Bioproducts & Biosystems Science, Engineering and Management (BBSEM)
A graduate studies program at the University of Minnesota

Graduate Student Learning Outcomes (SLOs)

About the Program
The bioproducts and biosystems science, engineering and management (BBSEM) graduate program was initiated in 2007 as an interdisciplinary degree-granting program. The M.S. (Plan A & B options) and Ph.D. degrees are both conferred through this program. The purpose of BBSEM is to provide graduate students a strong foundation in the basic sciences, engineering, and management in support of renewable bio-resources utilization, environmental quality, and national security, while improving our global competitiveness. In five years, the BBSEM program has grown to include 39 graduate faculty members advising a total of 43 graduate students. Many faculty advise from within the Department of Bioproducts and Biosystems Engineering (BBE), but several adjunct members are affiliated from outside of BBE and the University of Minnesota.

The breadth of graduate faculty expertise in BBSEM provides framework within which a student can design a meaningful, interdisciplinary degree program focused around the common goal of sustainably utilizing natural resources. Adaptable coursework and committee choices, coupled with several program-specific experiences, allow students to harness depth of expertise and maximize its diversity, in context. The program is also working toward a cohort process among students with similar areas of specialization, and the students are actively involved in this SLO preparation. This scaffold, upon which students build their degrees to suite their career aspirations, is increasingly strengthened by both endowed fellowships and by teaching assistantships within BBSEM. These not only reflect the hard work and commitment of those affiliated with the program, they offer valuable teaching experiences, competitive merit-based awards, and recruiting/retention tools to stabilize the program around the student experience.

In BBSEM, general areas of specialization include 1) bioproducts science and engineering, 2) biosystems science and engineering, and 3) bioproducts marketing and management. These general focus areas are described as follows:

1) **Bioproducts science and engineering** - This specialization focuses on the fundamental science and engineering of the various manufacturing processes used in sustainable conversion of biomass into bio-based products and their effective end-use applications. Bioproducts include "green" materials, chemicals and energy derived from bioresources including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more.

2) **Biosystems science and engineering** – This specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles that are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management.

3) **Bioproducts marketing and management** – This specialization is designed for graduate students who seek to build on a strong diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.
Potential areas of interest relate to application and management of those specific specializations outlined in the science and engineering tracks, above.

Our Approach for Integrating SLOs
The aims for this effort are to define the student learning outcomes (SLOs) for the graduate students and to match these SLOs with the metrics for tracking their success. In BBSEM, this parses into a two-step process. 1) With the input of both faculty and students, develop a list of graduate student outcomes best suited to the strengths and goals of the BBSEM program. 2) Use an iterative process to match these outcomes with an assessment strategy that is feasible and helpful.

Specifically, this process has been initiated with this draft document. The first draft has been created with the help of templates from the pilot efforts at the Graduate School and the input from an informal subcommittee of students and faculty. This document has been circulated with a ‘request for input’ among all graduate faculty in BBSEM and current students. This has been done electronically as well as with discussion among faculty at regular faculty meetings. Given the size of the graduate program (43 current students), students have been invited to give feedback again on a ‘walk-in’ basis in the office of the DGS, and there are plans to do this at a student social this Spring (2015). This student feedback has been invaluable, particularly in terms of assessments and feasibility. This verbal and written feedback has been integrated into this document, and this final version is subject to feedback above the Program level.

Identified SLOs for BBSEM
The BBSEM graduate program is designed to prepare students with core competencies and a broader skill set that prepares them for success as scientists, engineers, or managers/practitioners in the areas of natural resource sustainability. These focus areas are identified in our purpose statement and bulleted above.

Below, we have identified specific SLOs that we expect for students emerging with a BBSEM graduate degree. Individual SLOs are matched with metrics (letters in parentheses). These are broadly covered by a mission to 1) train students to be ethical, collaborative, and at the cutting-edge of their field, at the time of graduation and 2) equip students with the tools, familiarity with the creative process, and communication skills to self-propel with their degrees in-hand.

SLOs for BBSEM Graduate Degree

1. Documented and effective training in the ethics of science, engineering, and management. (E, F)
2. A focused line of study (core competency) within one of the BBSEM specialization areas. (A, E, K, L)
3. An interdisciplinary coursework approach that broadens the context for student training. (B)
4. An interdisciplinary research experience that provides an avenue for cross-pollination and trains the student to work collaboratively. (C)
5. Direct experience of the creative process, with critical thinking skills for solving real-world problems relevant to BBSEM. (A, D)
6. A demonstrated ability to conceive, articulate, and design a research plan that promises to reveal novel and useful insight into sustainable use of natural resources.
   (E, K)

7. Competency in methodologies for experimental design and data collection/synthesis.
   (H)

8. A demonstrated ability to communicate results in writing, both accurately and convincingly.
   (F, K, L)

9. A demonstrated ability and repeated experience presenting results, with training to do so both ethically and effectively.
   (G, L)

10. Exposure and participation beyond the BBSEM program, the University of Minnesota, and, if possible, beyond the United States, in communicating and networking.
    (G)

11. Teaching and mentoring experience, coupled with pedagogical training.
    (I)

12. Demonstrated experience in service, outreach and/or extension activities.
    (J)

13. Successful carry-forward when applying the degree in the workforce, etc. beyond the degree.
    (M)

**Metrics for Evaluation of SLOs**

A) Successful Degree Program plan, agreed upon by a committee and the DGS.

B) A coursework area of ‘minor’ specialization (12 credits, at present), to broaden coursework to include a complementary focus area.

C) A committee that must include participation of an outside member, not from within BBE.

D) Successful completion of Seminar I course (BBE 8001), involving ethics training and a thorough introduction to both giving presentations outside of the student’s area of specialization and critically asking/answering questions.

E) Successful completion of Seminar II course (BBE 8002), continuing ethics training as the student progresses, as well as a matured presentation in the student’s area of specialization.

F) Submitted manuscript(s) or other material ‘products’ deemed acceptable within a specific area of specialization, including peer-reviewed scientific journal articles.

G) Poster and presentation citations, including audiences beyond the BBSEM program and the University of Minnesota.

H) Acceptable performance in a Statistics course that adequately covers experimental design (at present as BBE 8013).

I) Teaching Assistantship, experience as a mentor for undergraduates, and/or other classroom experience that can prepare a student with mentoring/teaching skills.

J) Documented service, outreach or extension experience by the time of thesis defense.

K) Successful Dossier submission and review by members within BBSEM (Ph.D., only) for advancement to candidacy. The Dossier is to be completed early enough in progression that the reviews can both critique the student’s potential and offer useful reviewer feedback during the design and implementation phase of their experience.

L) Successful thesis defense for the M.S. or Ph.D. degree.

M) Exit and follow-up surveys to guide and validate the SLOs and track student successes, navigating with the degree in-hand.