FINAL SCIENTIFIC / TECHNICAL REPORT

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Project Title: Multi-Disciplinary Education and Training in Biobased Products: Graduate Major in Bioresource Engineering

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DISCLAIMER

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EXECUTIVE SUMMARY

Multi-Disciplinary Education and Training in Biobased Products: Graduate Major in Bioresource Engineering

The overall goal of this project was to establish an education and training program in biobased products at Iowa State University (ISU). In particular, a graduate program in Biorenewable Resources and Technology (BRT) was to be established as a way of offering students advanced study in the use of plant- and crop-based resources in the production of biobased products. The program was to include three fundamental elements: an *academic* program, a *research* program, and *industrial interactions*.

The academic program set out to introduce a new graduate major in *Biorenewable Resources and Technology*. Unlike other schools, which only offer certificates or areas of emphasis in biobased products, Iowa State University offers both M.S. and Ph.D degrees through its graduate program. Core required courses in Biorenewable Resources and Technology include a foundation course entitled *Fundamentals of Biorenewable Resources* (BRT 501); a seminar course entitled *Biobased Products Seminar* (BRT 506); a laboratory course, and a special topics laboratory course. The foundation course is a three-credit course introducing students to basic concepts in biorenewable resources and technology. The seminar course provides students with an opportunity to hear from nationally and internationally recognized leaders in the field. The laboratory requirement is a 1-credit laboratory course or a special topics laboratory/research experience (BRT 591L). As part of student recruitment, quarter-time assistantships from DOE funds were offered to supplement assistantships provided by faculty to students.

Research was built on platform teams in an effort to encourage interdisciplinary research and collaborative student learning in biorenewable resources. A platform is defined as the convergence of enabling technologies into a highly integrated system for transforming a specific feedstock into desired products. The platform teams parallel the way industry conducts research and product development. Platform teams organize faculty and students for cross-disciplinary, systems-oriented research and collaborative learning. To date, nine platforms have been developed, although these will most likely be reorganized into a smaller number of broader topics.

In the spring of 2004, BRT faculty initiated a *regional* partnership and collaborative learning program with colleagues at the University of Minnesota, Kansas State University, and South Dakota State University to develop distance education courses in biorenewable resources and technology. As a fledgling graduate program, the BRT graduate program didn't have the breadth of resources to offer a large number of courses in biorenewables. Other schools faced a similar problem. The academic consortium as first conceived would allow students from the member schools to enroll in biorenewables courses from any of the participating schools, which would assure the necessary enrollment numbers to offer specialized course work. Since its inception, the collaborative curriculum partnership has expanded to include Louisiana State University and the University of Wisconsin.

A second *international* curriculum development campaign was also initiated in the spring of 2004. In particular, several BRT faculty teamed with colleagues at the University of Arkansas, University of Washington, University of Gent (Belgium), National Polytechnic Institute of Toulouse (France), and Technical University of Graz (Austria) to develop an EU-US exchange program in higher education and vocational education/training (entitled "Renewable Resources and Clean Technology").

PROJECT SUMMARY

Multi-Disciplinary Education and Training in Biobased Products: Graduate Major in Bioresource Engineering

INTRODUCTION

During the 2001-02 academic year, Iowa State University (ISU) President Gregory Geoffroy invited faculty to propose university-wide initiatives that would enhance scholarship at ISU. Among the twenty-six proposals submitted, the Bioeconomy Initiative was one of six selected for support by the President.

The primary goal of the Bioeconomy Initiative is to develop technologies for converting crops and plant materials into chemicals, fuels, fibers, and energy. Advances in molecular biology, agriculture, chemistry, and engineering offer new opportunities for biobased products to compete with products derived from fossil resources (crude oil, coal and natural gas). Economic development and growth in the 20th Century was driven by the use of these raw materials in the production of chemicals, fuels, and energy. Sustainable economic development for the 21st Century dictates that biorenewable resources provide a new foundation for these sectors of the economy.

In the wake of Hurricanes Katrina and Rita, and their impact on both domestic and foreign oil supplies, renewable transportation fuels and alternative energy technologies are receiving even greater national attention. A biobased economy (or bioeconomy) will bring several benefits to the United States and other parts of the world. The substitution of indigenous biorenewable resources for imported petroleum will improve national security by reducing our nation's dependence on resources from politically unstable regions of the world. Biobased products will improve environmental quality by reducing pollutant emissions associated with fossil fuel usage, especially sulfur, heavy metals, and greenhouse gases. Additionally, biobased products will transform rural development by introducing new crops and new markets to the agricultural economy.

The biobased products industry is based on complex engineered systems constructed from four major thrust areas: plant science, production, processing, and utilization. Traditionally, academic researchers have specialized in only one of these thrust areas. However, meeting ambitious national goals of providing at least 25% of organic carbon-based industrial chemicals and 10% of liquid fuels from biobased products by 2020 demands a concerted and integrated effort in all four thrust areas. We plan to achieve this vision in biorenewable resources by encouraging platform teams composed of researchers *and students* from multiple disciplines to concurrently perform fundamental and applied research related to all aspects of converting agricultural feedstocks into biobased products.

A fundamental element of Iowa State's Bioeconomy Initiative is its Biorenewable Resources and Technology graduate program. This academic program was established primarily as a way to correct a deficiency inherent to the emergence of any new industry, and that is, adequate training and preparedness of its workforce. In this case, very few scientists and engineers have been appropriately educated for the interdisciplinary field of biorenewable resources. Traditional academic disciplines are not well organized to train students for the biobased products industry. Rather, they must acquire knowledge outside traditional academic disciplines, gain an appreciation of system-level research and development, hone skills for working on teams and

communicating with diverse groups of people, and understand the culture of market-driven companies.

Through three separate yet integrated components, the Biorenewable Resources and Technology graduate program at Iowa State helps students prepare for careers in the biobased products industry. First, the academic component targets coursework in traditional academic areas such as chemistry, microbiology, agronomy, and engineering with specialized courses in biorenewable resources. Second, the research component emphasizes new pathways for the utilization of lignocellulose to value-added products. Last, the industrial interactions component is designed to assure that the academic and research programs are targeted at topics of relevance to the biobased products industry.

Iowa State University's central location in the country's agricultural heartland – combined with its rich traditions of research and service – provide it with a unique opportunity to be the leading technological contributor to the emerging bioeconomy. Many essential pieces of the multi-disciplinary research base that is required to assume leadership in the bioeconomy already exist at ISU. The Biorenewable Resources and Technology graduate program, as part of the Bioeconomy Initiative, is unifying research efforts and enhancing the university's growing reputation as one of the premier universities in the country.

PROJECT GOALS AND OBJECTIVES

The overall goal of this project was to establish an education and training program in biobased products at Iowa State University (ISU). In particular, a graduate program in Biorenewable Resources and Technology (BRT) was to be established as a way of offering students advanced study in the use of plant- and crop-based resources in the production of biobased products. The program was to include three fundamental elements: an *academic* program, a *research* program, and *industrial interactions*.

Specific Objectives

During award negotiations, we were asked by program managers to complete a "Milestone Plan," whereby specific objectives or tasks were identified and milestones/deliverables charted in relation to the project timeline. These original milestones and projected completion dates are shown in Table 1.

Table 1. Original milestone plan for the period 7/1/01 to 6/30/04.

