COMMISSION FOR HIGHER EDUCATION
Friday, September 14, 2012

DECISION ITEM A-2: **Bachelor of Science in Environmental and Ecological Engineering To Be Offered by Purdue University West Lafayette at West Lafayette**

Staff Recommendation

That the Commission for Higher Education approve the Bachelor of Science (B.S.) in Environmental and Ecological Engineering to be offered by Purdue University West Lafayette at West Lafayette, in accordance with the background discussion in this agenda item and the *Program Description*.

Background

Purdue University will seek ABET accreditation for its proposed B.S. in Environmental and Ecological Engineering. At present, there are no standalone, ABET-accredited Environmental Engineering baccalaureate programs in public or independent universities in Indiana. In FY2011, the Purdue University West Lafayette campus enrolled a total of 7,394 headcount or 7,164 FTE students in baccalaureate Engineering programs. In that same year, the West Lafayette campus graduated 1,397 bachelor's degree recipients in Engineering disciplines.

Although the curriculum for the proposed program exceeds the standard expectation of 120 semester hours of credit for baccalaureate programs, the University has provided an adequate justification for this exception. While the ABET program criteria for this field – which were developed in conjunction with the American Academy of Environmental Engineers as the lead society – do not specify credit hours, they do detail, at some length, the subject matter that needs to be covered by required coursework.

The University had its proposed curriculum examined by four external reviewers, including one from the University of Texas at Austin, who has chaired a dozen teams of ABET evaluators. All reviewers agreed that a curriculum of 120 hours would make it very difficult, if not impossible, to achieve ABET accreditation, and that a 128-hour curriculum should ensure ABET accreditation. Two reviewers commented further that 128 hours is the minimum number of credits needed for programs that have achieved ABET accreditation.

Purdue University has an articulation agreement with Vincennes University for the proposed program. The University is still working with Ivy Tech Community College to

develop an articulation, but this has not yet been finalized because of the need for further discussions around the mathematics requirement. The University and the College are optimistic that an agreement can be formalized by the end of the Fall 2012 semester. Commission staff will actively monitor this situation to help ensure that this much needed articulation agreement can be reached.

Supporting Documents

Program Description – Bachelor of Science in Environmental and Ecological Engineering To Be Offered by Purdue University West Lafayette at West Lafayette.

1. **Characteristics of the Program**
   a. **Campus Offering Program**
   Purdue University West Lafayette
   b. **Scope of Delivery**
   Specific Site
   c. **Mode of Delivery**
   Classroom
   d. **Other Delivery Aspects (Co-ops, Internships, Practical)**
   Students will have the option of participating in co-op and internship programs, administered by the College of Engineering's Office of Professional Practice. These are paid positions ranging from one summer to several semesters, typically earning 55-85% of starting BS salary.
   e. **Academic Unit Offering Program**
   Division of Environmental and Ecological Engineering in Purdue's College of Engineering
2. **Rationale for the Program**
   a. **Institutional Rationale**
   The EEE program will contribute to the mission of Purdue University by serving the citizens of Indiana, the United States, and the world through dissemination of knowledge which prepares our graduates to succeed as leaders, professionals, informed consumers, responsible citizens, and lifelong learners. The EEE program will play a leadership role in Indiana's economic and social development by providing graduates to join a high quality educated workforce in an area of national need. To see Purdue University's strategic plan,
   go to: http://www.purdue.edu/strategic_plan/
   For a continued discussion of Institutional Rationale, see full proposal.
   b. **State Rationale**
   The proposed Bachelor of Science Degree in Environmental and Ecological Engineering (BSEEE) program has been designed in response to student demand for education that will prepare them to meet employment opportunities in an area of national need. Professionals engaged in environmental and ecological engineering (EEE) apply the principles of biology, chemistry, physics and mathematics to manage to environmental problems and ensure that industries and governmental agencies comply with environmental regulations. In their careers, graduates from the BSEEE program will perform a wide range of critical tasks for companies, the State of Indiana, and other agencies. (For more, see full proposal.)
   c. **Evidence of Labor Market Needs**
      i. **National, State, or Regional Need**
      There are no accredited environmental engineering undergraduate degree programs at any public or private Indiana institution of higher education (though the University of Notre Dame offers a related program: an environmental engineering concentration within their accredited Civil Engineering degree). Our program will therefore be unique in the state as a degree program with a central focus on Environmental Engineering, accredited using the Environmental Engineering standards of ABET.
      Within the region there are four accredited environmental engineering or similarly named programs: Northwestern University (Evansville, IL); Ohio State University (Columbus, OH); Michigan Technological University (Houghton, MI); and the University of Wisconsin-Platteville. While there are certainly similarities between the proposed Purdue program and the existing programs in the region, this program has been designed with a distinct ecological focus. We have sought to move beyond traditional environmental engineering topics (including, for example, pollution control and contaminated site remediation) to modern environmental engineering approaches, utilizing ecological design concepts and broad systems thinking. The capacity of the entire U.S. environmental engineering programs is

