# Board of Regents, State of Iowa

## REQUEST TO IMPLEMENT A NEW BACCALAUREATE, MASTERS, DOCTORAL OR FIRST PROFESSIONAL DEGREE PROGRAM

*THE PURPOSE OF ACADEMIC PROGRAM PLANNING: Planning a new academic degree program provides an opportunity for a Regent University to demonstrate need and demand as well as the university's ability to offer a quality program that is not unnecessarily duplicative of other similar programs offered by colleges and universities in Iowa.*

**Institution:** Iowa State University

**Departments involved:** Agricultural & Biosystems Engineering

**CIP Discipline Specialty Title[1]:** Agricultural/Biological Engineering and Bioengineering

**CIP Discipline Specialty Number (six digits):** 14.0301

**Level:** B4 **M** **D** **FP**

**Title of Proposed Program:** Biological Systems Engineering (BSE)

**Degree Abbreviation:** B.S.

**Approximate date to establish degree:** August, 2008

**Contact person(s):** D Raj Raman 515-294-0465 rajraman@iastate.edu
Carl Bern 515-294-1270 cjbern@iastate.edu

[1] US Department of Education, Institute of Educational Sciences, Classification of Instructional Programs 2000, http://nces.ed.gov/pubs2002/cip2000/

**Please provide the following information (use additional pages as needed).**

**1. Describe the proposed new degree program, including the following:**

**a. A brief description of the program and a statement of objectives including the student learning outcomes and how the learning outcomes will be assessed;**

Biological Systems Engineering (BSE) is an engineering discipline that integrates life sciences with engineering to solve problems related to, or using, biological systems. These biological systems may include microbes, plants, animals, humans and/or ecosystems. Biological systems engineers have a worldview shaped by an understanding of fundamental principles of engineering and life-science. They use their understanding of engineering to analyze organisms or ecosystems, and their knowledge of biological systems to inspire and inform their designs. They approach engineering design from a biological systems perspective, meaning that they appreciate the complexity of biological systems and can develop solutions that accommodate and anticipate the adaptability of biological systems. Biological systems engineering analysis may include characterization, measurement, and modeling of biological processes and interactions between living systems and their environment. Biological systems engineering design may include developing processes and systems that monitor, simulate, replace, modify, control, optimize, or utilize the mechanisms of living organisms and their products.

The BSE program will have four options, as follow:

(1) Biorenewable Resources Engineering Option: Biorenewable Resources Engineering will focus on understanding the economics, environmental impacts, and sustainability of biorenewable resource production systems, biomass-derived fuels, and processing of biomass for energy and/or chemicals. Employment opportunities for graduates of the Biorenewable Resources Engineering option are with firms that design or operate industrial-scale bioconversion systems, such as biodiesel and ethanol plants. Students in this option will have a broad view of the entire biorenewable production and processing industry, with expertise in front-end harvesting and processing steps, and exposure to bioprocessing and downstream processes to successfully work with chemical process engineers. Students in the Biorenewable Resources Engineering option will take a full year of organic chemistry, including a 2-credit hour lab focused on organic chemistry relevant to biorenewable resources. This will complement training in sustainable engineering and international development, and process modeling and control. Students will be able to select additional coursework in topics like grain processing and handling, total quality management, or applied economic optimization.

(2) Bioenvironmental Engineering Option: Bioenvironmental Engineering focuses on the biology and engineering principles relevant to soil, water, and air quality. They use this background to study water pollution prevention and soil preservation in bioresource production systems – a critical topic given the increased demand for crops in the future. Students in this option will receive additional chemistry training in organic chemistry and in quantitative and environmental analysis. They will be able to take additional courses in subjects such as total quality management, environmental biotechnology, and water and

wastewater treatment. Employment opportunities for graduates of the Bioenvironmental Engineering option are with consulting firms, government agencies (e.g., Natural Resources Conservation Service), and larger companies that employ engineers to manage and improve environmental systems.

(3) Food Engineering Option: Food engineering focuses on the science and engineering needed to design and operate modern food processing systems. Students in this option will receive additional science training in the form of organic chemistry, food chemistry, and food microbiology. These sciences will underlie applied courses in grain processing and handling, food engineering, and food processing (including an extensive lab experience in the ISU Center for Crops Utilization Research Pilot Plant. These students will have employment opportunities in the food processing industry, a multi-billion dollar enterprise in the US alone, with great relevance to Iowa and the world.