ID No.	WBS Task	Year 1 (ending 6/30/02)				Year 2 (ending 6/30/03)				Year 3 (ending 6/30/04)			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.1	ISU approval of academic program												
1.2	Regents approval of program												
1.3	First offering of graduate program												

1.4	First offering of core required courses												
1.5	First students supported												
1.6	Corn stover platform developed												
1.7	Levoglucosan platform developed												
1.8	Phosphite esters platform developed												

Shortly after administration of the grant was transferred from the Idaho Operations Office to the Golden Field Office, we were asked by our new DOE project team to revise the Statement of Work to include more quantifiable objectives. The grant was subsequently amended, and we were asked to report on our progress accordingly. In this way, the information could be more easily incorporated into the DOE Biomass Program's Annual Operating Plan and miscellaneous other reports. These amended milestones and corresponding due dates are itemized in Table 2.

RESULTS AND DISCUSSION

FROM ORIGINAL STATEMENT OF WORK (7/1/01 TO 6/30/04)

1.1 ISU Approval of Academic Program

While other schools have been developing certification programs or areas of emphasis in existing programs, Iowa State University set out to introduce a new graduate major offering M.S. and Ph.D degrees in *Biorenewable Resources and Technology*. The first step in establishing any new academic program at Iowa State is preparation of a proposal by an appropriate group of faculty or administrators. The proposal is then reviewed by the department or sponsoring group, the college dean, the appropriate college curriculum committee, the college faculty, the Faculty Senate Curriculum Committee, the Faculty Senate, the Provost, and finally, the Board of Regents. [NOTE: For a complete accounting of the University's "New Program Approval Procedures," please visit www.academicprograms.iastate.edu/policy/newprogramapproval.html.]

In accordance with these procedures, Principal Investigator Robert Brown and faculty colleagues prepared a new program proposal and submitted it in Fall 2001 for institutional review and approval. This extensive process took almost a full academic year from beginning to end and included recruiting faculty from all departments to participate in the proposed program; obtaining endorsements from the colleges in which these departments reside; submitting the proposal for review by the requisite curriculum committees; and gaining final approval from the Board of Regents. Nevertheless, by all accounts, the proposal progressed fairly rapidly through the system and required only a minimal number of revisions to the original document.

Projected Completion Date:	6/30/02
Actual Completion Date:	5/31/02

Table 2. Milestone plan for the period 10/1/03 to 6/30/05.

WBS #	Task	Milestone/Task Title	Person Responsible	Performance Measure/Target	Due Date
6.3.2.1.8	NA	Overall project milestone	Brown	Complete collaborative curriculum with four universities and establish industrial liaisons for graduate major in bioresource engineering	6/30/05
6.3.2.1.8	1.a.	Hire DOGE	Brown, Anex	Recruit students and administer the BRT program	7/31/04
6.3.2.1.8	1.b.	Develop collaborative curriculum with at least four universities	Brown	Offer pilot course (BRT 501) via distance education programs at other institutions	6/30/05
6.3.2.1.8	2.a	Award 5-6 graduate fellowships in Fall 2004	Brown, Anex	Disburse fellowship funds to eligible Ph.D. candidates	8/15/04
6.3.2.1.8	2.b	Award 3-4 graduate fellowships in Spring 2005	Brown, Anex	Disburse fellowship funds to eligible Ph.D. candidates	12/31/04
6.3.2.1.8	3.a	Organize Industrial Advisory Board meeting	Brown, Anex, Love	Conduct self assessment and prepare program overview for advisory committee	10/31/04
6.3.2.1.8	3.b	Conduct Industrial Advisory Board meeting	Brown, Anex, Love	Present program overview to evaluation committee and distribute rubric	12/31/04

1.2 Regents Approval of Academic Program

The final step in establishing a new academic program at ISU is to gain Board of Regents (BOR) approval. To facilitate BOR review, proposed programs are asked to answer a set of questions about the need for the program; duplication and/or collaboration with other institutions in the state; potential enrollment; employment opportunities for graduates; accreditation and national academic standards; and additional resource needs. We responded carefully to these questions, and in August 2002, the Iowa Board of Regents approved the new graduate program in Biorenewable Resources and Technology. A copy of the approved New Program Proposal and all accompanying documentation is provided in this report as Appendix A.

Projected Completion Date:	9/30/02
Actual Completion Date:	9/18/02

1.3 First Offering of Graduate Program

A Program Coordinating Committee was formed immediately upon receiving Board of Regents approval. Those appointed to the committee included the original proposal development

team. They were charged with administering the new graduate program, and the committee chair was to serve as Director of Graduate Education (DOGE). The first, and perhaps most important, task to be performed by the coordinating committee was to incorporate information from the program proposal into the Iowa State University Catalog, the official bulletin of courses and programs. They succeeded insofar as the new program was first officially listed in the 2003-05 Catalog.

The coordinating committee has met bi-weekly since program approval. Committee membership has changed since its inception, however, as other academic departments have come on board. The present composition of the BRT Program Coordinating Committee is shown in Table 3.

Table 3. Current membership of the BRT Program Coordinating Committee.

Name	Affiliation(s)
Anex, Robert P. (Chair)	Agricultural & Biosystems Engineering
Brown, Robert C.	Mechanical Engineering / Center for Sustainable Environmental Technologies
Johnson, Lawrence A.	Food Science & Human Nutrition / Center for Crops Utilization Research
Kraus, George A.	Chemistry / Biorenewable Resources Consortium / Center for Catalysis
Liebman, Matt	Agronomy / Sustainable Agriculture
Lummus, Rhonda R.	Logistics Operations & Management Information Systems
Miranowski, John A.	Economics
Nikolau, Basil	Biochemistry, Biophysics & Molecular Biology
Shanks, Brent H.	Chemical & Biological Engineering
Stokke, Doug D.	Natural Resource Ecology & Management

Projected Completion Date:	9/30/02
Actual Completion Date:	9/1/02

1.4 First Offering of Core Required Courses

Students admitted to the Biorenewable Resources and Technology program develop their Programs of Study from six credits of core required courses, a selection of designated core elective courses, and several elective courses.

Core required courses in Biorenewable Resources and Technology include a foundation course entitled *Fundamentals of Biorenewable Resources* (BRT 501); a seminar course entitled *Biobased Products Seminar* (BRT 506); a laboratory course, and a special topics laboratory course. The foundation course is a three-credit course introducing students to basic concepts in biorenewable resources and technology. The seminar course provides students with an opportunity to hear from nationally and internationally recognized leaders in the field. Section B (R-credit option) requires students to attend five or six seminars from an approved list of seminars hosted not only by the BRT program, but also by participating departments and affiliated research units on campus. It must be taken every semester during the student's course of study except one, when Section A is taken. Section A (one-credit option) requires students to attend five or six seminars and also present their own research seminars. It is taken only once during the course of study. The laboratory requirement is a 1-credit laboratory course (e.g., BRT 535L, *Thermochemical Processing of Biomass*) or a special topics laboratory/research

experience (BRT 591L) to be designed and developed in consultation with the student's major professor.

Courses organized for the 2002-03 academic year included BRT 506, *Biobased Products Seminar*, and one laboratory course. Both of these courses were first delivered in the fall of 2002. The foundation course, BRT 501, *Fundamentals of Biorenewable Resources*, was not offered until the spring of 2003, primarily because of the extensive planning required for this multi-disciplinary, team-taught course.