sufficient to meet approximately only 30% of the projected employment demand over the next decade.

ii. Preparation for Graduate Programs and Other Benefits

Growth in Environmental Engineering employment within Indiana is expected to be equivalent or better than national projections. The creation of this degree program will position Purdue Engineering students well to meet this need. Excellent employment opportunities in EEE exist for individuals at all degree levels (BS, MS, and PhD). Accordingly, some students completing the EEE program will choose to continue to graduate level education. The requirement for admission to graduate programs in this field is a strong academic performance in an undergraduate program in environmental engineering or science. The top performing graduates of the EEE program will be qualified for admission to any graduate program in this field. The employment prospect for graduates with advanced degrees is excellent.

iii. Summary of Indiana, DWD and/or U.S. Department of Labor Data

The US Bureau of Labor Statistics predicts that the number of Environmental Engineering jobs will grow "much faster than average" with the addition of almost 17,000 jobs (31% increase) over the next decade.[1] Thus, on the order of 1,700 new positions for Environmental Engineers are expected to be available each year. Nationwide U.S. institutions of higher education produced 503 graduates with a Bachelor's Degree in Environmental Engineering in the 2008-2009 academic year, leaving an unmet need of approximately 1,000 employees.[2] These positions have typically been filled by graduates from Civil or Chemical Engineering programs. However, graduates with degrees in Environmental Engineering would be more competitive for Environmental Engineering jobs.

The Indiana Department of Workforce Development projects there will be 63 openings (7.7% growth) for Environmental Engineers in the State requiring a Bachelor's Degree by 2012 paying an annual wage of $76,634. Projections for Indiana through the year 2018 are for the creation of 315 new Environmental Engineering openings (32.9% growth).[3]

iv. National, State, or Regional Studies--None

v. Surveys of Employers or Students and Analyses of Job Postings--None

vi. Letters of Support (See Appendix A)

3. **Cost of and Support for the Program**

a. Costs (To see Table of Direct Program Costs and Sources of Program Revenues, see Appendix B.)

i. No new faculty are needed. See full proposal for list of participating faculty.

ii. Facilities

Laboratory Facilities for EEE Courses

Approximately 1,100 ft^2 of laboratory space is being renovated in the Civil Engineering Building (CIVL room 2146). The EEE program will have

[1] US Bureau of Labor Statistics, Occupational Outlook Handbook 2010-2011, http://www.bls.gov/oco/ accessed Nov 15, 2011.

[2] Gibbons, M.T., 2010. Engineering by the Numbers. http://www.asee.org/papers-and-publications/publications/college-profiles/2010-profile-engineering-statistics.pdf, accessed Nov. 15, 2011.

[3] Indiana Department Workforce Development, Occupational Projections (Long Term) http://www.hoosierdata.in.gov/dpage.asp?id=39&page_path=&path_id=&menu_level=smenu4&panel_number=5&view_number=2, accessed Nov 15, 2011.

scheduling access to this new laboratory space for dedicated EEE courses. Completion of the renovation project is expected in October 2012. The renovation project is being funded by private gifts and the Purdue's ongoing Renovation and Rehabilitation (R&R) initiatives. This space will supplement existing laboratory and project space available to faculty and students across the College and University.

iii. **Other Capital Costs**

No additional learning resources are necessary for the implementation of the BSEEE program.

b. **Support**

i. Nature of Support

Reallocation

Except the Head (who holds a 100% appointment in EEE), the faculty listed as "core faculty" hold either 0% ("courtesy") appointments with EEE, or partial appointments (typically 25%, either permanent or limited-term). The total faculty need for the program will increase to 5.0 FTE by FY 2017, from the current 2.625 FTE (an increase of 2.375 FTE). This will be primarily accomplished through internal reallocations of appointments of existing faculty. No "new-to-Purdue" faculty are immediately required to implement the program.

ii. Special Fees above Baseline tuition

There will be no additional fees for the BSEEE program other than the current College of Engineering Differential Fee."

