Master of Engineering Committee Meeting  
November 13, 2002, 8:00 – 9:00am  
240 Carpenter Hall

Attendees:  Graeme Bailey, James Bartsch, John Belina, Larry Cathles, Claude Cohen,  
Mark Eisner, David Grubb, Mike Hayes, Associate Dean Isaacs, Fred Kulhawy, Michel Louge, Larry Newman, Mark Otis, Dawn Warren  

Guests:  Karen Biesecker, Michael Shuler  

Absent:  Bing Cady, Scott Coldren, Jim Jenkins, Bruce Kusse  

Jim Bartsch called the meeting to order at 8:00am.

Approval of October 2002 Minutes:  
Jim asked the MEC for comments & corrections on the 10/02 minutes.  Two corrections were noted:

1) Claude Cohen was incorrectly noted as an attendee of the 10/02 MEC meeting.  
2) Fred Kulhawy was incorrectly noted as absent at the 10/02 MEC meeting – it should have read that Patty Apgar represented him.  

The amended minutes were approved unanimously.

Biomedical Engineering Program Proposal:  
Mike Shuler reminded the MEC of his attendance at the September 2002 MEC meeting.  The MEC members received a DRAFT 1.0 version of the BMEP proposal via e-mail the day before the MEC meeting, so it was decided that Mike S. would respond to questions posed by the MEC.  Mike S. indicated that he used the Systems Engineering proposal as an example, and he noted that the big difference between the two programs is that Biomedical Engineering already has a graduate program.

- F’04 would be the first class for the proposed BMEP M.Eng. program, and they expect an initial intake of 12 students with a goal of 36.  Mike S. noted that it would take a while before they can estimate how many undergraduates who have chosen a minor in Biomedical Engineering will apply to the BMEP M.Eng. program.  He feels that a fair number of their graduate applicants will be inclined to apply for the M.Eng. in BMEP as opposed to an M.S./Ph.D. The Masters degree makes more of a differential sense to students in Biomedical Engineering.  He also feels that many of the ChemE students will pursue the Biomedical M.Eng. degree.  Student applicants from outside of Cornell are expected to be well over ½ of the enrollment.  
- The Bioengineering Certificate will continue to be offered because it works for a different population.  The certificate covers all bioengineering, not just biomedical engineering.
• When asked how many of the BMEP classes are in place currently, Mike Shuler indicated the following:
  o All of the 600 level classes are in place
  o The BME501 and the ENGRG classes exist
  o The Nucleic Acid Engineering class (BEE 6??) is planned for F’03
  o The Drug Delivery Systems class (BME 6??) taught by David Putnam is planned for F’03

The only course that needs to be put in place is BME550.

• All these courses will be offered each year. Mike S. added that by ‘04 they hope to have enough faculty to switch teaching responsibilities around (so sabbaticals won’t interfere with the offerings).

• Mark Eisner noted that biology isn’t one of the admissions requirements -- Mike S. indicated those students would have to make up classes beyond the 30 required credits. BMEP is anticipating a large number of potential sources for students – a couple of those sources won’t have to take much over the 30 credits, many of the others will. Mark E. asked, “If a student did terribly in biology, they would be able to complete their degree” -- Mike S. replied, “as long as the student received a C- or better.”

• BMEP plans to accept students in the top ½ of their class – a 3.3 GPA requirement. Mike S. feels that a one-year professional masters degree will attract a lot of B.S. students from elsewhere. Mike Hayes commented that in his recruiting travels this year he received numerous inquires for a Biomedical Engineering program such as the proposed BMEP M.Eng. program, and he feels that we will be positioned very well.

Jim B. noted that the “Bio GM” should be changed to “Bio BM.”

A motion was made to approve the proposal, and it was unanimously approved.

In closing, Mark Eisner indicated that Mike Shuler would want to hear about the proposed funding changes for the Master of Engineering programs. Larry Cathles asked Mike S. when they would have materials for distribution to students? Mike S. indicated that they could distribute the DRAFT 1.0 version of the proposal as an informal advisor to allow students to know what might be happening.