(4) Pre-Professional and Pre-Graduate Option: Although the BS degree is the professional degree in engineering, it can also serve as a springboard into other professions – from science (via MS – PhD route) to medicine and law. Because of the strong training in engineering fundamentals, systems approaches, and biology that characterize this new curriculum, we felt that it was appropriate to develop a **limited enrollment option** aimed at students who are expecting to enter a professional track other than engineering. (Of course, it is entirely possible that students in the other options would opt for graduate study, but we expect those students to typically pursue MS and PhD work in Biosystems-related engineering disciplines.) Students in the Pre-Professional and Pre-Graduate Option will take the one-year organic chemistry sequence with lab, along with a process modeling and control or applied computational intelligence course. They can then select from a broad range of sequences of courses at or above the 200 level. For example, students expecting to pursue medicine might opt for the human physiology sequence, while those considering law might opt for the political science sequence. However, students, under the guidance of their advisor, and within the confines of the prerequisites listed in the ISU course catalog, can create their own areas of focus in this option.

The Biological Systems Engineering Curriculum has the following educational objectives for its graduates in their first two to five years post-graduation:

- Have performed engineering design in a biological context (includes thinking creatively, formulating problem statements, applying fundamental mathematical, scientific, and engineering principles, communicating effectively, synthesizing information, and evaluating and implementing solutions);
- Have demonstrated an awareness and accommodation of issues such as ethics, safety, cultural diversity, globalization, environmental impact, social impact, and economic impact;
- Have demonstrated a commitment to professional and technical growth through the pursuit of higher levels of job-responsibility and continuing education;
- Have demonstrated the ability to lead and/or collaborate with diverse groups of people, and to successfully manage multiple simultaneous projects.

The specific learning outcomes of the Biological Systems Engineering Curriculum will ensure that we have well trained students who can combine engineering principles with the biological understanding needed in the food, feed, fiber, and environmental sectors. By the time they graduate, Biological Systems Engineering students will have demonstrated[2]:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multi-disciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
l. proficiency in mathematics through differential equations, a thorough grounding in chemistry and biology, and a working knowledge of advanced biological sciences consistent with the program objectives.
m. competence in the application of engineering to biological systems.

The assessment of these outcomes will be according to the well established assessment procedures in place for the existing Agricultural Engineering degree program. We use a broad range of direct measures of key competencies, including employer evaluations of interns and graduates, portfolios, evaluations of senior design performance. These competencies were selected by external constituents of the department, and are linked to the outcomes (a – m).

**b. The relationship of the proposed new program to the institutional mission and how the program fits into the institution's, college's, and department / program's strategic plan;**

This proposal seeks to create a new undergraduate degree program to better serve the engineering needs in the bioeconomy, specifically as related to food, feed, and fiber processing and environmental systems. This new degree builds upon Iowa State University's internationally-recognized Agricultural Engineering program, and leverages the department's strengths in biology-related systems engineering.

The BS degree in Biological Systems Engineering (BSE) is linked strongly to the scientific discipline of biology and to the systems engineering perspective that has always been a hallmark of Agricultural Engineering. In keeping with the recommendations of the Battelle Report on the Bio-economy for Iowa, and with the Iowa State University President's initiatives to develop programs that serve

[2] These outcomes meet the requirements of the Accreditation Board for Engineering and Technology (ABET).

the bioeconomy, the goal of this degree program is to prepare engineers to better serve the biological system engineering needs of companies, organizations, and agencies in Iowa and the world. Because of the importance of growing the Iowa economy, and the opportunity for bioeconomy firms to leverage the raw biomass available in Iowa, this degree program will explicitly teach entrepreneurship to students. Furthermore, as globalization progresses, it becomes increasingly important that engineers being able to work at the systems level. Thus this degree program explicitly teaches students about systems level analyses, from both economic and mass-energy-environment perspectives (i.e., life cycle analyses).

Iowa produces abundant raw biological products including row crops, livestock, and manure, making it a natural home for bio-based companies[3]. State leaders have realized this and are advancing Iowa's bioeconomy by developing programs, such as the BIOWA Development Association, to create and attract additional bio-based companies to the state. These companies will need engineers who can transform the knowledge generated by research into products and services that add value to Iowa's raw biomass while protecting its environment.