4. **Similar and Related Programs**

a. List of Programs and Degrees Conferred

i. Similar Programs at Other institutions

A survey of peer institutions shows that most have responded to these societal needs by offering specific BS degrees in Environmental Engineering fields; however, there are no accredited, publicly supported baccalaureate Environmental Engineering degree programs in Indiana.

There are no accredited environmental engineering undergraduate degree programs at any public or private Indiana institution of higher education (though the University of Notre Dame offers a related program: an environmental engineering concentration within their accredited Civil Engineering degree). Our program will therefore be unique in the state as a degree program with a central focus on Environmental Engineering, accredited using the Environmental Engineering standards of ABET.

Within the region there are four accredited environmental engineering or similarly named programs: Northwestern University (Evansville, IL); Ohio State University (Columbus, OH); Michigan Technological University (Houghton, MI); and the University of Wisconsin-Platteville. While there are certainly similarities between the proposed Purdue program and the existing programs in the region, this program has been designed with a distinct ecological focus. We have sought to move beyond traditional environmental engineering topics (including, for example, pollution control and contaminated site remediation) to modern environmental engineering approaches, utilizing ecological design concepts and broad systems thinking. The capacity of the entire U.S. environmental engineering programs is sufficient to meet approximately only 30% of the projected employment demand over the next decade.

ii. Related Programs at the Proposing Institution

The College of Engineering currently awards an ABET-accredited Bachelor of Science in Multidisciplinary Engineering (MDE), which can serve as an "incubator" for new curricular programs. A formal EEE plan of study was implemented within this program

in 2007; three students have graduated through the MDE EEE plan of study, and about 12 more students graduated in 2011-12. Upon approval of the BSEEE program, new admissions into the MDE EEE plan of study will be halted, and current students will be provided with the option to switch to BSEEE. A well-coordinated transition plan, made possible by a high level of communication and collaboration between the MDE and EEE offices, is in place. We anticipate that all students graduating in May 2013 or later will be able to transition seamlessly (students graduating in Dec 2012 or earlier will likely remain in the MDE program). The EEE program has an established Academics Committee which has an active role in the MDE EEE curriculum and a long term strategy for the EEE curriculum. A number of EEE courses have been approved and are being offered to students currently .

b**. List of Similar Programs Outside Indiana**

Northwestern University (Evanston, IL); Ohio State University (Columbus, OH); Michigan Technological University (Houghton, MI); and the University of Wisconsin-Platteville.

c. **Articulation of Associate/Baccalaureate Programs**

The Purdue EEE program has entered into a formal Articulation Agreement with Vincennes University (see appendix), with a full listing of Vincennes courses and their transfer equivalent of courses counting toward the BSEEE degree at Purdue. This agreement was designed to allow students following the plan to complete an AS degree in Engineering Science at Vincennes in two years, followed by the BSEEE at Purdue in an additional two years.

As part of the degree development procedure, EEE investigated a full articulation agreement with Ivy Tech Community College. However, a full agreement is not currently possible, as the Mathematics courses at Ivy Tech do not currently transfer to Purdue as equivalent credit for the courses required at Purdue for the BSEEE degree. EEE believes the decision on this course equivalency is the purview of the respective Departments of Mathematics, and we will seek an articulation agreement if proper course equivalency is determined. However, to facilitate transfer from Ivy Tech Community College, EEE will work with representatives to develop and share advising materials and accepted course transfer lists, based primarily on the CTL (see appendix for current list of required course equivalencies between Ivy Tech and Purdue EEE).

For information about transfer from other degree programs, see full proposal.

d. Collaboration with Similar or Related Programs on Other Campuses--None

5. **Quality and Other Aspects of the Program**

a. Credit Hours Required/Time to Completion . For more information, see full proposal.