Projected Completion Date:	9/30/02
Actual Completion Date:	12/31/02

1.5 First Students Supported

Another important early task to be performed by the coordinating committee was student recruitment. The committee determined that the quickest way to raise enrollment was to recruit students who were already pursuing degrees in more traditional academic disciplines at Iowa State and encourage them to enroll in BRT as co-majors. As an incentive, students were awarded research assistantships. Each student received a quarter-time assistantship from the DOE grant and a quarter-time assistantship from research funds at the disposal of his/her major professor. In this way, the program was able to enroll its first five students in the spring of 2003.

Projected Completion Date:	12/31/01
Actual Completion Date:	5/15/03

1.6 Corn Stover Platform Developed

In addition to developing the academic program in biobased products, the program coordinating committee worked to expand the research program as well. To this end, it was decided early on to invest in platform teams as an important basis for achieving interdisciplinary research and collaborative student learning in biorenewable resources. A platform is defined as the convergence of enabling technologies into a highly integrated system for transforming a specific feedstock into desired products. The platform teams parallel the way industry conducts research and product development. Platform teams organize faculty and students for cross-disciplinary, systems-oriented research and collaborative learning.

To date, nine platforms have been developed, although these will most likely be reorganized into a smaller subset around specific feedstocks or processing technologies. A complete list and description of the platforms as currently organized is available at www.biorenew.iastate.edu/research/. Several of these platforms were built around existing projects at Iowa State University which showed particular relevance and development potential at the time the proposal for this grant was submitted. As identified in that proposal, the projects included: 1) Harvesting and Storage of Corn Stover; 2) Levoglucosan as a Platform Chemical in the Production of Biobased Products; and 3) Phosphite Esters as Solvents for Lignocellulose.

The "Harvesting and Storage of Corn Stover" project has evolved since that time and has been renamed "Lignocellulosic Feedstock Development." The platform now focuses on production, harvest, storage and preprocessing of lignocellulosic biomass. Building efficient supply chains for these feedstocks is critical to cost effective conversion, which is the goal of several of the other platforms. While lignocellulosic biomass is in abundant supply, conventional approaches result in relatively expensive feedstocks of uneven quality and raise environmental

concerns that must be addressed. Storage of these annually harvested feedstocks for year-round manufacturing facilities is another problem of pressing concern. The university's integrated and interdisciplinary approach to these central challenges is attracting considerable attention and financial support. New projects within this platform are supported by the USDA, DOE, John Deere, Cargill-Dow, the Iowa Biotechnology Byproducts Consortium (USDA), and the Leopold Center for Sustainable Agriculture. These projects are developing innovative harvesting strategies and equipment, analyzing the impacts of residue harvest rates and cropping systems on soil erosion and soil organic matter, and investigating enzyme-enhanced fermentation technologies for biomass storage and pretreatment.

Projected Completion Date:	6/30/04
Actual Completion Date:	On-going

1.7 Levoglucosan Platform Developed

Originally, the objective of this particular project was to establish an integrated study of thermal pyrolysis and chemical and biochemical synthesis of value-added products from pyrolysis liquid. Specific goals were to convert corn stover and switchgrass into lactic acid via a fermentation route and into ethylene glycol and propylene glycol by a hydrogenolysis route.

While a platform (as defined) was never organized around this project, much has been accomplished in relation to stated goals. Most of these results were discussed, however, in reports submitted to the agencies that provided the lion's share of funding for this work. These sponsors included the Iowa Energy Center, Great Lakes Regional Biomass Energy Program, and Iowa Biotechnology Byproducts Consortium.

More recently, the USDA and the Department of Energy notified Prof. Robert Brown of their intent to fund his proposal, "Environmental Enhancement through Corn Stover Utilization." The pending award totals nearly $1.9 million with an additional $500,000 in matching funds being provided by the Iowa Energy Center, Iowa State University, and industry partners. This project, which features research in the area of bio-oils, is one of eleven funded through the Biomass Research and Development Initiative.

Through this research, Brown and his team are looking to control pyrolysis conditions to achieve optimum mass fractions of bio-oil, char, and gas for the production of fertilizer. Additional goals for the project include improving steam reforming of bio-oil to obtain hydrogen for synthesis of anhydrous ammonia; synthesizing ammonium bicarbonate-impregnated char with desirable agronomic properties; establishing the carbon sequestration potential of the proposed N-rich char fertilizer; evaluating the corn yield response to the application of different amounts of nitrogen-char fertilizer to soils; and evaluating the economic performance of the proposed fertilizer system.

In order to meet these goals, Brown and his colleagues propose a new system for maintaining soil fertility that employs corn fiber for production of nitrogen-rich, biologically active char that enriches the soil and sequesters carbon from the atmosphere. In this system, corn stover or corn hulls are collected and preprocessed locally to yield fine, porous char and energy rich bio-oil.

The bio-oil, which can be thought of as densified biomass, is transported by tanker truck to a central facility for steam reforming to hydrogen followed by some part of it being converted to anhydrous ammonia. The process yields excess hydrogen which can be used for other applications. Using existing infrastructure of the agricultural fertilizer industry, anhydrous ammonia is transported back to the distributed preprocessing facilities where it is reacted with carbon dioxide, water, and char, which are byproducts from pyrolysis of biomass, to yield

ammonia bicarbonate precipitated within the pores of the char. The nitrogen-rich char is injected into the soil where it serves three purposes: nitrogen fertilizer, biologically-active soil amendment, and a means for sequestering carbon from the atmosphere.

Brown, the principal investigator of this project, is joined by an extensive team of researchers from Iowa State, Cargill, Inc., Eprida, Inc., Demonstratives, Inc., the National Renewable Energy Laboratory, Oak Ridge National Laboratory, and the USDA-ARS North Central Soil Conservation Research Laboratory in Morris, Minnesota.

Projected Completion Date:	6/30/04
Actual Completion Date:	On-going

1.8 Phosphite Esters Platform Developed

In order to use biorenewable resources such as switchgrass and corn stover effectively as a green "chemical factory," they must be broken down and solubilized. Existing degradation methods include hydrolysis with strong acid followed by neutralization of the acid by strong base. The latter process involves the cost of the acid and base plus the energy cost of removing prohibitively large volumes of water by distillation. The economical solubilization of corn stover, wood, and other cellulosic materials not only allows the recovery of potentially useful organic chemicals and biochemicals, but it also provides accessibility to the cellulosic and lignin components, allowing further breakdown to other useful chemicals.

Iowa State researchers proposed to overcome these solubilization inefficiencies via a different approach, and the goals of their project were three-fold: 1) develop an organophosphorus compound that efficiently and economically dissolves biorenewable resources; 2) determine the composition of the phosphitylated products; and 3) remove the organophosphorus solvent that has not reacted.

Much like the other projects described here, a majority of this research was supported by other agencies to whom the results have already been reported. Thus, the results are not repeated here. Suffice it to say, there is a great deal of interest in the outcome of this work, and research is continuing thanks to the support of organizations such as the Ames Laboratory and Center for Catalysis at Iowa State.

