand. The second faculty member would explore actual service demands and connectivity in real-world Ubiquitous computing systems. This topic is critical to Ubiquitous computing and communications because mobile devices are resource-limited. The faculty member would bring expertise in areas such as:

- Mobile ad-hoc networking,
- Cognitive networking,
- Stochastic wireless networks,
- Optimization of quality of service (QoS) in networks.

The Embedded Systems and Network faculty positions would significantly advance the UNH ECE department's teaching mission and could leverage research opportunities with the InterOperability Lab. Importantly, both new hires could teach EE and CE courses from the department's current undergraduate curricula. The embedded systems faculty member would provide support for courses such as ECE 543, 548, 562, 583, 649, 711, 715, 775, 781. The networking faculty member would provide support for courses such as ECE 543, 562, 633, 634, 647, 734, 757.

In addition to supporting courses already in the curricula, the two new hires would be able to expand our course offering in meaningful ways. The embedded systems faculty member will build on existing courses in electronics, signal processing and networking to create a number of courses on sensor design and sensor networks. For the networking faculty member, an excellent opportunity exists in adding new courses to help students explore the various aspects of computer networking. Currently the department only offers one networking course, however, our constituents such as BAE and the IOL would bene-

fit from more depth and breadth in this offering. Furthermore, a faculty member in computer networking can draw upon the resources of the IOL to create more immersive experiences in undergraduate and graduate courses.

The UNH ECE Department aspires to become a leader among its peer institutions in making meaningful and lasting progress in responding to the needs and concerns of minorities and women. Therefore, we will actively recruit members of underrepresented groups to apply for the two proposed positions. In addition to using contacts through SWE and the ECE Department Heads Association, Professors Miller, Kun and Kirsch will actively recruit minority candidates at upcoming conferences, including Ubicomp (premier conference in Ubiquitous Computing), AutomotiveUI (premier conference on in-vehicle human-computer interaction), and Interactive Tabletops & Surfaces (premier conference in surface technologies; these are a prominent building block of many Ubiquitous computing systems).

Even though the two positions in Ubiquitous Computing and Communications are requested for ECE, the team would be enhanced with a faculty member from Computer Science, especially a faculty member specializing in software engineering.

Expand Faculty Positions in Biomedical Engineering

Biomedical engineers analyze and design solutions to problems in biology and medicine, with the goal of improving the quality and effectiveness of patient care. Biomedical engineers work in manufacturing, universities, hospitals, research facilities of companies and educational and medical institutions, teaching, and government regulatory agencies. Employment of biomedical engineers is expected to grow by 62 percent from 2010 to 2020, much faster than the average for all occupations. Demand will be strong because an aging population is likely to need more medical care and because of increased public awareness of biomedical engineering advances and their benefits.

Presently, four UNH ECE faculty are involved in research and teaching on topics in biomedical engineering. Professor LaCourse work on instrumentation to detect diseases and provide therapeutic modalities for the injured, diseased and people with congenital challenges. Specifically, Professor LaCourse is working presently with nursing faculty to develop simulation training devices for student nursing programs, equipment communication in the surgical ward, and instrumented dance shoes to determine the onset of injuries in ballet dancers. Dr. Wayne Smith Senior Lecturer is interested in non-invasive non-contacting electrodes for electroencephalographic recordings. Associate Professor Messner is a specialist in imaging and Assistant Professor Yu is interested in reliable integrated circuits for medical applications. Assistant Professor Song is researching flexible electronics with applications to biomedical engineering.

Our faculty, including the requested faculty position, will have five major thrust areas. These areas are: 1) instrumentation, 2) flexible bio-sensing device development and integration, 3) embedded electronics, 4) hybrid digital/optical processing, and 5) physiological control systems. Of these areas, four are currently in-house, and the fifth will be associated with a new position request.

Currently there are five ECE faculty who have expressed interest and are actively involved with the evolution of a Biomedical program. Those faculty can be seen listed below along with their expertise and research interest areas.

The current proposing members bring a broad level of diverse expertise to the table which will allow for the development of a substantial research program that will attract new students as well as allow the group to compete for dwindling grant dollars.

Professors LaCourse, Messner, Smith, Song and Yu feel that there is potential for jointly conducting grant-funded research that would explore biomedical instrumentation for the detecting of disease and providing modalities for cure more thoroughly than their individual efforts currently allow. However, this potential would be significantly strengthened by the addition of two new members to the faculty or possibly: one in neurophysiology from COLSA and one in biological control systems in CEPS ECE. This research and educational team would augment and/or expand the existing Biological Engineering Program in Chemical Engineering as well.

In biomedical engineering, anecdotal evidence suggests that the field is inherently appealing to women, especially in comparison to the more traditional disciplines such as mechanical and electrical engineering. Women are more connected to the biological and medical sciences, which have greater gender equity than engineering sciences. The unique challenges to gender equity in biomedical engineering are the flip side of these advantages. First, the inherent appeal of biomedical engineering to women can foster complacency about diversification and lack of attention to the real problems of attrition and, sometimes, discrimination. Second, as a younger discipline, we have fewer senior women role models. Third, the interdisciplinary nature of the discipline contributes to the leaky pipeline since at all levels – BS, MS and PhD – highly trained women may be recruited into medicine and the biological sciences where they perceive the intellectual challenges to be similar but the barriers to their success, such as isolation, less daunting American Society for Engineering Education, 2010).

It is our intent to develop a Biomedical Engineering Program. The program would require faculty participation from COLSA and CHHS.

Articulation Agreements

To boost our undergraduate enrollment, the ECE Department continues to maintain a two plus two-and-one-half semesters articulation agreement with the New Hampshire Technical Institute (NHTI) and from that agreement we gain between 5-10 students per year.

Due to our success with the NHTI, the ECE Department is venturing to develop articulation agreements with the following institutions.

- Hellenic American University
- Nashua Community College

On-Line Courses

To boost our undergraduate and especially the graduate program enrollment, the ECE Department intends to offer courses on-line to be more flexible on pedagogy and to reach

a larger audience be it pre-college, college, and professional. This effort would significantly advance the UNH ECE department's teaching mission.

Strategically, it makes sense to target sub-programs (certificate programs) for on-line delivery first, and by adding other programs later on, the ECE Department may get the entire graduate program on line. The first sub-program to develop relates to Communications and Electromagnetics where we have faculty teaching in that area who have interest and experience in online learning (Chamberlin, Kirsch, and Kun). The courses we have in mind for development are Electromagnetics and Antennas Wireless Communication, Digital Signal Processing. These courses can be packaged as a Microwave Communication Certificate Program, and we have reason to believe that there will be interest in it from local industry based upon comments from our Industrial Advisory Board.

Placing the above courses into a quality on-line format will take effort and investment, and our proposal is that the college fund faculty to convert courses in the targeted areas. Based upon Professor Chamberlin's own experience in online learning, he estimates one month of faculty effort to develop an existing course for online delivery. The return on investment will be realized by a greater number of students, greater faculty productivity and a greater selection of courses in our program.