Historically, agricultural engineers in the Department of Agricultural and Biosystems Engineering at Iowa State University have worked at the interface of engineering and food, feed, and fiber-producing biological systems. In the early 20th century, these agricultural engineers focused on development of mechanized equipment, rural electrification, and drainage. As biological knowledge has exploded over the past three decades, our discipline has evolved to more deeply address the biological issues related to design and management of agricultural, food processing, and natural resource systems. Our faculty are currently working in areas critical to Iowa including water quality, bacteria and pathogen monitoring and modeling, wetlands and riparian buffer strip design, biofuel life-cycle analysis, bioconversion of biomass for nutrients and energy, biomass harvesting, processing, quality and preservation, food safety and processing, and biosensors. The Department of Agricultural and Biosystems Engineering External Advisory Council has recommended that we offer an undergraduate BSE degree to capitalize on the department's underlying expertise in biological systems engineering and to reflect the current work and future direction of our department as the bioeconomy grows.

**c. The relationship of the proposed new program to other existing programs at the institution; describe how the proposed program will enhance other programs at the university.**

The proposed degree program builds upon two options currently offered under the Agricultural Engineering degree program: The Food and Biological Engineering option and the Environmental portion of the Agricultural and Environmental Systems option. The resulting BSE curriculum includes more bioscience-relevant courses and integrates more biology into the associated engineering courses. The Biorenewable Resources Engineering option exposes students to bioprocessing and downstream processes so they can successfully work with chemical process engineers, such as those trained in the Chemical

[3] Battelle Institute Report on Iowa's Bioeconomy 2004.
http://www.legis.state.ia.us/lsadocs/IssReview/2005/IRRIT000.PDF

Engineering degree program offered by the Department of Chemical and Biological Engineering at Iowa State University.

Many of our sister Agricultural and Biosystems Engineering departments around the country have similarly reorganized their programs. In so doing, they have enhanced student recruitment (especially women and underrepresented minorities), and improved their relevance to bio-based companies in their states. We expect that this program will have a similar impact at Iowa State University, which will benefit the College of Engineering's efforts to enhance gender diversity.

**d. The relationship of the proposed new program to existing programs at other colleges and universities in Iowa, including how the proposed program is different or has a different emphasis than the existing programs; and**

The University of Iowa has a strong Biomedical Engineering program, focused on "educate engineering students who will promote human health by solving problems dealing with living systems." There is minimal overlap between this program and the proposed program, as the proposed program is focused on the non-medical areas of natural resource production, protection, and processing, rather than on human health via medicine.

Although the University of Northern Iowa has strong programs in allied areas such as Applied Physics/Engineering and Biotechnology, no comparable degree program exists there.

Dordt College has a single accredited Engineering major, which in turn has emphasis areas in "mechanical, electrical, civil-environmental, computer, or biomedical engineering." While some overlap clearly exists in the core engineering content of this proposed program and those of Dordt College, there is minimal overlap in this programmatic emphasis and theirs.

**e. Special features or conditions that make the institution a desirable, unique, or appropriate place to initiate such a degree program.**

- The strength of the Agricultural & Biosystems Engineering Department at Iowa State University: First Agricultural Engineering program in the world, and one of the largest student enrollments in the nation.
- The dedication of the department's faculty to all aspects of the land-grant mission, including high quality instruction, research, and outreach.
- The institutional emphasis on the bioeconomy initiative at Iowa State University.
- The leadership roles played by Agricultural and Biosystems Engineering faculty in the bioeconomy initiative, including two Associate Directors of the Office of Biorenewable Programs, and the former and current Directors of Graduate Education for the Biorenewable Resources and Technology Interdepartmental Graduate Program.
- The unique position of the Agricultural & Biosystems Engineering Department at Iowa State University, bridging the College of Engineering and the College of Agriculture.

- The highly collaborative nature of Iowa State University, including the willingness on the part of Agricultural & Biosystems Engineering Department to team with faculty from across the campus in teaching, research, and outreach efforts.

**f. Does the proposing institution have personnel, facilities, and equipment adequate to establish and maintain a high quality program?**

Generally yes. The department has been successful in recent years at recovering from years of decreasing faculty numbers, and has made several new hires in the last three years, with several more anticipated in the next year. The ISU College of Engineering Cluster Hire program includes clusters in sustainability, biosciences and engineering, which could easily lead to one or more additional faculty member available to assist with this program. The department has modern equipment available for teaching, in large part due to the strong support we have enjoyed from alumni and our External Advisory Committee. Some differential tuition funds have recently been used to update teaching equipment also.

