U.S. and Canadian Clinical Engineering (CE) Education and Internships

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Buenos Aires, Argentina
April 24-28, 2006
Agenda

- Evolution of CE programs in the U.S. and Canada
- Examples
  - Academic Programs
  - Practical Internships
CE Programs

◆ Academic Programs
  – BS Degree in Biomedical Engineering or related engineering
  – MS, PhD Degrees in Biomedical Engineering

◆ Practical Training
  – Short and long term internships in hospitals, medical device industry, research, other
Examples

Structure and Content of Available Clinical Engineering Educational Programs

**Example 1:** University of Connecticut (UCONN), Masters in Biomedical Engineering with an Internship Program in Clinical Engineering

**Example 2:** Wayne State University, Michigan Masters in Biomedical Engineering with an “Introduction to CE and Technology Management” course and an available internship in Clinical Engineering
Examples

Structure and Content of Available Clinical Engineering Educational Programs

Example 3: University of Toronto (U of T), Masters in Health Science in Clinical Engineering with an internship
Example 1: University of Connecticut
Storrs, Connecticut, USA
UCONN MSBME and CE Internship Program

- 33 years of CE education
- Previously at Hartford Graduate Center and Trinity College, Hartford, CT - directed by Dr Joseph Bronzino for 25 years
- Presently at University of Connecticut - directed by Frank Painter
- 1st and 2nd year students
  - 2006: Six 1\textsuperscript{st} year students & Six 2\textsuperscript{nd} year students
- www.bme.uconn.edu
UCONN - MS in Biomedical Engineering

◆ **Academic Experience**
  – Coursework in Clinical and Biomedical Engineering

◆ **Practical Experience**
  – CE internship program at participating hospitals

◆ **Applied Experience**
  – Thesis project
**UCONN - MSBME CE Internship Program**

<table>
<thead>
<tr>
<th>Year 1 – first semester</th>
<th>Year 1 – second semester</th>
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<tbody>
<tr>
<td>20 hr/wk Internship + 2 courses + clinical rotations</td>
<td>20 hr/wk Internship + 2 courses + clinical rotations</td>
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<tr>
<th>Year 2 – first semester</th>
<th>Year 2 – second semester</th>
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<tr>
<td>20 hr/wk Internship + 2 courses + thesis project</td>
<td>20 hr/wk Internship + 2 courses + thesis project</td>
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<td>2 9/8/04</td>
<td>UCONN Health Ctr</td>
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<td>3 9/15/04</td>
<td>Hartford Hospital</td>
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<td>4 9/22/04</td>
<td>Baystate HC</td>
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<td>5 9/29/04</td>
<td>UCHC</td>
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<td>6 10/6/04</td>
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<td>7 10/13/04</td>
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<td>8 10/20/04</td>
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<td>9 10/27/04</td>
<td>Hartford Hospital</td>
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<td>10 11/3/04</td>
<td>St. Francis Hospital</td>
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<td>11 11/10/04</td>
<td>KNS 201</td>
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Academic Experience

Biomedical Engineering Courses

- Physiological Systems
- Human Biomechanics
- Biomaterials & Tissue Engineering
- Clinical Instrumentation
- Physiological Modeling
- Drug Design
- Assistive Technologies Design
- Biofluids Modeling
- Advanced Ultrasound Imaging Techniques
- Biosensors
- Communication & Control in Physiological Systems
Academic Experience

Clinical Engineering Courses

Clinical Engineering Fundamentals, examples
- Technology & Equipment Management
- Quality Management
- Risk Management
- Ethics
- Administration
- Safety Management
Academic Experience

Clinical Engineering Courses

Human Error & Medical Device Incidents, examples

- Human Error
- Human Factors Design
- FDA and Medical Devices
- Root Cause Analysis and FMEA (Failure Mode and Effect Analysis)
Academic Experience

Clinical Engineering Courses

Engineering Problems in the Hospital, examples

- Networks, PACS and Telemedicine
- EMI/Frequency Management
- HVAC
- Nosocomial Infections and Infection Control
- Healthcare Architectural Design
Academic Experience

Clinical Engineering Courses

Medical Instrumentation, examples

- Anesthesia Monitoring & Gas Delivery Systems
- Lasers
- CT and MRI Technologies
- Radiation Therapy
- Cardiac Assist Devices
- Laboratory Technology
- Digital Imaging Systems
Practical Experience – CE Internship

Participating Hospitals in CT, MA and RI

- Hartford Hospital (CT)
- UCONN Health Center (CT)
- Baystate Health Systems (MA)
- Connecticut, VA Medical Center (CT)
- UMASS Medical Center (MA)
- St. Francis Hospital (CT)
- Yale New Haven Hospital (CT)
- Rhode Island Hospital (RI)
Practical Experience