Presentation and Proposal Regarding M.Eng. Returns:
Michel announced that the subcommittee has met three times since the October MEC meeting, and at this point everyone on the committee is in agreement on the principle. He displayed the overhead entitled “The Money Trail” which reflects the current formula. The Subcommittee has learned that the 250-student threshold isn’t retained by Day Hall -- it is returned to the College. His next overhead was entitled “Current Returns” (refer to on-line PDF attachment).

The Subcommittee is proposing that we switch to a complete proportional return (refer to on-line PDF attachment “Proportional Return.”) which would start each field at the same point (without the threshold). The question is where the slope
appears. The committee still feels that it is fairer to go completely proportional (linear). The “Principles” overhead was displayed, and Michel explained that the Early Admit students shouldn’t be calculated into the returns because the College doesn’t actually receive those funds – the students are still officially considered undergraduates by the university. In the FY ’01 the Dean would have saved $606,000 if they had instituted that change. The Subcommittee feels that this concession to the Dean is an important concession – we cannot request money from the College that they don’t receive. Additionally, the departments need to be held harmless -- they have long-running staffing strategies that necessitate the funds they receive from the College. Graeme Bailey voiced concern regarding the loss of the Early Admit monies – their M.Eng. program consists of approximately 60% Early Admit students.

Michel used Systems Engineering to explain the percentages indicated in his overhead entitled “Principles.” Systems didn’t exist in ’00/’01, but if the slope were set at 13.4%, they would receive the same amount that they would have received under the old formula. If the slope were set at 16%, Systems would receive an additional 2.6%. Conversely, if the slope were set lower than 13.4%, Systems would lose money relative to what it would have been under the current scheme. The Subcommittee has proposed to negotiate a fraction which, based upon last year, would be between 33% (to hold the Dean harmless) and 40% (to hold ORIE harmless). If a department is below 40%, they would individually negotiate a plan with the College, and there would be an installment plan in place.

Michel displayed the “Motion (already approved)” overhead that reads,

“In order to raise the program's national prominence across the broadest number of Fields, the subcommittee recommends that alternatives to the existing formula for financial M.Eng. returns be sought.”

Michel displayed three overheads reflecting three motions that the Subcommittee has not voted on yet. He suggested that the MEC could either vote on the three motions today, or bring them to the December MEC meeting. The proposed motion reads,

(1) Students in the early admit semester should not be included in the calculation of “returns”. Rationale: These students are enrolled as undergraduates and thus eligible to receive financial aid. Unlike M.Eng. graduate tuition, the undergraduate tuition along with any associated undergraduate financial aid does not flow directly to Carpenter Hall. The College administration will save substantial funds (606,000 in F01/S’02 by implementing this recommendation.

(2) The return to departments should be comprised between 33% and 40% of tuition – administrative fees. Rationale: Based on FY 2002 returns, all departments would be held harmless if the return per student from the College to the Departments was set at 40% of tuition minus administrative
fees (TMAF). In FY 2002, this represents about $8,400 per student. The average return in FY 2002 across departments was 33% of TMAF (or $6,800 in FY 2002).

(3) If the Dean adopts a return less than 40% of TMAF, then an installment plan should be negotiated with each department that would experience a possible shortfall.

Graeme reminded the MEC that three years ago the modification appeared to change how the Early Admit students are counted (prior to this change, the Departments did receive funds for their Early Admit students). He indicated that he wasn’t in a position to vote on the above motions until he has seen how this change will affect Computer Science.

Michel paid tribute to the College because Cathy Long contributed information to him without hesitation.

Mike Hayes added that Cathy Long wants to make sure everyone understands about the budget. Four years ago, when the big budget cut was imposed, this is the way the College made it up. Tuition has risen 4.5%, but faculty salaries have increased by 8-9%, which has forced the College to take a larger chunk of the M.Eng. returns.

Mark Eisner pointed out that the more students we support in the programs, the better off the College will be. Larry Cathles noted that seeing an actual return based on student numbers gives the departments an entrepreneurial incentive. Mike Hayes suggested that the MEC “package” this proposed change as an incentive to help the Directors and Chairs understand.

