

Biomedical Engineering Education

From around the world to Vietnam

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Talk Outline

- What is Biomedical Engineering?
- Around the world
- VaNTH Core BME Curriculum
- BME in Vietnam
- Opportunities & Challenges
- Some questions

Biomedical Engineering

Definition

- Biomedical Engineering (BME): application of engineering concepts, mathematics, analysis, design, and possibly other methods to unsolved problems in biology and medicine.
- “BME is a discipline that advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice” [Whitaker Foundation]
- Synonym: Bioengineering

Biomedical Engineering

What is a BMEngineer?

- BMEngineer has the ability to “speak the languages” of engineering and medicine, a familiarity with human physiology and physiopathology, an educational breadth.
- Because of the breadth of educational knowledge, it is sometimes difficult for BME graduates to find jobs at (small) companies, requiring specific skills (for example, electrical engineering for medicine). Also, industry has difficulty in defining capabilities of BME engineers

Biomedical Engineering

Where do BMEngineers work?

- Where do they work?
 - Industry
 - Academic institutions
 - Hospitals
 - Government agencies
- 2 major segments of industry:
 - Biomedical instrumentation
 - And pharmaceutical and drug delivery-oriented

Biomedical Engineering

What do BMEngineers do?

- Design medical devices
- Develop new drug therapy
- Study how the body and biological systems function
- Build artificial organs to replace lost/failed organs
- Develop wireless technologies to assist patients and doctors
- Develop micro/nano technologies to repair cell damage or alter gene function
- ...

Biomedical Engineering

Key areas of BME

- Bioinformatics
- BioMEMS
- Biomaterials
- Biomechanics
- Biosignal processing
- Biotechnology
- Clinical engineering
- Genomics/Proteomics
- Radiology
- Information technology
- Imaging & image processing
- Instrumentation, sensors & measurements
- Micro and nanotechnology
- Neural system engineering
- Physiological system modeling
- Rehabilitation engineering
- Robotics in surgery
- Telemedicine
- ...

Biomedical Engineering

BME Organizations

- IEEE Engineering in Medicine and Biology society
- Biomedical Engineering Society
- National Institute of Biomedical Imaging and Bioengineering
- European Alliance for Medical and Biological Engineering and Science
- International Federation for Medical and Biological Engineering

Biomedical Engineering

Is there a core curriculum?

- Originally, many undergraduate engineering programs (e.g. Electrical Engineering) offered a specialization in BME (e.g., Biomedical Electronics).
- Then, formal BME programs are offered, integrating various engineering, biology and physiology domains
- Is it a program for a distinct discipline, or an interdisciplinary field without a core of its own?
- If it is a distinct discipline, how much of core BME knowledge, apart from specialization, is needed for ALL BME engineers?

VaNTH core BME curriculum

- VaNTH: Vanderbilt-Northwestern-Texas-Havard/MIT Engineering Research Center for Bioengineering Educational Technologies
 - "Uniting educators and engineers, in industry and academia, to develop curricula and technologies that will educate future generations of bioengineers."
 - Problem: Diversity in programs is good but industry faces difficulties in defining capabilities of a BMEngineer
 - 8-year funded Project: develop a CORE curriculum for undergraduate BME programs

VaNTH core BME curriculum

- Use Delphi survey method to survey industry and academia for developing a core BME curriculum
 - Form a group of experts, comprising industry and academia, to brainstorm a comprehensive list of (274) concepts for a core set of BME knowledge and competency, in 17 engineering, biology, physiology domains.
 - Pass to a group of survey participants (also from industry and academia) to rate the importance/relevance of each concept and recommend additional concepts
 - Revisit concepts which did not receive consensus and introduce concepts which were additionally recommended.
 - Pass to the group of participants to re-rate (with justification on their previous rating)
 - Iterate the above until consensus is reached

VaNTH core BME curriculum

- Survey started in 2004, 2 rounds have been done, project is now closed.
- Ratings of concepts and recommendations can be found at www.vanth.org/curriculum
- Results:
 - Strong agreement between industry and academia on which topics are important, with significant divergence occurring on only a handful of concepts
 - No engineering domain dominates the list of concepts
 - 65% feel that working toward a core is valuable for improving employment opportunities of biomedical engineers
 - 85% feel that beyond the core some type of specialization is required at the undergraduate level

Around the world

- 3rd BME Education Summit Meeting (7/2008)
- Around 185 representatives of BME programs, from US, Latin America, Europe and Asia
- Discussions on:
 - BME content and courses
 - Designing learning environments
 - Intersection of academia and industry
 - Preparing for the future