In contrast to the faculty numbers and equipment, facilities have been a weak point for the department, which has awaited a new building for several decades now. Fortunately, a naming gift was made during 2006, which is helping drive the effort to build a new primary building complex for the department. It will be extremely helpful to this new degree program if the new building be completed in a timely manner.

**g. How does student demand for the proposed program justify its development?**

Enrollment numbers at sister departments that have implemented a strong biological engineering program suggest that student demand will be strong. Students have been entering the existing Agricultural Engineering program at Iowa State University (typically into the food and biological engineering option) for nearly four years with intentions to move into a biological systems engineering program, which has been on the drawing board for that amount of time. Although these students were fairly well served by the concentration in food and biological engineering, many have commented that they wish to have a true biological systems engineering program available – one that had more of a biological focus that what was possible in the option alone.

**2. Describe the state and/or national workforce need and/or demand for graduates of the proposed program currently and in the near future (provide documentation about the sources of data used to estimate need and demand.)**

The US National Science Foundation, in their 2003 National Science Board Report, stress that “The global competitiveness of the US S&E [Science and Engineering] workforce and domestic competitiveness of S&E careers will depend ultimately on how schools, colleges, universities, and other education providers develop and refine human resources.” This wonderfully clear statement expresses the core goal of engineering education – to *develop and refine human resources*. The proposed degree program will provide unique educational experiences that prepare students to address issues of significant societal importance, including environmental quality, food production, and biorenewable resources production and processing. In this last role, exposure to bioprocessing and downstream processing will be provided so that these students can

successfully work with chemical process engineers, who are heavily involved in the processing of biorenewable resources. Agricultural engineers have a long history of serving leadership roles in many types of engineering and technical organizations, often outside of what one normally thinks of as "agriculture." We expect these students to be similar, in that their broad training will enable them to contribute to society in more ways than simply as biological systems engineers.

That said, below are the most recent Bureau of Labor Statistics outlooks for each of the options within Biological Systems Engineering[4]:

Biorenewable Resources Engineering Option: Closest BLS grouping is agricultural engineers, for which job opportunities are projected to increase "about as fast as the average for all occupations through 2014." In fact, with their specialized training in fuel and chemical crop processing, these students may have slightly better than average job opportunities.

Bioenvironmental Engineering Option: Closest BLS grouping is environmental engineers, for which job opportunities are projected to "increase much faster than the average for all occupations through 2014."

Food Engineering Option: Closest BLS groupings are agricultural engineers and food scientists, for which job opportunities are projected to increase "about as fast as the average for all occupations through 2014."

Pre-Professional and Pre-Graduate Option: This option, as discussed elsewhere, is not as focused on careers immediately after the B.S. degree. However, given the demand for post-baccalaureate trained persons, we expect high demand for these graduates.

**3. List all other public and private institutions of higher education in Iowa currently operating programs similar to the proposed new degree program. (For comparison purposes, use a broad definitional framework, e.g., such identification should not be limited to programs with the same title, the same degree designation, having the same curriculum emphasis, or purporting to meet exactly the same needs as the proposed program.)**

None (Please refer to item 1d above).

**4. Estimate the number of majors and non-majors students that are projected to be enrolled in the program during the first seven years of the program.**

**a. Undergraduate**

| Undergraduate | Yr 1 | Yr 2 | Yr 3 | Yr 4 | Yr 5 | Yr 6 | Yr 7 |
|---|---|---|---|---|---|---|---|
| **Majors** | 15 | 35 | 60 | 90 | 105 | 110 | 120 |
| **Non-Majors** | 5 | 10 | 15 | 20 | 20 | 20 | 20 |

**b. Graduate – Not applicable**

**c. What are the anticipated sources of these students?**

Students from Iowa and surrounding states with a strong interest in engineering and biology related to natural resources production, protection, and processing. There will certainly be some drain of students from our existing Agricultural Engineering program (particularly from the Food/Bio option, and to a lesser extent from the Agricultural/Environmental Systems option). However, we do not

[4] http://www.bls.gov/oco/ocos027.htm

expect the new program to jeopardize the existing program's existence. Although there are complementarities between programs, there is also significant distinction between them, particularly in regard to the focus on chemistry and biology in the BSE program. We expect to enroll students that have traditionally not chosen agricultural or related engineering degree programs.

5. **If there are plans to offer the program away from the campus, briefly describe these plans, including potential sites and possible methods of delivery instruction.** No such plans exist.