Scope of the Internship

- Two years at 20 hrs/week
- Involvement in department projects
  - Technology assessment
  - Incident investigations
  - CMMS management and more
- Clinical rotations
- Symposia/Conference participation & exposure
Applied Experience

Thesis Project, examples

- CE Benchmarking
- Image Processing
- Equipment Maintenance Strategies
- Biomaterials
- Functional MRI Applications
- Healthcare Failure Mode and Effects Analysis
Example 2: Wayne State University
Detroit, Michigan, USA
Wayne State University – MS in Biomedical Engineering

- **Academic**
  - MS in Biomedical Engineering with focus on biomechanics, smart sensors, rehabilitation engineering
  - Introductory Course on “Introduction to Clinical Engineering & Technology Management”
  - [http://bme.wayne.edu/bme/education/masters/](http://bme.wayne.edu/bme/education/masters/)

- **Practical**
  - One semester (3 months) internship in Clinical Engineering with William Beaumont Hospital
  - One to two students/semester
Wayne State University –
Academic Experience

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<thead>
<tr>
<th>DAY</th>
<th>DATE</th>
<th>CHAP.</th>
<th>TOPIC</th>
<th>INSTRUCTOR*</th>
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<tbody>
<tr>
<td>Tues</td>
<td>Week 1</td>
<td>TED</td>
<td>COURSE OUTLINE AND INTRODUCTION TO CLINICAL</td>
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<td>(PROJECT)</td>
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<td>Week 4</td>
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<td>IAG/RG</td>
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<td>Week 7</td>
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<td>RISK MANAGEMENT AND INCIDENT INVESTIGATIONS</td>
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<td>TED</td>
<td>INCIDENT INVESTIGATIONS (CASE STUDY)</td>
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<td>Week 11</td>
<td>TED</td>
<td>EXAM #2</td>
<td>IAG/RG</td>
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<td>Tues</td>
<td>Week 12</td>
<td>TED</td>
<td>MEDICAL EQUIPMENT PLANNING AND FACILITIES DESIGN</td>
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<td>PROJECT DUE</td>
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Wayne State University – Practical Experience

- Exposure to a wide range of clinical engineering projects at a level 1 trauma hospital (1060 beds)
- Opportunity to apply engineering techniques to patient care and hospital-based research
- Experience working with hospital personnel, including clinical engineers, biomedical engineering technicians, nurses, physicians and others
Wayne State University – MS in Practical Experience

- Interaction with medical device manufacturers and exposure to new medical technologies
- Understanding of medical technology regulations, including medical device standards and national patient safety goals
Activities during the internship

- Researching medical device databases for new medical technology assessments
- Testing medical devices in the laboratory as part of an engineering evaluation
- Creating a clinical trial evaluation document, to help process and analyze the clinical trial results, and draft a final report
Activities during the internship

- Assisting the technical specifications in a medical equipment purchase
- Flow-charting and writing a new clinical or technical procedure
Example 3: University of Toronto
Toronto, Canada
University of Toronto

◆ Academic
  – Master's Degree of Health Science in Clinical Engineering
  – Institute of Biomaterials and Biomedical Engineering
  – www.utoronto.ca/IBBME/

◆ Practical
  – CE internship
University of Toronto

- Prerequisite: bachelor's degree in Engineering
- Typical Clinical Engineering Curriculum
- Two year program
- Average of 4 or 5 students in each year
University of Toronto Coursework

◆ Fall term, Year 1
  – Clinical Engineering Instrumentation I
  – Transduction of Physiological Events
  – Canada's Health Care System
  – Human Physiology As Applied to Engineering (first half)
University of Toronto Coursework

- Spring term, Year 1
  - Clinical Engineering Instrumentation II
  - Special Topics in Clinical Engineering
  - Bioengineering Science
  - Human Physiology (continued, second half)
University of Toronto

- Summer term, Year 1
  - BME 4444L Internship I
  - Thesis Project
University of Toronto

• Fall term, Year 2
  – Internship II
  – Thesis Project
  – Theory and Practice of Strategic Planning and Management in Health Services Organizations
University of Toronto

- Spring term, Year 2
  - Internship II
  - Thesis Project
University of Toronto

- Summer term, Year 2
  - Internship III
  - Thesis Project
Supplemental Materials

- UCONN Course Curriculum
- Wayne State Course Curriculum
- University of Toronto Course Curriculum
Muchas Gracias

¿Preguntas?