Jim Bartsch asked the MEC if they would like to meet earlier than the scheduled December 11th meeting. It was decided that the MEC would convene on December 4th.

Michel offered to sit with anyone to explain the numbers, and Mike Hayes offered Cathy Long’s offer to sit in on discussions.

**Update on TA tuition remission issue:**

Mike Hayes reminded the MEC that through the unionization issue, we unearthed a Graduate School policy that states that a student receiving a TA stipend equivalent to 25% of the Graduate School stipend should be awarded a 25% tuition return. The M.Eng. program hasn’t adhered to that policy for a number of years. Some fields have been awarding tuition awards with TA stipends, but not necessarily to meet the Graduate School policy. This policy has huge implications for the M.Eng. program. Based on the 100 appointments made through ORGSPE for the Fall 2002 semester, the tuition return is well over ½ a million dollars. Mike will meet with Sarah Hale today at 10:30, and he will e-mail the MEC as to the outcome of that meeting. The College’s stance is that we
are not going to adhere to the policy. We may have to change titles. The Graduate School wants to know if the M.Eng. TAs are performing the same roles as the Ph.D. students. Various MEC members made comments that they don’t see a problem with MS/PhD TAs receiving more/different compensation than the M.Eng. TAs – their qualifications are different. Mark Eisner pointed out that the M.Eng. TAs earn about $35/hour, and possibly a second rule for the M.Eng. program could be created. Mike has calls in to both the Law School and the Business School to find out how they compensate their TAs (neither are tied to the Graduate School rules). Mike told the MEC that the S’03 TA appointments are being handled as usual. Mike will keep the MEC apprised of the situation.

Petition to admit student in BEE:
Jim Bartsch submitted a proposal for a student of theirs who graduated in May 2002 with a 2.58 GPA. The former student is currently working in the biotech research development area, and he wants to focus on R&D and he feels that an M.Eng. degree in BEE will be an asset. The former BEE student has an excited potential Advisor, he has a M.Eng. project proposal. BEE suggests that he work with his Advisor to have a full time load of M.Eng. classes with a B or better average. The student did very well in his undergraduate research, and the BEE faculty feels that it is indicative of the work he will do in the M.Eng. program. A motion was made to approve his petition, and the MEC voted unanimously in favor.

Change status of Ph.D. candidate to M.Eng. mid-semester:
Michel circulated a petition for a MAE student and a sheet of 4 transparencies (refer to the PDF attachments beginning with “Transition from MS/PhD to MEng, a paraphrase of Nicholas Zabaras’ suggestions”). The student began his Ph.D. program in F’01 on a fellowship. He’s currently in his 3rd semester, but he doesn’t want to continue. The usual solution would be to give him an A exam and for the student to fail so he can receive a Special Masters degree. The Special Committee would need to congregate with the intent of failing him. The MEC members disagreed with the need to fail him -- the Special Masters can be acquired by taking the A exam but not writing the thesis. Michel conveyed Nick Zabaras’ request for the M.Eng. degree to be used as a consolation prize in place of the Ph.D. Michel displayed the “Objectives” overhead (refer to PDF attachment “Objectives”). He next displayed the overhead entitled, “Uphold M.Eng. Rules” and finally “Proposed Amendments” (refer to PDF attachments “Uphold M.Eng. Rules” and “Proposed Amendments”) – Michel reminded the MEC that Nick Zabaras wrote all of the overheads.

Jim Bartsch indicated that Michel’s petition sounded as though he was asking for an endorsement of policy for future cases – Jim proposed that the MEC deal with this as an individual petition.
Based on the fact that the student can take the A exam (with no need to fail it), and walk out of Cornell with a Special Masters degree, Michel asked to withdraw his motion. He will instruct the Special Committee to meet and they will award the student with a Special Masters.

Mark Eisner added that counting work done on the Ph.D. thesis as an M.Eng. project doesn’t seem legitimate. Larry Cathles warned that blurring programs, particularly with regard to money, would bring a raft of problems.