6. **Has the proposed program been reviewed and approved by the appropriate campus committees and authorities? List them:**

7. **List date the program proposal was submitted to the Iowa Coordinating Council for Post High School Education (ICCPHSE) and the results of listserv review** (THIS WILL BE FILLED IN BY THE PROVOST OFFICE.)

8. **Will the proposed program apply for accreditation?** Yes. **When?** In the fall immediately after the first students graduate. This is critical to allow those students to be grandfathered into an accredited program, which can determine their ability to obtain engineering licensure in many states. This degree will be accredited by ABET (Accreditation Board of Engineering and Technology) which already accredits all the other degree programs in the College of Engineering.

9. **Will articulation agreements be developed for the proposed program? With whom?**
   It is likely that we will develop articulation agreements with community colleges in Iowa, such as Iowa Central Community College and Indian Hills Community College.

10. **Describe the faculty, facilities, and equipment that will be required for the proposed program.**

    Most faculty, facilities, and equipment for the proposed program will be those already supporting the existing degree programs within Agricultural and Biosystems Engineering, and other degree-granting departments of the Iowa State University College of Engineering. However, the growth of the department (total undergraduate student numbers currently above 500) will make it imperative that the new ABE building be completed soon, so that much improved teaching facilities can be used by this new program.

**Supplemental materials (to be used for internal ISU review):**

**11. Program requirements, including:**

**a. Prerequisites for prospective students:**
Same as existing for Agricultural Engineering program, but with AP biology or Biology 211 equivalent required.

**b. Language requirements:**
None.

**c. Courses and seminars presently available for credit toward the program:**
Please see *Appendix A* (attached) for a detailed curriculum description, clearly indicating new courses and modifications of existing courses.

**d. Proposed new courses or modifications of existing courses:**
Please see *Appendix A* (attached) for a detailed curriculum description, clearly indicating new courses and modifications of existing courses.

**e. Thesis and non-thesis options in master's programs:**
Not applicable.

**f. Implications for related areas within the university:**
Please see items 4c and 10 above for explanations of impact on existing Agricultural Engineering program.

**g. admissions standards for graduate programs:**
Not applicable.

**14. Attach to the program proposal memos from the department chair(s), the college dean(s), and other appropriate persons, agreeing to the allocation of new resources and/or the reallocation of resources as described in the Regents questions.**
(Please see *Appendix B*)

| Area & Courses | Credits |
|---|---|
| **1. Communications** | **9.5** |
| Engl 150 Composition I | 3 |
| Engl 250 Composition II | 3 |
| Lib 160 Library Instruction | 0.5 |
| *Select any one of the following:* | |
| Eng 309 Report & Proposal Writing | 3 |
| Sp Cm 212 Fundamentals of Public Speaking | 3 |
| Ag Eds 311 Presentation and Sales Strategies | 3 |
| CE 203 Civil Engineering Synthesis I[1] | 3 |
| **2. Mathematics** | **15** |
| Math 165 Calculus I | 4 |
| Math 166 Calculus II | 4 |
| Math 267 Elementary Differential Equations and Laplace Transforms | 4 |
| Stat 305 Engineering Statistics | 3 |
| **3. Social Science and Humanities** | **12** |
| US Diversity Course | 3 |
| International Perspectives Course | 3 |
| Social Science and Humanities Electives | 6 |
| **4. Biological and Physical Science Common Core** | **22[2]** |
| Physics 221 Introduction to Classical Physics I | 5 |
| Physics 222 Introduction to Classical Physics II | 5 |
| Chem 167 General Chemistry for Engineering Students | 4 |
| Chem 167L Laboratory in General Chemistry for Engineering Students | 1 |
| Biol 212 Principles of Biology II | 3 |
| Micro 302 Biology of Microorganisms | 3 |
| Micro 302L Microbiology Laboratory | 1 |

[1] This is the integrated engineering course offered by CCEE, and includes a lot of writing, along with other highly-relevant content (40% estimated to be cost engineering). Need to get CCEE's approval to have our students here.