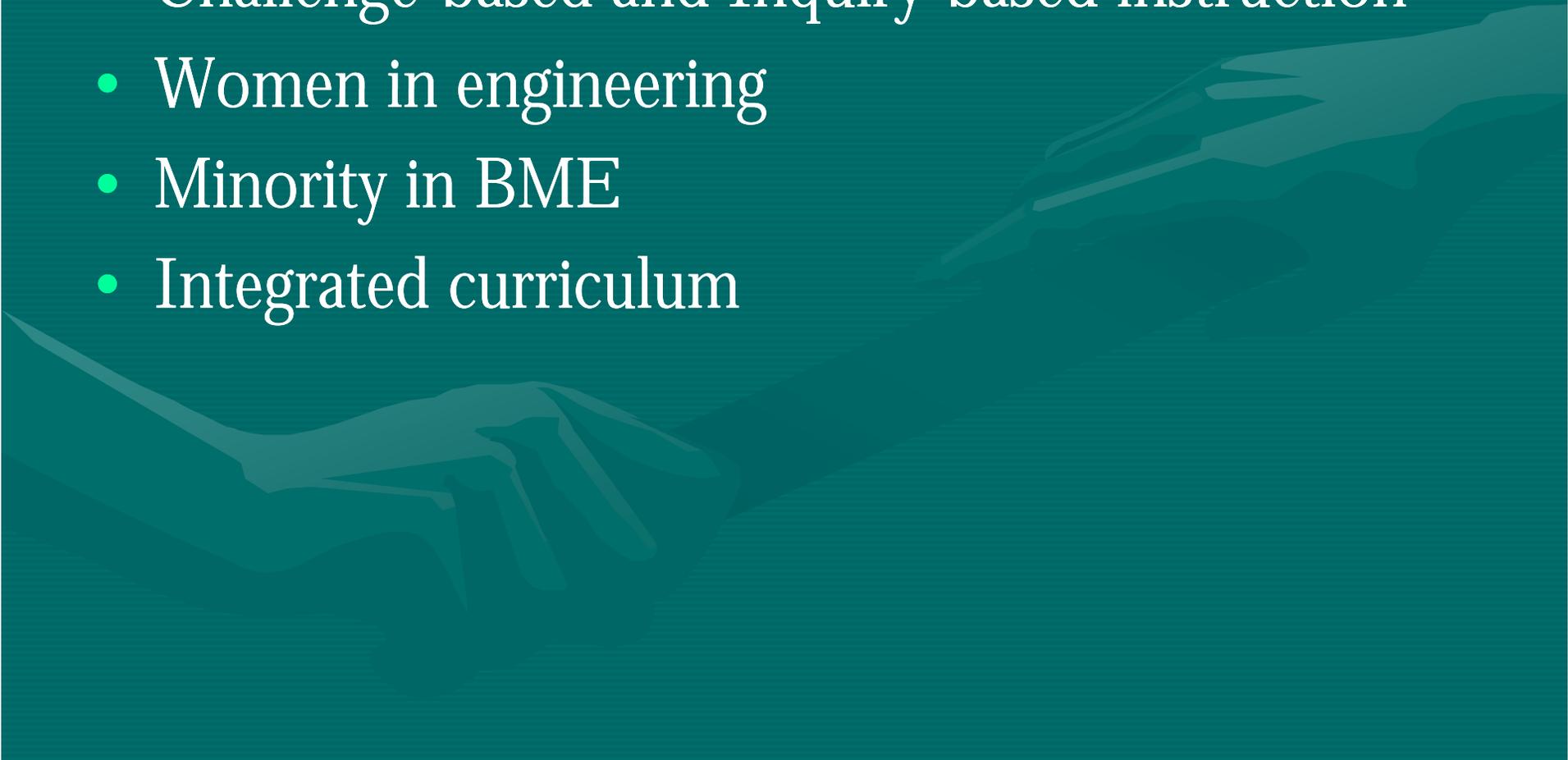
Around the world

BME content and courses

- Physiology and biology
 - Design
 - Modeling and simulation
 - Teaching materials
 - Laboratory education
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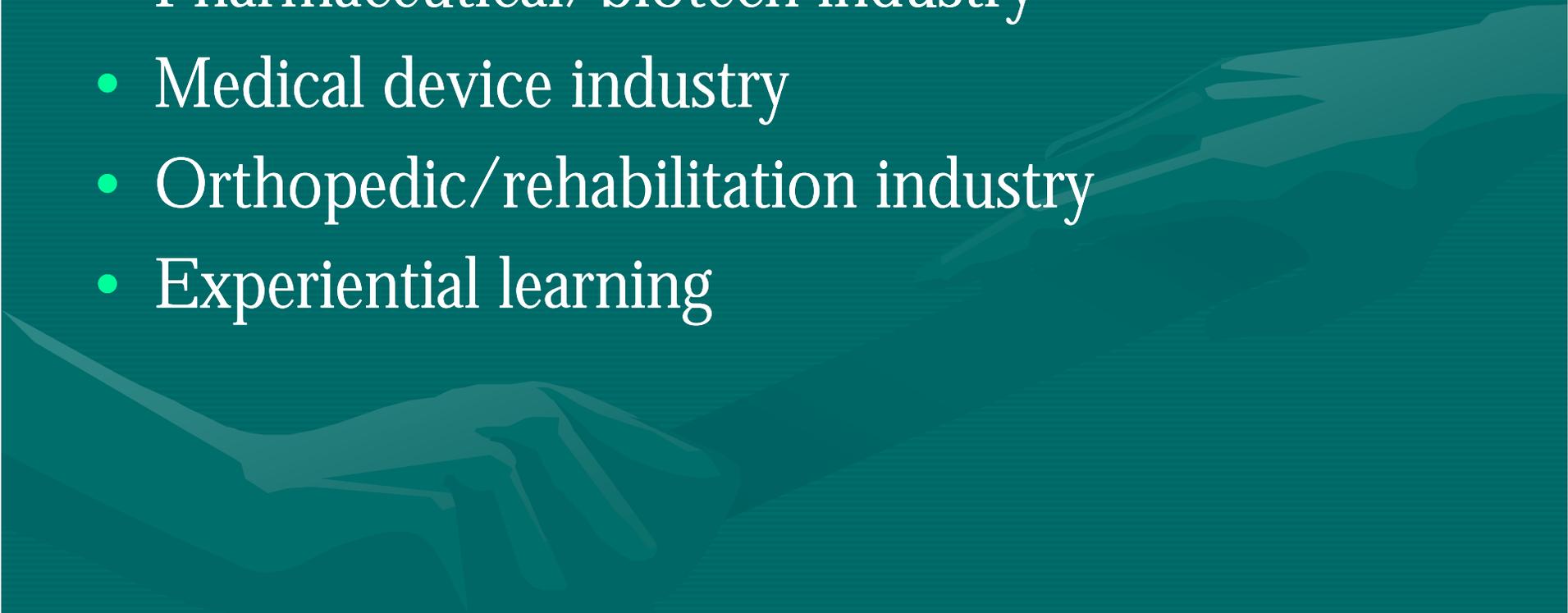
Around the world

Designing learning environments

- Assessing innovations
 - Challenge-based and Inquiry-based instruction
 - Women in engineering
 - Minority in BME
 - Integrated curriculum
- 

Around the world

Intersection of academia and industry

- Alumni panel
 - Pharmaceutical/biotech industry
 - Medical device industry
 - Orthopedic/rehabilitation industry
 - Experiential learning
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Around the world

Preparing for the future

- ABET criteria
- Globalization
- Core body of knowledge
- Professional licensure
- Funding to sustain/improve educational programs

BME in Vietnam

- Surveyed by a group of US professors in 2004*
- Research, education, industry are growing
- Policy makers are well aware of the potential of BME, and well supportive for, especially, human resource development
- Main BME areas: medical instrumentation, rehabilitation, biomaterials, biotechnology, bioinformatics.
- Education: formal BME programs exist, and mainly grew out from single traditional engineering disciplines

BME in Vietnam

- Most universities mainly form collaborations with external universities of medicine and hospitals instead of having their own school of medicine and university hospital
- Private universities start offering BME programs
- Industry: “Socialization” of medical equipment generates more BME jobs in the private sector
- Graduate programs are not offered (?)
- In general: have appropriate foundation to develop BME

BME in Vietnam

- Research: various research activities in universities and research institutes are seen throughout the country, most projects are of similar problems as in other countries, new in acupuncture.