The meeting adjourned at 9:11am.
Financial returns from the M.Eng Program to the Departments

Subcommittee on financial returns
Wednesday, November 13, 2002

John Betz (BCD), Larry Novosel (Systems), Mark Kroner (CS&A),
Steve Cohen (BCD), Michel Louge (MAE), Jim Barlow (BSEE), Mark Oda

The money trail

Total College M.Eng Enrollment - 250 students
Tuition + administrative fees
30% to College
70% to Departments
Distributed using a non-linear formula

Non-linear formula

Number of full-time-equivalent faculty F

- one share per student up to an enrollment of F/2;
- two shares per student enrolled between F/2 and F;
- four shares per student enrolled above F.

Original rationale: encourage the growth of small programs.

Current returns

Principles

- Do not count early admit students.
- Hold departments harmless.

Department return proportional to the number of students enrolled.

<table>
<thead>
<tr>
<th>Department</th>
<th>F03/S01</th>
<th>F04/S02</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE</td>
<td>18.2%</td>
<td>20.5%</td>
</tr>
<tr>
<td>OE</td>
<td>22.9%</td>
<td>24.3%</td>
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<td>GE</td>
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<td>21.7%</td>
</tr>
<tr>
<td>CE</td>
<td>29.2%</td>
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<td>EE</td>
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<tr>
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<td>7.9%</td>
<td>11.1%</td>
</tr>
<tr>
<td>ARM</td>
<td>13.0%</td>
<td>11.1%</td>
</tr>
<tr>
<td>HEE</td>
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</tr>
<tr>
<td>CSE</td>
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<td>CPME</td>
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<tr>
<td>MTL</td>
<td>12.7%</td>
<td>32.8%</td>
</tr>
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</table>

November 12, 2002
Motion (already approved)

"In order to raise the program’s national prominence across the broadest number of fields, the subcommittee recommends that alternatives to the existing formula for financial MEng returns be sought."

Motion

(1) Students in the early admit semester should not be included in the calculation of "returns".

Rationale:

These students are enrolled as undergraduates and thus eligible to receive financial aid. Unlike MEng graduate tuition, the undergraduate tuition along with any associated undergraduate financial aid does not flow directly to Carpenter Hall. The College administration will save substantial funds ($606,000 in FY1/02) by implementing this recommendation.

Motion

(2) The return to departments should be comprised between 33% and 40% of tuition - administrative fees.

Rationale:

Based on FY 2002 returns, all departments would be held harmless if the return per student from the College to the Departments was set at 40% of tuition minus administrative fees (TMAF). In FY 2002, this represents about $8,400 per student. The average return in FY 2002 across departments was 35% of TMAF (or $6,900 in FY 2002).

Motion

(3) If the Dean adopts a return less than 40% of TMAF, then an installment plan should be negotiated with each department that would experience a possible shortfall.
1.0. Introduction

The Biomedical Engineering Program (BMEP) requests the College of Engineering (COE) to approve a new degree program, M.Eng. in Biomedical Engineering (BME). The BMEP was activated in April 2002 with Michael L. Shuler as Director and Donald L. Bartel as Associate Director.

The BMEP was founded as a university-wide unit to bridge biology, medicine, and engineering. Appendix A is a copy of the document establishing BMEP; this document, prepared by Dean Craighead, was approved by all department chairs and directors in the COE, as well as the Deans of A&S, CALS, and VET and the Provost. Among the charges to the BMEP is “coordination and delivery of educational programs in BME”. The Director of BMEP is charged specifically to: “Develop and deliver a professional masters (M.Eng.) in BME, including an offering of a 5 year BS/M.Eng. program in BME”. This proposal initiates the process to form such a degree program.

The current members of the graduate field of BME are listed in Appendix B. A subcommittee of Donald L. Bartel (M&AE), Michael S. Isaacson (A&EP), William L. Olbricht (CBE), and Michael L. Shuler (CBE) have prepared this proposal. We have solicited comments from the BME field, the external advisory board for BMEP (Appendix C lists members), and the Bioengineering Curriculum Committee (Appendix D lists membership) on the proposed structure and content for the M.Eng. BME.