Degree Requirements

The BSEEE degree program will include a minimum of 128 credit hours, including the courses or course options listed below. Minimum graduation GPA requirements include: (a) 2.0 overall; and (b) 2.0 in College of Engineering courses at the 20000-level and above.

Semester-by-semester sample plan of study

The following is a sample plan of study, demonstrating how a student would complete the BSEEE program in eight semesters of study. Actual student plans may vary.

FIRST YEAR

Fall Semester			*Spring Semester*		
ENGR 13100	Ideas to Innovation I	2	ENGR 13200	Ideas to Innovation II	2
MA 16500	Calculus I	4	MA 16600	Calculus II	4
CHM 11500	General Chemistry I	4	CHM 11600	General Chemistry II	4
ENGL 10600	First-Year Composition	4	PHYS 17200	Modern Mechanics	4
ENGR 10300	Engineering for the Planet	1	COM 11400	Fund's of Speech Comm.	3
		15			17

SECOND YEAR

Fall Semester			*Spring Semester*		
EEE 25000	Env. Ecol. Eng. Systems.	3	CE 35500	Engr. Env. Sustainability	3
MA 26100	Multivariable Calculus	4	MA 26200	Linear Alg. + Diff. Eqns.	4
CHM 25700	Organic Chemistry	4	CE 29700	Basic Mechanics I (Statics)	3
	Technical Elective	3	ABE 21000	Thermodynamic Principles…	3
	General Education Elective	3		General Education Elective	3
		17			16

THIRD YEAR

Fall Semester			*Spring Semester*		
EEE 30000	Environ. Ecol. Modeling	3	CE 340/343	Hydraulics and lab	4
CE 35000	Environmental Engineering	3	IE 23000	Statistics	3
CE 29800	Basic Mechanics II	3	EEE 39000	EEE Professional Preparation	1
BIOL 12100	Biol. I: Div., Ecol., Behav.	2	EEE 43000	Industrial Ecology and LCA	3
	EEE Selective	3	BIOL 28600	Intro. Ecology & Evolution	2
	General Education Elective	3		EEE Selective	3
		17			16

FOURTH YEAR

Fall Semester			*Spring Semester*		
EEE 48000	EEE Senior Design	1	EEE 48000	EEE Senior Design	2
	EEE Selective	3		EEE Selective	3
	EEE Selective	3		EEE Selective	3
BIOL 58500	Ecology	3		General Education Elective	3
	Technical Elective	3		General Education Elective	3
	General Education Elective	3			
		16			14

Total Credits Required for Graduation = 128.

b. Exceeding the Standard Expectation of Credit Hours

To meet the ABET Criteria for Accrediting Engineering Programs 2012-2013, 128 hours of coursework are required. For more information, see full proposal.

Requirement	Associated Course(s)	Number of Credits
Math through differential equations	MA 165, 166, 261, 262	16
Probability & statistics	Several options	3
Calculus-based physics	PHYS 172, 241	7
General chemistry	CHM 115, 116	8
Earth science	Several options	3
Biological science	BIOL 121, 286, 585	7
Fluid mechanics	CE 340	3
Environmental issues assoc. with air, land, and water	CE 350, 355, EEE 250	9
Lab experiments in more than one major focus area	CE 343, EEE selective	4
Engineering design integrated throughout the curricula	ENGR 131, 132, EEE 480 & selective	10
Professional practice, roles & responsibilities	EEE 390	1
Ecological engineering courses*	EEE 300 plus one EEE selective	6
One and one-half years engineering core topics (not already above)		21
One year math & science (not already above)		0
Statewide general education transfer core		30
		128

c. Program Competencies or Learning Outcomes (For additional information, see full Proposal.

The faculty of the Division of Environmental and Ecological Engineering at Purdue have established the following **objectives** for the BSEEE degree program.