Projected Completion Date:	6/30/04
Actual Completion Date:	On-going

FROM SUPPLEMENTAL STATEMENT OF WORK (10/1/03 TO 6/30/05)

1.a DOGE Hired

In the summer of 2003, Iowa State University hired a new associate professor in the Department of Agricultural and Biosystems Engineering. Prof. Robert P. Anex, whose primary research interests were in economic and environmental modeling and life cycle assessment of biobased products, was brought to Iowa State to help build a research program in this area, and also, to develop BRT courses in the area of life cycle assessment applied to biorenewable resources and biobased manufacturing. Almost one year later (July 1, 2004), he was named the Director of Graduate Education for the BRT graduate program. He has since been actively performing the duties associated with this position, including student recruitment and administrative oversight of the program.

The appointment of Prof. Anex has already netted huge dividends for the university. He is the recent recipient of a large, inter-disciplinary NSF award that focuses on analyzing the natural and industrial ecology of the bioeconomy. He is also lead investigator on a large, multi-institutional USDA award, the focus of which is integrated feedstock supply systems for corn stover biomass. These two projects alone help support a number of BRT graduate students.

Projected Completion Date:	7/31/04
Actual Completion Date:	7/1/04

1.b Collaborative Curriculum Developed

In the spring of 2004, BRT faculty initiated a *regional* partnership and collaborative learning program with colleagues at the University of Minnesota, Kansas State University, and South Dakota State University to develop distance education courses in biorenewable resources and technology. As a fledgling graduate program, the BRT graduate program didn't have the breadth of resources to offer a large number of courses in biorenewables. Other schools faced a similar problem. The academic consortium as first conceived would allow students from the member schools to enroll in biorenewables courses from any of the participating schools, which would assure the necessary enrollment numbers to offer specialized course work. Since its inception, the collaborative curriculum partnership has expanded to include Louisiana State University and the University of Wisconsin.

In the Spring term, 2005, Robert Brown taught Iowa State's BRT 501, *Fundamentals of Biorenewable Resources*, as the first course in the pilot program. More than 30 students registered for the course. While Iowa State students met on campus for lectures in a distance education classroom, other students accessed the lectures by downloading streaming video from the Internet. Lecture notes, homework assignments, and supplementary materials were also available on the Internet for both on- and off-campus students. Monica Prasetio, a Ph.D. candidate at the University of Minnesota, signed up for the course after the chair of her department told her about it. She reported that even though her institution offered courses in biobased products, it did not have a course comparable to the fundamentals course offered at Iowa State. So she was happy to take advantage of the opportunity.

Distance delivery is not without its challenges. For example, Prof. Brown would have liked to include tours of companies that process biorenewable resources into biobased products, but this was impossible with distance delivery. Instead, he toured Midwest Grain Processors and West Central Coop with a student videographer who helped him turn the footage into "virtual tours" of the plants that were shown during class.

Faculty and students also have difficulty adjusting to distance education communication. Katherine Edwards, a junior in agricultural engineering at Iowa State, noticed that students were hesitant to speak up in class when they knew they were on camera. But she found that access to videotaped lectures was beneficial in the few instances she was unable to attend class or needed to review a topic presented in a previous lecture.

While Iowa State is the only school in the United States with a degree-granting graduate program in biorenewables, other schools offer courses related to biorenewables. The goal is for each school to offer at least one unique course through this consortium. BRT 501 is being offered again in the fall of 2005, but other schools are working to offer additional courses. The ultimate goal of the consortium is to deliver biorenewables courses to students at schools across the nation. The pilot program was run on a shoestring this past spring, but with luck, additional

resources will be identified that will allow the BRT graduate program to expand its offerings to additional schools and more students.

Early on in this endeavor, the BRT program enlisted the help of Iowa State's Engineering Distance Education (EDE) program to handle most of the administrative legwork involved in getting a collaborative curriculum program such as this up and running. The response has been excellent, and EDE's efforts have included preparing memoranda of understanding with each institution in the partnership, reserving media-enhanced classrooms, assessing tuition, and otherwise arranging course delivery. EDE continues to work with similar units at the other institutions to overcome difficulties arising from differences in tuition assessment systems, delivery methodology, and course promotion.

A second *international* curriculum development campaign was also initiated in the spring of 2004. In particular, several BRT faculty teamed with colleagues at the University of Arkansas, University of Washington, University of Gent (Belgium), National Polytechnic Institute of Toulouse (France), and Technical University of Graz (Austria) to develop an EU-US exchange program in higher education and vocational education/training (entitled "Renewable Resources and Clean Technology").

A primary objective of the exchange program is to develop a series of intensive short-courses covering topics of interest to the renewable resources research community. The first of these intensive short-courses, entitled "Renewable Biomaterials," was offered April 9-24, 2005, in Toulouse, France. It provided students a comprehensive overview of the sustainable production of biomaterials and an opportunity to analyze the supply chain from primary production and transformation of biorenewable resources to environmentally friendly consumer and industrial products. It involved 30 hours of coursework taught by international experts, practical exercises, cultural excursions, and a multiple choice final examination. All partnering institutions were involved in the design and organization of this course, including course delivery and student recruitment. Specifically, each institution was tasked with identifying three eligible graduate students to attend the short-course, and several collaborating faculty from each institution participated in developing course content and actual instruction. The intensive program in "Renewable Biomaterials" will be offered again January 8-23, 2006, in Ghent, Belgium.

A second objective of the EU-US exchange program is to provide graduate students with an opportunity to study abroad for up to six months. While students are abroad, they will work on research projects and take courses. Two students from Iowa State University have been chosen to participate in this program in the Spring term, 2006. Scott Bents, a Master's student co-majoring in BRT and Mechanical Engineering, will study at the Technical University of Graz in Graz, Austria, and John Schmitz, a Ph.D. student co-majoring in BRT and Food Science, will study at the National Polytechnic Institute of Toulouse in Toulouse, France.

Funding for the international exchange program was provided entirely by a grant co-sponsored by the U.S. Department of Education and the European Union. No DOE funds were provided for this activity; hence, complete results are not reported here. Rather, the international consortium is mentioned only to give DOE program managers a complete picture of activities in the area of curriculum development. Those wishing to learn more about the exchange program are encouraged to visit the web site at www.crrct.iastate.edu/.

Funding for continuation and expansion of both the regional and international consortia is being sought through the Cargill Foundation. If a gift is awarded, it would support not only the graduate program and efforts to bolster existing resources for course instruction, but also a third curriculum development campaign that would expand student learning opportunities to include undergraduates as well. This would include freshman experiences in biorenewables — for the

purpose of building enthusiasm among underclassmen — involving a series of simple lab experiments. These lab experiences would be offered through the collaboration of several departments, including Agronomy, Agricultural and Biosystems Engineering, Chemical and Biological Engineering, Materials Science and Engineering, and Mechanical Engineering. Additionally, the Cargill gift would support the training of upperclassmen in common laboratory facilities, where students could build skills relevant to biobased industries. The immediate focus would be on thermodynamics, fluids, mass transfer, and materials, but commonalities among the participating departments will need to be exploited further if these goals are to be realized.

Projected Completion Date:	6/30/05
Actual Completion Date:	On-going

2. Graduate Fellowships Awarded

The BRT Program Coordinating Committee originally planned to identify nine to ten outstanding graduate student applicants to receive one-year BRT graduate fellowships during the 2003-04 and 2004-05 academic years. The $5,000 fellowships were to be awarded to supplement research assistantships offered by faculty to prospective graduate students. These supplements were thought to be excellent inducements for attracting high caliber students to Iowa State and the BRT graduate program. The fellowships would be limited to two per participating department in the case the number of outstanding applicants exceeded the number of available fellowships. Preference was to be given to Ph.D. candidates.