We believe that such a degree program will serve Cornell and its students well.

2.0. Motivation

Our mechanistic understanding of biology has increased rapidly over the last 20 years and many expect biology to drive engineering and technology in the next 50 years in much the same way that physics drove engineering advances and technology in the twentieth century. As biology has become more mechanistic, the opportunities to apply engineering approaches has increased enormously. Simultaneously, the humanitarian needs and economic opportunities for the application of engineering to improve health care has increased significantly. The shifting age distribution in the US population alone is sufficient to guarantee rapidly increasing demand for improved biomedical devices and therapies that are also cost effective. Engineers that understand biology and who can apply their knowledge and skills to improve human health are increasingly in demand (http://www.whitaker.org). A professional degree in BME will prepare students to fill this increasingly critical need.

To prepare students for professional practice as biomedical engineers is a challenge as the breadth and depth of knowledge required to be effective is difficult to impart in a four year BS degree program. As described in Appendix A, the BMEP is designed to address this challenge by providing students the opportunity to complete a BS in one of the traditional departments (in COE, BEE, or in Biological Sciences) while completing a minor or program of study in BME and then to complete a M.Eng. in BME. We believe this BS/M.Eng.
combination will serve students well who expect to enter professional practice as biomedical engineers by providing a strong combination of biology and engineering.

Also, we believe that a M.Eng./BME degree program will serve Cornell well. Historically, BME programs attract higher levels of women (> 40%) and under-represented minorities than other engineering disciplines. A M.Eng. BME and the BS/M.Eng. combination will enhance diversity in the COE. Additionally, BME attracts many of the best students. Two anecdotal examples are the University of Wisconsin and Georgia Tech. At the University of Wisconsin a GPA of 3.5 is required for undergraduates to affiliate with BME. At Georgia Tech over half of the entering freshman projected a BME major; enrollment in BME was capped at 50/year resulting in a minimum GPA of 3.7 to affiliate. Should Cornell lack an attractive BME option, we believe it would be detrimental to the diversity and quality of the student pool available to the COE. Implementation of a M.Eng. in BME is critical to our strategy for Cornell to remain attractive to the broad base of prospective engineering freshman.

Another component to the strategy of a BS/M.Eng. combination is practical. The alternative would be to begin, as most others have, a BS in BME. Based on discussion with BME advisory board members we believe that a 5 year BS/M.Eng. will be a more marketable degree for BME students than the BS in BME. With a BS/M.Eng. combination and a BME minor available to all students the presence of BME enhances all units. Thus, establishment of a M.Eng. is a critical element in a strategy to develop a “win-win” situation for BMEP and all other units associated with the COE.

Our current M.Eng. option in bioengineering (Dean’s Certificate) does not fill the role projected for the M.Eng. in BME. First, it must be recognized that bioengineering is broader than BME; it applies to all the possible intersections of biology and engineering, many of which do not address human health directly. Secondly, the bioengineering option allows students to choose from a long list of possible courses and does not attempt to achieve a specific educational goal. The M.Eng. in BME serves a different student population than the current bioengineering option.

We believe that for Cornell to maintain as vibrant COE as possible, it should create the M.Eng. in BME.

3.0. External Advisory Board

The membership of the external BMEP Advisory Board are listed in Appendix C. The board has 5 academic members and 8 industrial members. We believe this mixture is ideal for providing us guidance on the formation and evolution of a M.Eng. in BME. At least three members (Boehringer, Fischell, and Newman) have agreed to assist us with specific lectures in our proposed course on professional aspects of BME (e.g. product engineering, the health care reimbursement system, and dealing with FDA regulations). Several have provided significant gifts. Four members are also members of the NAE.