- Some recent research events in BME:
 - International Conferences on Development of BME in Vietnam (1st-2005, 2nd-2007)
 - 14th ASEAN Association of Radiology Meeting (2008, Hanoi), focusing on imaging but mainly clinical studies rather than engineering ones

Opportunities

- Vietnam already has the foundation to support development of BME (education, research, industry, policies)
- World integrated efforts in developing BME education, and dissemination is available (like VaNTH)
- Initiatives for research funding in Vietnam (both within VN and from other countries)

Challenges

- Infrastructure for BME is often costly, need to find the right direction to develop complete BME core programs, following the experience of other countries (e.g. VaNTH) while adapting well with Vietnamese environment => relevant models for different institutions
 - formal BME programs in universities which have an in-house school of medicine and university hospital, or
 - specializations in BME at universities which otherwise rely on external collaborations with independent medical universities/hospitals
- BME “works” on living systems => need to understand and practice professional ethics and licensure to be able to develop devices that are reliable, medically approved, and ecosystem-friendly
- Bring up the level of education by pursuing accreditation

Some issues

- Research drives education and vice-versa: => Need collaborated effort (biology – medicine – engineering) to find out Vietnam specific research and development problems => for specialization in undergraduate programs and open graduate programs (institution-oriented)
- Medical centers are more interested in providing clinical services and perform clinical research, interested in engineering research is limited.
- Extension of BME programs/areas: Apart from medical instrumentation, should we get into the big industry of drug delivery therapy? Then, how can we prepare for BME graduates?
- Extension of research areas: Research in cellular/molecular BME?