Regrettably, only three of these fellowships were ever actually awarded (see Table 4). This was due to the admission of fewer than expected eligible Ph.D. students.

Table 4. Recipients of the"Fellowship in Biobased Products."

Name	Term Awarded	Major Professor	Co-Major Department
Li, Ke	Fall 2004	Robert C. Brown	Mechanical Engineering
Oshel, Reed	Fall 2004	John G. Verkade	Chemistry
Isci, Asli	Spring 2005	Robert P. Anex	Agricultural & Biosystems Engineering

Projected Completion Date:	12/31/04
Actual Completion Date:	2/28/05

3. Industrial Advisory Board Meeting Organized and Conducted

A program evaluation committee was convened on December 9, 2004, to review progress and address how the BRT graduate (training) program could best serve the biobased industry and ensure that BRT graduates were suitably prepared for jobs in the field. Membership on the committee included several industry representatives who were already on campus at that time to provide guidance to researchers of two other federally funded projects at ISU. These individuals are listed in Table 5.

At the meeting, Prof. Brown presented an overview of the BRT graduate program. Committee members were then asked to complete a rubric that was created specifically for the purpose of evaluating the academic program and soliciting feedback from committee members. This rubric and a summary of committee responses to each metric are presented in Appendix B.

To summarize, of the 13 metrics evaluated, 100% of the evaluators scored eight of the metrics as either "exceeds expections" or "meets expectations." Only two of the metrics received

"needs improvement" scores from more than 30% of the evaluators. The program was scored low by 70% of the evaluators for the relatively small number of Ph.D. students who published their research. However, since none of the Ph.D. students had graduated from the program, this concern seemed a bit premature. Thirty percent of the evaluators expressed concern about the sustainability of the graduate program. This concern arose when we were not able to report with certainty a source of future funding once the current DOE project came to a conclusion.

On the basis of this first program evaluation, the BRT Program Coordinating Committee is considering improvements to the program.

Projected Completion Date:	12/31/04
Actual Completion Date:	12/9/04

Table 5. Composition of BRT graduate program Industrial Advisory Board.

Name	Affiliation
Anex, Robert P.	Iowa State University
Brown, Robert C.	Iowa State University
Carter, Brian	Genencor International
Downing, Mark	Oak Ridge National Laboratory
Glassner, David	Cargill-Dow (now NatureWorks, LLC)
Johnson, Stanley R.	Iowa State University
Lynd, Lee	Dartmouth College
Miller, Ray W.	DuPont (Bio-Based Materials)
Moniruzzaman, Mohammed	Genencor International
Moore, Kenneth J.	Iowa State University
Richard, Thomas L.	Pennsylvania State University
Sheehan, John	National Renewable Energy Laboratory
Sokhansanj, Shahab	Oak Ridge National Laboratory
Stephens, Lyle	John Deere Technology Center

CONCLUSIONS AND RECOMMENDATIONS

Comparison of Accomplishments to Project Objectives

What Went Right

Perhaps the most successful outcome was the project team's ability to put together a New Program Proposal which fairly easily passed the scrutiny and critical evaluation of institutional representatives and the Board of Regents. Perhaps this is because we started the process early, promptly responded to any calls for clarification, and engaged the entire university in the establishment of the program. The end result was the expeditious creation of the Biorenewable Resources and Technology interdepartmental graduate program at Iowa State University, the first degree-granting program of its kind in the United States.

Further to this last point, unlike other universities that offer certificate programs or minor programs related to biobased products and bioenergy, the Iowa State team decided to offer Master's and Ph.D. degrees in this new field, as well as a minor for students obtaining degrees in other majors. The program strongly encourages, but does not require, students to obtain co-major

degrees in BRT and a more traditional discipline. This dual-degree status surely gives our graduates an edge over the competition when applying for positions in the biobased products industry.

Additionally, BRT faculty were required early on to match quarter-time BRT assistantships with quarter-time assistantships from research or discretionary funds at their disposal. This provided the leverage and support the program needed to begin recruiting students into the program.

Finally, the fundamentals course (BRT 501) was designed and developed to give students from a wide variety of science and engineering backgrounds a true systems perspective of the field. Perhaps the fact that this course is offered to several other institutions via distance education is testimony to the course's value in meeting this important training need. Table 6 illustrates the popularity of the fundamentals course and other BRT course offerings.

Table 6. Number of students enrolled in BRT courses each term.

Course	S'03	SS'03	F'03	S'04	SS'04	F'04	S'05	SS'05	Total
501	22		15	8		12	32	2	91
506A	2		1	7		1	3		14
506B	12		13	9		13	13		60
535L		13			5			9	27
591L								2	2
699								1	1

** Key: S = Spring; SS = Summer Session; F = Fall terms.*

What Went Wrong

In response to growing demands from academic accrediting organizations for continuous quality improvement, many institutions have begun to incorporate outcomes assessment into their academic programs. Accordingly, the BRT graduate program is following suit. But without the cooperation of faculty in this effort, it is difficult for BRT Program of Study committees to measure and assess these outcomes during student examinations. We hope to resolve this problem by improving communication and enhancing mentoring opportunities among BRT faculty. This may include annual faculty retreats, educational seminars, and the like.

It is also difficult to get faculty to develop or teach new courses outside their home departments. In most cases, they have already heavy workloads, and their academic units give them neither the resources nor the recognition to adequately motivate their active participation in interdepartmental programs, especially in teaching and learning activities. Fortunately as the case may be, this problem is not unique to the BRT graduate program. Rather, lack of recognition and resources is a problem facing all interdisciplinary programs. At Iowa State, the Provost's Office recognizes the obstacles this presents to the health and vitality of these programs, and it has created a task force to identify issues for which policy development may be needed. Incentive-based budgeting is being looked into, also, as a means to level the playing field. In this case, resources will be allocated to units that show progress in quantifiable measures such as enrollment. Some interdisciplinary programs at Iowa State have seen greater growth in student numbers than more traditional disciplines.

What Would We Do Differently

Listed below are actions we would take in hindsight to address the challenges and issues identified in the preceding sections:

- We would not build the research program around specific projects. Rather, we would focus on development of the academic program itself. This would include signing on additional faculty, recruiting more high-caliber Ph.D. students, developing more lecture-based courses, designing and offering more laboratory courses, etc.
- We would integrate into our program more formal interaction with other schools, especially those that received funding from the same DOE program (Multi-Disciplinary Education and Teaching Program in Biobased Products). We realized this lost opportunity when Iowa State co-chaired a session on academic programs at a national technical conference.
- We would also formalize and increase industry interactions. At a minimum, this would keep us apprised of industry needs with respect to employee training and research topics of interest, and it would afford our students mutually beneficial coop/internship experiences.
- We would focus on obtaining additional funding for course development and instruction as opposed to funding for student support (assistantships, fellowships, tuition waivers, etc.). The latter is generally more widely available through research contracts and grants of participating faculty. Resources for curriculum development are far more scarce, and therefore, coveted.
- We would encourage the involvement of a greater number of students from outside the engineering disciplines. The majority of our students are co-majors in BRT and Agricultural Engineering, Chemical Engineering, and/or Mechanical Engineering. Very few of our students have backgrounds in Agronomy, Biochemistry, Chemistry, Economics, or Food Science.
- We would provide our students a greater sense of community by affording them more opportunities for networking, group study, field trips, etc.