4.0. Competitive Masters Programs in BME

A complete listing of BME programs can be found at the web site maintained by the Whitaker Foundation (http://www.whitaker.org). Almost all of these programs offer a MS degree. In many cases a coursework option only degree program exists. Typically, these programs do not have design projects equivalent to Cornell’s M.Eng. programs. While there are some 3/2 programs (e.g. Memphis) that provide a combined BS/MS, most of these
Masters programs are not designed for close integration with the BS program. Many institutions recognize that while the 4 year BS BME degree prepares students well for admission to medical school it does not prepare students as well for professional engineering practice and recommend students complete a MS degree. For example, the chair of BME at the University of Wisconsin reports that while the local industry does not wish to hire the BS students they eagerly seek students who have done the BS & MS in BME. At Georgia Tech they are planning a one-year Master’s degree to serve BS BME students who wish to enter professional practice.

Another type of degree is offered by Case Western Reserve University through its “Institute for the Integration of Management and Engineering”. This 12-month degree program in Master of Engineering and Management (MEM) has an option for Biomedical Entrepreneurship. While this program has a strong professional orientation, its focus is on management skills and not on advanced technical and engineering knowledge and skills.

5.0. Description of Goals and Program Structure

5.1. Educational Goal of M.Eng. in BME

We expect to prepare students for professional practice in BME. Students in the program will acquire a broad perspective of the biomedical engineering discipline that complements their undergraduate training in engineering or science, and an in-depth knowledge of an essential area in biomedical engineering. Graduates will be equipped to design biomedical devices and develop therapeutic strategies within the bounds of health care economics, the needs of patients and physicians, the regulatory environment for medical devices and pharmaceuticals, and stringent ethical standards of biomedical engineering practice.

Students will acquire breadth in biomedical engineering by participating in a bioengineering seminar and by satisfying specific course requirements in the curriculum. Students will acquire depth by extending undergraduate specializations, by selecting one of three areas for concentrated study, and by completing a design project in their selected area of concentration. Design projects will be carried out in teams to take advantage of the diversity of student backgrounds and, when possible, projects will be done in collaboration with industrial partners.

5.2. Admission Requirements and Applicant Base

All students will satisfy the following admission requirements:

- a) BS degree or equivalent in engineering or science
- b) Calculus-based physics (8 credits), mathematics starting with calculus (12 credits), and an introductory computer science course or equivalent
- c) An undergraduate GPA of at least 3.3 or standing in the upper half of their class.
- d) Knowledge of molecular- and cellular-based biomedical engineering and engineering analysis of physiological systems at the level of BME 301, 302, 401, or 402. This knowledge can be demonstrated through appropriate undergraduate coursework or by passing a diagnostic exam before matriculation. Students lacking appropriate background will take courses (in addition to the 30 credits required for the M.Eng.) to satisfy this requirement.
We expect the program will attract a diverse applicant pool, including students with the following educational backgrounds:

i) Cornell undergraduate engineering students who minored in BME
ii) Cornell undergraduate engineering students who did not minor in BME
iii) Non-Cornell students who majored in biomedical engineering
iv) Non Cornell students who majored in traditional engineering disciplines
v) Cornell undergraduate biology students who completed a program of study in BME (currently in discussion)
vi) Undergraduates from Cornell and other universities who majored in biology (or a closely related life sciences field) but did not complete a BME program of study
vii) Undergraduates from Cornell and other universities who majored in physics or chemistry.

The M.Eng. curriculum is designed for students in groups (i) and (v), and those students can readily satisfy admission requirements. However, we expect that the majority of applicants will be from outside Cornell (based on the large numbers of applicants to the MS program in the BME graduate field and on the large difference in starting salaries for BME students with a BS (at $47,850) and Masters (at $62,600+)). Because of the diversity of applicants and the range of job opportunities, it will be necessary to customize requirements to recognize each individual’s background and goals while maintaining intellectual coherence and quality. Students in categories ii, iii, iv, vi, and vii may need more than 30 credits to complete the program, depending on specific classes they took in their BS programs.