[2] All students will take an additional 8 – 16 credit hours of Biological and Physical Sciences within program options, for a total of 30 – 38 credit hours of this foundational material.

| Area & Courses | Credits |
|---|---|
| **5. Engineering Core** | **22** |
| Engr 101 Engineering Orientation | R |
| Engr 160 Eng. Problems with Computer Lab & Programming | 3 |
| Engr 170 Engineering Graphics and Intro Design | 3 |
| EM 274 Statics of Engineering | 3 |
| EM 324 Mechanics of Materials | 3 |
| EM 327 Mechanics of Materials Lab | 1 |
| ME 330 Thermodynamics | 3 |
| ChE 356 Transport Phenomena I[3] | 3 |
| ChE 357 Transport Phenomena II | 3 |
| **6. Biological Systems Engineering Core** | **27** |
| BSE 110 Experiencing Biological Systems Engineering | 1 |
| AE 203 Computer Applications and Systems Modeling | 3 |
| AE 216 Fundamentals of Agricultural and Biosystems Engineering | 3 |
| AE 363 Agri-Industrial Applications of Electric Power and Electronics | 4 |
| **BSE 201 Entrepreneurship Seminar** | 1 |
| **BSE 301 Leadership and Ethics Seminar** | 1 |
| **BSE 380 Principles of Biological Systems Engineering** | 3 |
| **BSE 401 Professionalism Seminar** | 1 |
| AE 404 Instrumentation for Agricultural and Biosystems Engineering | 3 |
| BSE 415 Biological Systems Engineering Design I | 2 |
| BSE 416 Biological Systems Engineering Design II | 2 |
| **BSE 480 Engineering Analysis of Biological Systems** | 3 |

[3] Need to formalize approval of prerequisite violations with CBE Department.

| Area & Courses | Credits |
|---|---|
| **7. Options** | **19** or **20** |
| **7a. Biorenewable Resources Engineering Option**<br>*Required:* | **20** |
| Chem 331 Organic Chemistry | 3 |
| Chem 331L Laboratory in Organic Chemistry (biobased focus[4]) | 2 |
| Chem 332 Organic Chemistry | 3 |
| AE 388 Sustainable Engineering and International Development | 3 |
| BSE 403 Process Modeling and Control for Biosystems Engineering[5] | 3 |
| *Select 6 additional credits from approved course list – for example: Biol 312 Ecology; Biol 313 Principles of Genetics; TSM 310 Total Quality Management; Econ 207 Applied Economic Optimization; BSE 469 Grain Processing and Handling; FSHN 471 Food Processing; BRT 5nn Biomass Derived Fuels[6]; TSM Safety Course; AE 406 Applied Computational Intelligence for Agricultural and Biological Systems* | *6* |
| **7b. Bioenvironmental Engineering Option**<br>*Required:* | **20** |
| Chem 231 Elementary Organic Chemistry | 3 |
| Chem 231L Laboratory in Elementary Organic Chemistry | 1 |
| Chem 211 Quantitative and Environmental Analysis | 2 |
| Chem 211L Quantitative and Environmental Analysis | 2 |
| CE 326 Principles of Environmental Engineering | 3 |
| AE 431 Design and Evaluation of Soil and Water Conservation Systems | 3 |
| *Select 3 credits from:* | |
| AE 436 Design and Evaluation of Soil and Water Monitoring Systems | 3 |
| CE 421 Environmental Biotechnology | 3 |
| CE 428 Water and Wastewater Treatment Plant Design | 3 |
| EnSci 381 Environmental Systems | 3 |
| *Select 3 additional credits from approved course list – for example: Biol 312 Ecology; TSM 310 Total Quality Management; TSM 475X Animal Waste Management; AE 388 Sustainable Engineering and International Development; AE 406 Applied Computational Intelligence for Agricultural and Biological Systems; ChE 406 Environmental Chemodynamics* | *3* |

[4] Chemistry Professor George Kraus suggested the possibility of them offering a biobased organic chemistry lab if we offer this curriculum. This is a really exciting prospect for our students, so we have built it into the curriculum. If it did not pan out, we would simply do the 331 – 332 sequence with lab for the same number of credit hours.

[5] This is a course that shares theory and programming lectures with AE 403 *Modeling and Controls for Agricultural Systems*, but that diverges when discussing specific systems to be modeled and controlled.