Were Outcomes Resulting from this Grant Worthwhile

Were it not for the financial support of this DOE program, the following strategic outcomes might never have been realized:

- A degree-granting program in Biorenewable Resources & Technology was established at Iowa State University;
- A distance engineering course in biorenewable resources was designed and offered;
- Iowa State entered into regional and international academic consortia;
- The BRT graduate program was able to attract outstanding students;
- New contacts were made with representatives in industry; and perhaps most notably,
- The students listed in Table 7 would not have received Master's degrees in BRT.

Table 7. Graduates of the BRT program.

Name	Degree	Name	Degree
N. R. Brown	M.S.	A. L. Ogletree	M.S.
N. A. Emsick	M.S.	S. S. Riggs	M.S.
D. G. Lahr	M.S.	J. A. Ritzert	M.S.

PRODUCTS DEVELOPED UNDER THIS AWARD

Publications / Conference Papers / Other Public Releases

Student Dissertations / Theses

Brown, N. R. 2004. *Hot gas cleanup of biomass-derived syngas from a pilot-scale, air-blown, fluidized bed gasifier.* Unpublished M.S. thesis, Iowa State University, Ames, Iowa.

Emsick, N. A. 2004. *Switchgrass derived producer gas as a reburn fuel.* Unpublished M.S. thesis, Iowa State University, Ames, Iowa.

Lahr, D. G. 2005. *Mechanistic Insight into the Production of Ethylene Glycol and Propylene Glycol from Biorenewable Resources*. Unpublished M.S. thesis, Iowa State University, Ames, Iowa.

Ogletree, A. L. 2004. *Life cycle assessment of a biobased process for producing 1,3-Propanediol.* Unpublished M.S. thesis, Iowa State University, Ames, Iowa.

Riggs, S. S. 2004. *Carbon monoxide and hydrogen mass transfer in a stirred tank reactor.* Unpublished M.S. thesis, Iowa State University, Ames, Iowa.

Ritzert, J. A. 2004. *Factors influencing the efficiency of a moving bed granular.* Unpublished M.S. thesis, Iowa State University, Ames, Iowa.

Journal Articles

No articles were published in refereed journals as a direct consequence of work funded under this DOE grant. However, the following articles were published as a result of work funded through similar or related grants:

Brown, R. C., D. Radlein, and J. Piskorz. 2001. Pretreatment processes to increase pyrolytic yield of levoglucosan from herbaceous feedstocks, *in* Chemicals and Materials from Renewable Resources, ACS Symposium Series 784, American Chemical Society, Washington, DC, pp. 123-132.

Daugaard, D. E. and R. C. Brown. 2003. Enthalpy for pyrolysis for several types of biomass, *Energy and Fuels* 17:934-939.

Fan, M., W. Marshall, D. Daugaard, and R. C. Brown. 2004. Production of activated carbon from fast pyrolysis of oat hulls and corn stover, *Bioresource Technology* 93(1):103-107.

Khiyami, M. A., A. L. Pometto III, and R. C. Brown. 2005. Detoxification of corn stover and corn starch pyrolysis liquors by ligninolytic enzymes of *Phanerochaete chrysporium*, *Journal of Agricultural and Food Chemistry* 53:2969-2977.

Ren, H., Richard, T.L., Chen, Z., Kuo, M., Bian, Y., Moore, K.J., and Patrick, P. 2005. Ensiling corn stover with enzyme addition as a feedstock preservation method for particleboard manufacturing. *Proceedings of the Institute of Biological Engineering*, M.Eiteman (ed). IBE Publications, Athens, GA.

Ren, H., Richard, T.L., Moore, K.J., and Patrick, P. 2004. Long-term kinetics of corn stover bioconversion in an enzyme enhanced mixed culture fermentation. ASAE Paper No. 047066. ASAE, St. Joseph, MI.

Ren, H., Richard, T.L., Moore, K.J., and Patrick, P. 2004. Effect of enzyme additive rate on solid-state fermentation of corn stover. *Proceedings of the Institute of Biological Engineering*, M.Eiteman (ed). IBE Publications, Athens, GA.

Ren, H., Richard, T.L., Moore, K.J., and Patrick, P. 2004. Use of cellulase and hemicellulase mixtures to enhance mixed-culture solid-state fermentation of corn stover. *Proceedings of the Institute of Biological Engineering*, M.Eiteman (ed). IBE Publications, Athens, GA.

Richard, T. L., K. J. Moore, C. Tobia and T. Patrick. 2002. Enzyme enhanced ensilage for biomass pretreatment, *Proceedings of the Institute of Biological Engineering*, 3:45-53.

Richard, T. L., H. V. M. Hamelers, A.H.M. Veeken and T. Silva. 2002. Moisture relationships in composting processes, *Compost Science and Utilization*, 10(4):286-302.

Sandvig, E., G. Walling, D. Daugaard, R. Pletka, D. Radlien, W. Johnson, and R. C. Brown. 2004. The prospects for integrating fast pyrolysis into biomass power systems, *International Journal of Power and Energy Systems* 24(3).

Books

Brown, R. C. 2003. *Biorenewable Resources: Engineering New Products from Agriculture*,* Blackwell Publishing Co., 286 pp.

* *This was the textbook used by students in BRT 501, Fundamentals of Biorenewable Resources.*

Conference Presentations and/or Talks

Information about the BRT graduate program was circulated at several different conferences and graduate student recruiting events. These materials included recruiting flyers and program brochures. However, no formal talks or presentations were made.

Internet Sites

Information about the BRT graduate program is available on the Internet at www.biorenew.iastate.edu/graduate/about.html. This web site provides prospective and existing students with information about degree requirements, financial aid, admissions procedures and application information, course offerings, the international exchange program, research and

technology platforms, affiliated faculty, and links to other resources such as the Iowa State Graduate College web site and miscellaneous academic forms.

Networks or Collaborations Fostered

A regional consortium was developed with the goal of developing and offering biorenewables-related courses via distance education. The consortium includes Iowa State University, the University of Minnesota, University of Wisconsin-Madison, South Dakota State University, Kansas State University, and Louisiana State University.

In addition, an international consortium was also developed. Renewable resources and clean technology are becoming vital areas within the context of global sustainable development. The transatlantic Master's and Ph.D. graduate degree courses offered through this program will bring together expertise in agriculture, biotechnology, chemistry, and environmental sciences to develop a unique study program. The project involves curriculum development, faculty and student mobility, and exchange of students among the six partner institutions. Academic recognition by the European Credit Transfer System (ECTS) and U.S. institutions is guaranteed. Members of this consortium include Iowa State University, the University of Washington, University of Arkansas (prime), University of Gent (Belgium), Technical University of Graz (Austria), and National Polytechnic Institute of Toulouse (France). Visit www.crrct.iastate.edu/ for more information.

Inventions/Patent Applications and/or Licensing Agreements

No inventions, patent application, or licensing agreements to report.