Graduates of the EEE Undergraduate program will:

1) be prepared to assume immediate employment in the fields of environmental and ecological engineering or to continue education in an advanced degree program, and
2) participate fully and ethically in the advancement of the profession within five years of graduation, as measured by one or more of the following:
   i) achievement of, or significant progress toward, professional licensure,
   ii) achievement of, or significant progress toward, an advanced degree
   iii) publication of research results and/or field reports,
   iv) advancement to leadership roles within an engineering organization,
   v) professional participation in international engineering activities, and
   vi) participation with organizations, agencies, or companies who offer solutions to major societal and environmental issues.

d. Assessment

Evaluation of the EEE program will occur through well established procedures developed by the Purdue College of Engineering. A thorough and intensive assessment process is required to acquire and maintain ABET accreditation status. EEE program stakeholders are assessed or surveyed as components of an overall integrated evaluation process. Key stakeholders are students, faculty, employers, alumni, the EEE advisory board, College of Engineering and the University.

Students are assessed for learning outcomes that are directly mapped to specific courses as part of the ABET accreditation process. Student feedback is obtained from University mandated evaluations of every course. The course evaluation process is administered by the Purdue University Center for Instructional Excellence. Exit surveys will provide additional feedback from students about their experience and satisfaction with their education.

Faculty are an integral part of the evaluation, assessment and continuous improvement process. Faculty receive all the information collected from assessments, surveys and evaluations of all stakeholders. Faculty are responsible for adapting and improving teaching methods, assessment methods, courses and curricula.

Employers of EEE graduates will be surveyed to determine whether EEE graduates have the skills, knowledge and problem solving abilities expected and necessary to meet their needs. Employers will be encouraged to provide constructive suggestions for how courses and curricula can be improved.

e. Licensure and Certification

Presuming the BSEEE program achieves ABET accreditation, graduates from the program will be eligible to pursue licensure as a "Professional Engineer," or "P.E." Feedback from our External Advisory Board has been unanimous in the support of the P.E. process and the importance of our program fully preparing students to pursue the P.E.

The P.E. process typically involves four steps:

1) Students must graduate from an ABET-accredited program.
2) Students must pass the Fundamentals of Engineering ("F.E.") written examination during their last semester of study. (Purdue typically has an F.E. pass rate in excess of 90%).
3) Graduates must accumulate professional experience, typically about four years.
4) Graduates must pass the Principles and Practice in Engineering ("P.E.") written examination in a chosen engineering discipline.

Both the F.E. and P.E. exams are administered by NCEES (the National Council of Examiners for Engineering and Surveying). Because P.E. licensure requires professional experience, holding a license is not required for entry into the profession. However, a P.E. is often required by state and federal codes for engineers performing or supervising certain kinds of engineering work, and it is therefore a valuable credential that tends to increase employability and salary.

f. Placement of Graduates

Because the program is new, we do not yet have placement statistics. However, students will have support from Purdue's Center for Career Opportunities and from a dedicated staff member within EEE (the Student Services Coordinator) in find employment. We anticipate that student placement will be similar to the excellent record of the College of Engineering as a whole.

g. Accreditation

The proposed EEE program will seek accreditation from the Accreditation Board for Engineering and Technology (ABET). Students must have earned a degree from an ABET accredited program in order to earn certification as a Professional Engineer. The EEE program has been designed to successfully acquire ABET accreditation. Issues such as EEE control of course staffing and content, laboratory courses and access to teaching laboratory facilities have been considered in order to meet the expectations of ABET.

In order to acquire ABET accreditation the EEE program will complete and submit a self-study report in June 2013. On-campus ABET program evaluators will visit in the Fall of 2013. Accreditation decisions are expected in spring 2014 which will be retroactive to May 2013.

NEW ACADEMIC DEGREE PROGRAM PROPOSAL SUMMARY

Institution/Location: Purdue University West Lafayette to be offered at West Lafayette
Program: B.S. in Environmental and Ecological Engineering

	Year 1 FY2013	Year 2 FY2014	Year 3 FY2015	Year 4 FY2016	Year 5 FY2016
Enrollment Projections (Headcount)					
Full-Time	55	80	100	110	115
Part-Time	0	0	0	0	0
Total	55	80	100	110	115
Enrollment Projections (FTE)					
Full-Time	55	80	100	110	115
Part-Time	0	0	0	0	0
Total	55	80	100	110	115
Degree Completions Projection	12	18	25	33	36

CHE Code: 12-18
Campus Code: 1825
County: Tippecanoe
Degree Level: Bachelors
CIP Code: Federal - 141401; State - 141401