[6] This is a course that is likely to be developed if we receive funding from a USDA HEC grant submitted Jan '06.

| Area & Courses – Options Continued | Credits |
|---|---|
| **7c. Food Engineering Option** | **21** |
| *Required:* | |
| Chem 231 Elementary Organic Chemistry | 3 |
| BSE 469 Grain Processing and Handling | 3 |
| FSHN 311 Food Chemistry | 4 |
| FSHN 420 Food Microbiology | 3 |
| BSE 351 Food Engineering | 3 |
| FSHN 471 Food Processing | 3 |
| FSHN 472 Food Processing Laboratory | 2 |
| **7d. Pre-Professional and Pre-Graduate Option**[7] | **19 – 20** |
| *Required:* | |
| Chem 331 Organic Chemistry | 3 |
| Chem 331L Laboratory in Organic Chemistry | 1 |
| Chem 332 Organic Chemistry | 3 |
| Chem 332L Laboratory in Organic Chemistry | 1 |
| *Select 3 credits from:* | |
| BSE 403 Process Modeling and Control for Biosystems Engineering[8] | 3 |
| AE 406 Applied Computational Intelligence for Ag & Bio. Systems | 3 |
| *Select 8 – 9 additional credits of 200 level and above in a two to three course sequence. For example:* | |
| Human Physiology Sequence (Biol 255 & 256 + Lab) | 8 |
| Genetics/Molecular Cell Biology Sequence (Biol 313 & 314 + Lab) | 8 |
| Biochemistry Sequence (BBMB 404, 405, & 451) | 8 |
| Bioinformatics Sequence (Com S 207, BCB 484 & 495) | 9 |
| Management Sequence (Mgmt 310, 313, & 414 or 419) | 9 |
| Science Writing Sequence (JI MC 201, 202, & 347) | 9 |
| Political Science Sequence (Pol S 215, 319, & 320) | 9 |
| Globalization Sequence (AE 388, Agron 342 ME 484) | 9 |
| **Program Totals** | **126.5 – 128.5** |
| **Engineering Content** *(ABET requires 48)* | **48 – 54** |

[7] This option is enrollment-limited to one quarter of the students incoming BSE students per year. *This simultaneously makes the program more appealing (selective), while avoiding a loss of program and departmental identity – we do not wish to morph into a pre-med mill.*

**New Course Descriptions:**

**BSE 201[8] Entrepreneurship Seminar.** (1-0) Cr 1. S. Prereq: Sophomore classification in BSE. Exposure to importance of entrepreneurship through seminar presentations by entrepreneurs, development of a business plan, discussions and readings regarding economic impacts of entrepreneurship and strategic strengths of Iowa. Relationship of workplace competencies to entrepreneurship; portfolios.

**BSE 301 Leadership and Ethics Seminar.** (1-0) Cr 1. S. Prereq: 201. Leadership and ethics training through case studies and seminar presentations by practitioners. Relationship of workplace competencies to leadership and ethics; portfolios.

**BSE 401 Professionalism Seminar.** (1-0) Cr 1. S. Prereq: 301. Examination of professionalism in the context of engineering and technology. Coverage of personal time management, project management, personnel management, communications, and registration by speakers.

**BSE 380. Principles of Biological Systems Engineering.** (3-0) Cr. 3. S., Prereq: 216, Ch E 357. Unit-operation analysis of biological systems, through the study of mass, energy, and information transport in bioresource production and conversion systems. Quantification and modeling of biomass production, ecological interactions, and bioreactor operations.

**BSE 480. Engineering Analysis of Biological Systems.** (Dual-listed with 580.) (2-2) Cr. 3. F., Prereq: 380. Systems-level engineering analysis of biological systems. Economic and life-cycle analysis of bioresource production and conversion systems. Global energy and resource issues and the role of biologically derived materials in addressing these issues. Nonmajor graduate credit.

[8] Coordinate with Papajohn Center. May coordinate with Econ 331 *Entrepreneurship in Agriculture*. Robert Jolly (Econ) & Steve Nissen (An Sci).

# Appendix B: Letters of Support

B2: Iowa State University, Department of Civil Construction and Environmental Engineering
B3: Iowa State University, Department of Chemical and Biological Engineering[1]
B4: Iowa State University, Department of Food Science and Human Nutrition

[1] In preparation. Expected by Friday April 27, 2007

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Engineering
Department of Civil, Construction
and Environmental Engineering
Ames, Iowa 50011-3232
Phone 515 294-3892
FAX 515 294-8216

# Memorandum

TO: Ramesh Kanwar, *Professor and Chair*
Department of Agricultural and Biosystems Engineering
ISU-COE

FROM: James E. Alleman, *Professor and Chair*
Department of Civil, Construction, and Environmental Engineering
ISU-COE

DATE: *11 April 2007*

RE: PROPOSED AgBE DEGREE PROGRAM: BACHELOR OF BIOLOGICAL SYSTEMS ENGINEERING

Your proposed new BS degree in biological systems engineering is a bold new initiative and a logical step forward to meet a market demand in the constantly changing paradigm of engineering applications. We would certainly support this proposal.