Other Products

Educational Aids

For the fundamentals course (BRT 501), Prof. Brown toured Midwest Grain Processors and West Central Coop with a student videographer, who helped him turn the footage into "virtual tours" of the plants that were then shown during class, both live to on-campus students and via video-streaming through the Internet.

A textbook authored by Prof. Brown, *Biorenewable Resources: Engineering New Products from Agriculture,* was also used by students in BRT 501. Since its publication by Iowa State Press (now Blackwell Publishing) in 2003, the field of biorenewables has rapidly expanded. Yet to date, no competing textbook has been published in the United States. However, competitors are likely to appear as interest in this field increases. So while the first edition has been favorably reviewed and widely received, it is likely to be superseded unless updated in the next year or so. Consequently, a second edition of the text is planned, and the author hopes to have the manuscript ready for publication in mid-2007.

Curricula

A list of current course offerings is provided as Appendix C. This list includes core required and core elective courses.

APPENDICES

A. New Program Proposal (*includes Program Governance Document*)

B. Evaluation Rubric and IAB Responses

C. List of Core Required and Core Elective Courses

D. List of Current BRT Students

E. List of BRT Graduates

F. List of BRT Faculty

APPENDIX A. NEW PROGRAM PROPOSAL

DATE: July 2002

TO: Board of Regents, State of Iowa

FROM: Iowa State University

ACTION REQUESTED: Approve Iowa State University's proposal for a new interdisciplinary graduate program in Biorenewable Resources & Technology

The university is requesting approval of a proposal for a new interdisciplinary graduate program in Biorenewable Resources & Technology. The degree offerings will include a Masters degree, a Ph.D. degree, and a Ph.D. minor. The program will be administered by the Graduate College (with administrative support from the Center for Sustainable Environmental Technologies). It will involve faculty and advising services from Agricultural and Biosystems Engineering, Chemical Engineering, Mechanical Engineering, Food Science and Human Nutrition, and Forestry (via the proposed Department of Natural Resource Ecology and Management).

The graduate program in Biorenewable Resources & Technology will offer students advanced study in the use of plant and crop-based resources in the production of biobased products (fuels, chemicals, materials, and energy). The program is specifically designed to encourage students to obtain co-major graduate degrees in Biorenewable Resources & Technology and a more traditional academic discipline. Thus, students can use the Biorenewable Resources & Technology program to diversify their academic training.

A recent study released by the National Research Council estimates that one million new jobs would be created in the biobased chemicals industry alone (excludes fuels, materials, and energy) in the next twenty years. In anticipation of the growing national need for engineers and scientists to develop biobased products, the U.S. Department of Energy has recently launched a grants program to encourage formation of such programs at U.S. universities. Iowa State was successful in seeking funding from this grant program and therefore the new resources required for the proposed graduate program (primarily for graduate student support) will be borne by the grant.

No comparable programs have been identified at other universities within the state or nation.

The proposal has followed the necessary review and approval process and is recommended by the departmental and college curriculum committees, the Graduate College, the Faculty Senate, and the university administration.

Program Proposal

1. *Proposed interdepartmental program:* Biorenewable Resources & Technology

2. Proposed degrees: Masters degree in *Biorenewable Resources & Technology*; Ph.D. degree in *Biorenewable Resources & Technology*, and Ph.D. minor in *Biorenewable Resources & Technology*.

3. Departments involved: Departments involved in developing this graduate program include: Agricultural and Biosystems Engineering; Chemical Engineering; Food Science & Human Nutrition; Forestry; and Mechanical Engineering. This group is not intended to be exclusive; other departments are welcome to join after the program is established.

4. Need for the proposed program:

   The objective of this proposal is to establish an education and training program in biobased products at Iowa State University. A graduate program in *Biorenewable Resources & Technology* will be established that offers students advanced study in the use of plant and crop-based resources in the production of biobased products (fuels, chemicals, materials, and energy).

   Biorenewable resources are receiving increasing national attention.[1] A permanent council on biorenewable resources, consisting of the Secretaries of Agriculture and Energy, the EPA Administrator, the Director of the National Science Foundation and other agency heads coordinates national planning for research in biobased products. Companies are also organizing themselves to exploit biobased feedstocks. Large chemical companies, such as Dupont and Dow, have moved boldly into biobased products by purchasing companies with plant science and production capabilities to complement their processing and utilization expertise. However, very few scientists and engineers have been appropriately trained to work in the interdisciplinary field of biobased products. Iowa State University has an opportunity to lead the nation in training students for this emerging field.

   Traditional academic disciplines are not well organized to train engineers and scientists for such a biobased products industry. Students must acquire knowledge outside traditional academic disciplines, gain an appreciation of system-level research and development, hone skills for working on teams and communicating with diverse groups of people, and understand the culture of market-driven companies. We are proposing a Master's degree, a Ph.D. degree, and a Ph.D. minor in *Biorenewable Resources & Technology* at Iowa State University that will help students prepare for careers in the biobased products industry.

5. Objectives of the proposed program:

   The proposed program in *Biorenewable Resources and Technology* has the following strategic outcomes:

[1] National Research Council, Biobased Industrial Chemicals, National Academy Press, Washington, DC 2000.

1) Provide advanced training for students in the areas of plant science, production, processing, and utilization related to biobased products.
2) Facilitate interdisciplinary research focused on these technologies and their implementation.
3) Prepare students to address challenges involved in transitioning to a biobased economy in Iowa and other regions of the world.
4) Promote innovative research that reflects the university's commitment to public service and excellence in scholarship.

6. General description of the program:

The proposed academic program in *Biorenewable Resources & Technology* includes a M.S. degree, a Ph.D. degree, and a Ph.D. minor. The program will be administered by the Center for Sustainable Environmental Technologies, which operates on "neutral ground" outside the academic departments and colleges, but offers support to faculty working in biobased products. A Program Coordinating Committee, consisting of one representative from each participating department will oversee the program. The initial composition of the committee will be: Prof. Robert C. Brown (Mechanical Eng. and Chemical Eng.), Prof. Lawrence Johnson (Food Science and Human Nutrition), Prof. George Kraus (Chemistry), Prof. Basil Nikolau (Biochemistry, Biophysics, and Molecular Biology), Prof. Tom Richard (Ag & Biosystems Eng.), Prof. Brent Shanks (Chemical Eng.), and Prof. Joe Colletti (Forestry).

The **Master's of Science degree** in *Biorenewable Resources & Technology* will require 30 credits including 6 credits of core required courses, 9 credits of core elective courses, at least 9 credits of research, and an additional 6 credits selected from elective courses (including additional research credit).

Student learning outcomes at the M.S. level include:

1) A deep understanding of the science and technology underlying three of the four component disciplinary areas of the program: plant science, production, processing, and utilization.
2) A broad understanding of the structure, function, and interactions among all four components as they are organized in biobased industrial systems.
3) The ability to communicate effectively with both lay and technical audiences about the challenges and opportunities of a biobased economy.
4) Teamwork skills needed to coordinate diverse multidisciplinary teams to solve challenges in the biobased products industry.
5) A demonstrated contribution to a research problem at either the system level or in a component disciplinary area of the program.

The **Ph.D. degree** in *Biorenewable Resources & Technology* will require 72 credits including 6 credits of core required courses, 18 credits of core elective courses, at least 24 credits of research, and an additional 24 credits selected from elective courses (including additional research credit).