5.3 Curriculum Requirements (30 credits total)

a) All students will satisfy the following course and credit requirements for graduation:

i) BME 550 - Product Engineering and Design in Biomedical Engineering (new in fall 2004; D. Bartel, organizer) – 3 credits
ii) BME 591 – Design Project (new in fall, 2004; Staff) – 3 to 6 credits
iii) BME 501 (ENGRG 501) – Bioengineering Seminar – 1 credit
iv) Biomedical Engineering Foci. (12 credits minimum)

All students must complete at least 3 credits in each of the areas listed below and at least 6 credits in one area, which they designate as their area of concentration. Students who have previously completed coursework at a comparable level in one area may petition the director of the BMEP to complete 9 credits in their designated area of concentration and none in the area covered by prior coursework.

Area D1 Biomedical Mechanics and Materials

A&EP 662 – Micro/Nano-fabrication and Processing – 3 credits
BME 605.3 (ENGRG 605.3) – Biomaterials – 1 credits
BME 606.3 (ENGRG 606.3) – Biomechanics of Musculoskeletal Systems – 2 credits

* Based on 2001 salary survey of National Association of Colleges and Employers
M&AE 565 – Biomechanical Systems – Analysis & Design – 3 or 4 credits
M&AE 663 – Adv. Topics in Neuromuscular Biomechanics – 3 credits
M&AE 664 – Mechanics of Bone – 3 credits
TXA 439/539? – Biomedical Materials and Devices for Human Body Repair – 3 credits

**Area D2: Bioinstrumentation/Diagnostics**

BME 606.1 (ENGRG 606.1) – Biomedical Instrumentation and Diagnosis – 1 credit
BEE 652 - Instrumentation: Sensors and Transducers – 3 credits
BEE 658 - Biosensors and Bioanalytical Techniques – 4 credits
ECE 511 - Bioelectric Signal Analysis and Processing – 3 credits
ECE 578 - Computer Analysis of Biomedical Images – 4 credits
ENGRG 690 – Physics of Various Imaging Methods; Application to Medical Systems – 2 credits

**Area D3: Drug Delivery/Tissue & Cellular Engineering**

BME 605.1 (ENGRG 605.1) – Cellular Dynamics and Cancer – 1 credit
BME 605.2 (ENGRG 605.2) – Physiological Systems – 1 credit
BME 606.2 (ENGRG 606.2) – Artificial Organs and Tissue Engineering – 1 credit
BEE 6?? – Nucleic Acid Engineering (planned for fall 03, D. Luo) – 3 credits
BME 6?? (CHEME ???) – Drug Delivery Systems (planned for Fall 2003, D. Putnam) – 3 credits
COMS 626 – Computational Molecular Biology – 4 credits

b) Students will fulfill requirements described in i) or ii), depending on their prior coursework in engineering and life sciences.

i) Requirements in life sciences for students with an undergraduate degree in engineering or a physical science

Students who majored in engineering or physical sciences as undergraduates must demonstrate basic knowledge in biochemistry/genetics and physiology to receive a BME M.Eng degree. To demonstrate such knowledge, students can complete a course in each area listed below. Up to two courses (6 credits) can count towards the M.Eng credit requirement. Students entering the program who have completed course work at a comparable level in one or both of these areas are excused in the corresponding area(s). These students should substitute upper level BME courses or advanced life science courses that build on prior course work.
The following courses are acceptable in each area; others will be considered by petition to director of the BMEP:

ia) Biochemistry/Genetics
- BIOGM 330 - Principles of Biochemistry, Individualized Instruction – 4 credits
- BIOGM 333 - Principles of Biochemistry, Proteins, Metabolism, and Molecular Biology – 4 credits
- BIOGM 331 - Principles of Biochemistry, Proteins and Metabolism – 3 credits
- BIOGM 332 - Principles of Biochemistry, Molecular Biology – 2 credits
- BIOGD 281 – Genetics – 5 credits

ib) Physiology
- BIOAP 311 – Introductory Animal Physiology Lectures – 3 credits
- BIONG 222 – Introduction to Neurobiology – 3 or 4 credits
- BIOGD 389 – Embryology – 3 credits

ii) Requirements in engineering for students with an undergraduate degree in biology

Students who majored in biology as undergraduates must have completed the minimum required courses in physics, mathematics, computer science and molecular and cellular BME and BME analysis of physiological systems as part of their undergraduate studies. To receive the BME M.Eng. degree, they must complete at least 6 credits of “traditional” engineering courses in their area of BME concentration from the recommended courses listed below. Up to two courses (6 credits) can count towards the M.Eng credit requirement.