The time has come to meet the challenges by the ever expanding plant and animal based industry in Iowa and the Mid-West. These industries are no longer optimally served by the traditional engineering disciplines. A new brand of engineer is required to take this specialized industry into the 21st Century. We already see the blossoming of such programs at other universities and for Iowa to maintain its rightful share in producing the new leaders in this industrial sector; ISU should take the lead with this program.

We are pleased to be able to cooperate in offering this program with some courses from this department. Dr. Hans van Leeuwen has been serving on your committee for this new degree program. Dr. Shihwu Sung has also been involved in discussions with yourself and faculty from your department about the program.

The curriculum for your new program is a pleasing selection of courses and will impart the required multidisciplinary strength in the education of candidates. While there are some minor similarities with our environmental engineering program, we see the need for this program in addition to our own. Our program addresses the needs of metropolitan society to take care of its waste products and maintain and provide clean water. In addition, your plan addresses more the requirements of a bio-based and rural industry. The new program also clearly distinguishes itself from traditional agricultural engineering in moving away from farm mechanization.

Thank you for providing this collaborative opportunity to review your proposal. Thank you also for having involved representatives from our department in the planning of this program and for keeping us involved. We look forward to continuing our participation in this effort.

Good luck!

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Engineering
Department of Chemical
and Biological Engineering
2114 Sweeney Hall
Ames, Iowa 50011-2230
515 294-7642
FAX 515 294-2689

May 11, 2007

To Whom It May Concern:

I am writing in support of the bachelor of science degree program in **Biological Systems Engineering** proposed by the Department of Agricultural and Biosystems Engineering. The faculty of the Department of Chemical and Biological Engineering reviewed the proposed program, and faculty leaders in the biological area of the department suggested improvements both to coursework required and to the explanatory text in the proposal which were subsequently incorporated into the final document ("BSE Program Plan 4," April 13, 2007). We believe that the proposed program will complement the BS Chemical Engineering degree offered by the Department of Chemical and Biological Engineering.

We see the proposed biological systems engineering degree program in the ABE Department as lying somewhere between traditional agricultural engineering—with its emphasis on power and machinery systems and soil and water engineering—and biological applications of chemical engineering, with its emphasis on chemical process engineering including unit operations and biomolecular-level engineering and science. Just as faculty from the Chemical & Biological Engineering and Agricultural & Biosystems Engineering departments collaborate now, we believe that graduates of the BSE program will work with graduates of our own undergraduate program not only in existing industries, but also in exciting emerging industries of the 21st century.

We note that several core engineering courses in the BSE program are taught by the CBE department. We look forward to educating those BSE students and to enjoying the benefits of the interactions between these degree programs and between the two departments.

Very truly yours,

James C. Hill
University Professor and Chair
Chemical & Biological Engineering

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Department of Food Science
and Human Nutrition
2312 Food Sciences Building
Ames, Iowa 50011-1061
515 294-3011
FAX 515 294-8181

April 18, 2007

D Raj Raman, PhD, PE
Director of Graduate Education, Biorenewables Resources and Technology
Interdepartmental Graduate Program
Associate Professor, Agricultural & Biosystems Engineering
3222 NSRIC
Iowa State University
Ames, IA 50011-3310

Dear Dr. Raman,

The faculty of the Department of Food Science and Human Nutrition Department are supportive of the proposed Biological Systems Engineering BS degree program and the options in biorenewable resources engineering, bioenvironmental engineering, food engineering and pre-professional/pre-graduate. Based on the discussion with you, Carl Bern, Tom Brumm, Stephanie Jung and me on March 8, I understand that the Food Engineering option will require FSHN 311, 471, 472, and FSHN 351 taught by Dr. Jung, possibly with another designator. This new area of academic study in biorenewables will attract additional students, strengthen the interactions between food processing and food engineering, and offer interesting employment opportunities. I anticipate many creative developments in this rapidly growing industry and look forward to our continuing interactions.

Sincerely,

Cheryll A. Reitmeier, Ph.D.
Professor and Associate Chair
Curriculum Committee Chair
2543 Food Sciences Bldg.
Ames, IA 50011

cc: Dr. Stephanie Jung, Assistant Professor
Dr. Ruth MacDonald, FSHN Department Chair