



## Process (2)

**+ Meet with appropriate Chairs & Directors  
(April/May 2011)**

|                   |       |
|-------------------|-------|
| D. J. Aneshansley | (BEE) |
| L. A. Archer      | (CBE) |
| A. T. Zehnder     | (MAE) |
| F. Wise           | (AEP) |
| E. P. Giannelis   | (MSE) |
| T. Chen           | (ECE) |
| P. Liu &          |       |
| R. Richardson     | (CEE) |
| M. Shuler (BME)   | (BME) |

**+ Discuss/Alter Plan**

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Note that all COE departments have some "bio" activity but these 7 to 8 represent those that see "bio" as a critical component of future success.

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## Bioengineering Hiring Has Been Widespread

Over the last 3 years 7 Faculty have been hired with bio interests in COE.

| Department | Hired | Looking (2011-12) |
|------------|-------|-------------------|
| BME        | 1     | 1 (Dept. Chair)   |
| CBE        | 1     | -                 |
| CEE        | 0     | 1                 |
| MAE        | 2     | 1 to 2            |
| AEP        | ?     | 1                 |
| MSE        | 2     | -                 |
| ECE        | 1     | 1                 |

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## Bioengineering

- Biomedical Engineering
- Bioprocess Engineering
- Bioenvironmental Engineering

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## Why Bioengineering?

- Many of society's most significant problems arise from interaction of biology and engineering
  - Human health
  - Environment
- Biology has gone from a descriptive science to a mechanistic one. Principles of engineering can be used to understand the fundamentals of life
- Students sense the opportunities and intellectual excitement. 5 out of 7 COE freshman have some interest in the biology engineering interface

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## Biomedical Engineering

- Practiced in the COE for nearly 45 years
- Dispersed teaching/research efforts—disciplined focused
- Interactions with Weill Medical College—initiated by D. Bartel ca. 40 years ago
- In 2004 new BME department started
- Interactions with Weill Medical College and Vet College significantly intensified

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## BME Department

- **Mission:**
  - The primary mission of the Department of Biomedical Engineering is to educate students to understand the human body as an integrated system and the mechanisms of disease through quantitative engineering analysis, and to use that understanding to design better therapeutic strategies, devices, and diagnostics to improve human health.
- **Bridge Engineering/Physical Sciences with Medicine & Biology**

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## Strategy in Forming BME (2004-on)

- Connections to existing BME faculty in departments important
- Add new faculty (BME centric) to department rather than aggregating existing BME faculty into a new department
- Add new BME oriented faculty in both BME department and existing departments
- BME centric faculty vs. department centric BME faculty

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## Adding BME Undergraduate Major?

- Student demand for BS likely to be high
- BME department at ca. 95 PhD, 90 MEng, and 40 to 50 undergraduate minors
- If maintain MEng & add BS, BME will need expansion of faculty
- 3 year minimum for approvals to initiate BS

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## COE Efforts in Bioprocess & Bioenvironmental Engineering

- Strong efforts but fragile due to relatively small numbers
- Addition of faculty will stabilize efforts/add robustness

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## Biological & Environmental Engineering

- Not part of COE, so not part of direct analysis
- However, BEE is an important source of expertise in bioengineering and faculty additions in BEE augment/enrich COE activities
- COE and BEE plans need to be coordinated
- BEE would support addition of undergraduate major in BME and a redistribution of undergraduate students to allow a stronger BEE focus at Graduate level research

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## Goals & Aspirations (1)

- Goal: To become recognized as a national leader in Bioengineering research and education:
  - a) applied to human health emphasizing the need to relate quantitatively molecular and cellular level insights to human physiology and to an understanding of human disease and to design and test possible "cures" for disease
  - b) applied to bioprocess systems for production of pharmaceuticals, clean water, energy, or other products, based on understanding the quantitative relationship of molecular and cellular biology to the performance of bioprocesses

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## Goals & Aspirations (2)

- c) applied to human health emphasizing the need to relate quantitatively molecular and cellular level insights to human physiology and to an understanding of human disease and to design and test possible "cures" for disease
- d) applied to bioprocess systems for production of pharmaceuticals, clean water, energy, or other products, based on understanding the quantitative relationship of molecular and cellular biology to the performance of bioprocesses

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## Selected Strengths

- Collaborative, interdisciplinary research environment; effective interactions with Vet and Weill Medical College
- Diverse student body
- Able to attract strong/PhD students largely domestic; BME students highly successful with NSF Fellowships
- Key centers (NBTC/CNF, CMM, CCMR) provide unique facilities/opportunities
- Increasing demand for BME students (most of any discipline): 72% over next decade

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## Selected Weaknesses

- BME younger than competition; smallest of top 20
- Expansion space for BME problematic & wet lab space a challenge for COE
- Undergraduate bioengineering programs, which span colleges could be strengthened

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## Selected Opportunities

- Establish a leadership curriculum in BME based on quantitative, multiscale analysis
- Enhance connections to Vet School and Weill Medical College
- More diverse student body at all degree levels

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## Selected Threats

- Insufficient wet lab space in COE
- Loss of key faculty; small faculty size makes programs less robust
- Need for coordination of efforts, especially undergraduate program

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## Bioengineering Research

- Emphasis Areas:
  - Human Health
  - Bioprocessing
  - Energy
  - Biosensors/Instrumentation
- Nanobiotechnology as cross cutting theme
- Systems biology could be cross cutting theme
- Emphasis at cellular & molecular level

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## Centers

- Nanobiotechnology (NBTC; CMM)
- CCMR/Biomaterials
- Biofuels Research Lab/Sun Grant (primarily in BEE)

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## Enabling Actions/Faculty

- 24 positions (10 BME centric, 9 discipline based BME, 5 in bioprocess/bioenvironmental). Joint appointments Possible
- Endowments for 4 BME centric positions held in trusts/realignments of endowments
- BEE also intends to add bioengineering faculty (Molecular BME, all areas of bioprocessing and bioenvironmental)
- See Hiring Matrix

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## Enabling Actions/Facilities

- Need more wet lab space in COE
- Especially space for cell culture
- Payette study confirms need

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## Enabling Actions/Education

- Establish BS degree in BME
- Augmentation of courses in bioprocess/bioenvironmental
- Augment advanced courses in various COE departments in BME

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## Enabling Actions/Diversity

- Good initial progress at PhD student level (e.g. BME is 41% women and 23% URMs) but needs to be sustained/improved
- More progress needed at level of tenure track faculty (although graduate field of BME has 13 women/URM faculty out of 41)

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## Bioengineering Center

- Analogous to Cornell Center for Materials Research
- Strong center with bioengineering faculty from many departments
- However:
  - No funding source equivalent to the funding of CCMR
  - Diversity of faculty within bioengineering greater than materials (???)

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## Summary

- Broad interest/impact throughout COE; strong student interest
- Two prong approach to BME: develop both core department and BME faculty in most COE disciplines
- Bioprocess & Bioenvironmental areas need further development/BEE important augmentation
- Initiate BS in BME
- Wet lab space in COE significant limitation