Students entering the program with formal engineering coursework that is comparable to courses listed below in their area of concentration are excused for this requirement. These students should substitute upper level BME courses or advanced engineering courses that build on prior engineering coursework.

The program strongly recommends the following courses in each area of concentration:

iiia) Biomechanics Focus
- ENGRD 202 Mechanics of Solids
- ENGRD 203 Dynamics

iiib) Biomaterials Focus

Two of the following three:
- MS&E 261 Mechanical Properties of Materials
- MS&E 262 Electronic Materials
- MS&E 304 Kinetics, Diffusion and Phase Transformation
iic) Drug Delivery/Tissue Engineering Focus

Two of the following three:
- CHEME 323 – Fluid Mechanics
- CHEME 324 – Heat and Mass Transfer
- CHEME 399 – Reaction Kinetics and Reactor Design

iid) Instrumentation Focus

- ECE 210 Introduction to Circuits
- ENGRD 230 Introduction to Digital Logic Design

iii) Additional electives to fulfill the 30 credit requirement

Students who complete the requirements in the categories described above with less than 30 credits must take elective engineering courses approved by their advisor. Suitable electives include a 6-credit rather than 3-credit design course (BME 591), courses in the BME area of concentration, or courses in a traditional engineering subject, which is especially appropriate for students who majored in biology as undergraduates.

Example Curriculum

For BS Engineer (Had BS in M&AE with BME Minor)

<table>
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6.0. Administration and Space

The BMEP will administer the BME M.Eng. Currently, the BMEP is assigned rooms 270, 272, 260B, and 276 in Olin Hall and the instructional laboratory space in Kimball Hall. Expansion space to accommodate housing new M.Eng. BME students and adequate computer support for these students has been discussed with Asst. Dean Cathy Long and will be built into the emerging space plan for the College. The BMEP is expected to be an occupant of the New Life Sciences Technology Building which is expected to be completed after June 2006. The Provost and College are providing funds to support an additional staff line to support BMEP efforts, including the M.Eng. in BME program. It should be noted that the Graduate Field of BME has been in existence since 1998 and, unlike Systems Engineering, a new graduate field does NOT need to be created.

7.0. Financial Structure

Possible models for financial structure have been discussed with Asst. Dean Cathy Long. We anticipate that the M.Eng. in BME will significantly increase total M.Eng. enrollment in the COE and overall revenues to the COE. Since the M.Eng. committee is currently discussing a revision of the distribution formula, there is an additional element of uncertainty in the formula for distribution of funds. The model proposed by Systems Engineering is not applicable to BMEP. The BMEP core faculty lines are extra to the departments, but the teaching obligations of the BMEP core faculty go through the BMEP director. Thus, unlike Systems Engineering, the use of M.Eng. revenues to compensate existing departments for teaching services is unnecessary.

The BMEP is ready to work with the College of Engineering and the M.Eng. committee to find a mutually agreeable arrangement. As an initial suggestion, we propose that BMEP receive tuition return for all students enrolled in BMEP.

8.0. Timetable

- November 2002: MEC review, modification, and approval of proposal
- December 2002: Send proposal to graduate school for information/approval
- February 2003: Send request to NYS Department of Education
- December 2003: Approval from NYS
- Publicize new degree program
- August 2004: Matriculation of first M.Eng. class in BME
Appendix A

BMEP Structure Document
(from Harold Craighead
9/18/01)

Appendix B

BME Graduate Faculty List
(include Dave Putnam as nominated)

Appendix C

BMEP Advisory Board Members

Appendix D

Bioengineering Curriculum Committee
Member List