Student learning outcomes at the Ph.D. level include:

1) A deep understanding of the science and technology underlying three of the four component disciplinary areas of the program: plant science, production, processing, and utilization.
2) A rich understanding of the structure, function, and interactions among all four components as they are organized in biobased industrial systems.
3) The ability to communicate effectively with both lay and technical audiences about the challenges and opportunities of a biobased economy.
4) Teamwork skills needed to lead diverse multidisciplinary teams to solve challenges in the biobased products industry
5) The ability to perform independent scholarly research on critical questions in biorenewable resources and technology at either the system level or in a component disciplinary field.

The **Ph.D. minor** in *Biorenewable Resources & Technology* will require 15 credits including 6 credits of core-required courses and 9 credits of core elective courses.

Student learning outcomes for a Ph.D. minor will include:
1) A deep understanding of the science and technology underlying three of the four component disciplinary areas of the program: plant science, production, processing and utilization.
2) A broad understanding of the structure, function, and interactions among all four components as they are organized in biobased industrial systems.
3) The ability to communicate effectively with both lay and technical audiences about the challenges and opportunities of a biobased economy.
4) Teamwork skills needed to coordinate diverse multidisciplinary teams to solve challenges in the biobased products industry.
5) Articulation of system-level skills in biorenewable resources and technology as they interface with the disciplinary focus of the student's major.

The core required courses in the Biorenewable Resources & Technology graduate program include: a foundation course called "Foundations of a Bio-Economy;" two credits of laboratory; and a seminar course, "Topics in Biobased Product." The foundation course is a three-credit course introducing students to basic concepts in biorenewable resources and technology. The laboratory requirement is two, one-credit courses selected from among four laboratory courses developed in the Department of Chemical Engineering with support from the National Science Foundation: BRT 515L (bioinformatics); BRT 525L (metabolic engineering); BRT 543L (polymers); and BRT 562L (protein separation). The seminar is a one-credit course that will draw upon existing seminar series offered by the Department of Chemical Engineering, the Center for Crops Utilization Research, and other seminar series on campus.

The elective core courses must come from an approved list of courses presently available at ISU that encompass one or more of four areas considered as barriers in the development of biobased products: plant science, production, processing, and utilization.[2] Students must

[2] U. S. Department of Energy, The Technology Roadmap for Plant/Crop-Based Renewable Resources 2020, February, 1999, available on the Internet at http://www.oit.doe.gov/agriculture/.

include courses from at least three of the four barrier topical areas selected in consultation with the student's Program of Study (POS) committee.

The program encourages, but does not require, students to obtain co-major degrees in Biorenewable Resources & Technology and a more traditional discipline. Typically, the core required courses in Biorenewable Resources & Technology can be applied toward graduate credit in other disciplines while the wide flexibility in the core elective courses will help students meet requirements for other graduate degrees (see Section 8c for details on core required and core elective courses). In the co-major program, a single degree is granted by fulfilling the requirements of both majors. The Program of Study committee includes co-chairs, each of whom represents one of the co-majors. Both co-chairs must be members of the graduate faculty. For either the Masters or Ph.D. co-major degree, the research work should be related to both majors. For the Ph.D. co-major degree, the preliminary oral examination should be related to both majors. Students declaring co-majors must satisfy requirements established by each major as monitored by the representatives on the POS committee and the Departmental Officer of Graduate Education (DOGE) of the two majors.

In response to growing demands from academic accrediting organizations for continuous quality improvement, institutions of higher learning are starting to incorporate outcomes assessment into their academic programs. Accordingly, we will institute outcomes assessment on the student learning outcomes described previously. The assessments for the educational objectives are described in Table 1.

Table 1. Measures used in outcomes assessment of education objectives.

Objective No.	**Description**	**Outcomes Assessment**
1	Breadth of knowledge in component areas	Successful completion of core elective course requirements.
2	Systems perspective	Successful completion of the fundamentals course in Biorenewable Resources and Technology, evaluated by the course instructor using a rubric prepared for this purpose. Program review of student projects during an annual meeting.
3	Communication skills	Audience survey of student-presented seminars
4	Teamwork skills	Successful completion of core lab courses, evaluated by the course instructor using a rubric prepared for this purpose.
5a (M.S.)	Contribution to research	Evaluation by P.O.S. committee at each graduate exam using a rubric prepared for this purpose.
5b (Ph.D.)	Independent scholarly research	Evaluation by P.O.S.committee at each graduate exam using a rubric prepared for this purpose.
5c (minor)	Articulation of system level analysis in disciplinary research	Evaluation by P.O.S.committee at each graduate exam using a rubric prepared for this purpose.

7. Comparison with program at other universities:

   As recently as last year, no comparable programs existed at other universities. In anticipation of growing national need for engineers and scientists to develop biobased products, the U.S. Department of Energy has recently launched a grants program to encourage formation of such programs at U.S. universities. Iowa State has won two awards totaling $675,000 to launch training programs in biobased products. Other schools that have received awards to develop academic programs include Colorado School of Mines, Kansas State University, Oklahoma State University, and Michigan State University. Most are only proposing certificate programs or minor degree programs as cautious entries into this new field, giving ISU an opportunity to provide academic leadership. No such programs exist at the other Iowa Regent Universities.

8. Program requirements:

   a. Prerequisites for prospective students:

      Any graduate student with an identified major professor in one of the following departments may apply to the program: Agricultural and Biosystems Engineering; Agronomy; Biochemistry, Biophysics, & Molecular Biology; Botany; Chemical Engineering; Chemistry; Civil & Construction Engineering; Food Science & Human Nutrition; Forestry; Mechanical Engineering; and Microbiology. This list is expected to expand as additional departments and faculty decide to join the program. For the Ph.D. and M.S. majors, the Chair of the student's POS committee must be a member of the Biorenewable Resources and Technology faculty. For the Ph.D. minor, at least one member of the student's POS committee must be a member of the Biorenewable Resources and Technology faculty. The admission procedure for students majoring in Biorenewable Resources and Technology is detailed in the governance document for this program (Appendix B). <u>The home department of students enrolled in the program will be the department of the Chair of the student's POS Committee.</u>

   b. Language requirements: None

   c. Courses and seminars presently available for credit:

      Table 2 details both core required courses and core elective courses planned for the proposed graduate program. Although the core required courses will be new course offerings, all of the core elective courses come from existing courses at Iowa State University.

9. General description of resources currently available:

   a. Faculty members:

      Faculty members of virtually all the physical and biological sciences are welcome to participate in the proposed graduate program. However, the core faculty who will

Table 2. Courses and Seminars Available for Credit in the Biorenewables Resources & Technology Major and Minor Programs

Core Required Courses	Course Number	Credit Hours	Plant Science	Plant/Crop Production	Processing	Utilization
Foundations of a Bio-Economy	BRT 501	3	x	x	x	x
Bioresource Laboratory	see note *	2	x	x	x	x
Topics in Biobased Products**	BRT 501	1	x	x	x	x
Research	BRT 501	var.	x	x	x	x
* Students select two modules from among four offered: BRT 515L, BRT 525L, BRT 543L, and BRT 562L						
**Students must register every semester: one semester for 1 credit and other semesters for R credit						
Core Elective Courses						
Special Topics in Biorenewable Resources	BRT 590	3	x			
Introduction to Plant Breeding	Agron 421	3	x			
Forage Utilization	Agron 434	2		x		
Crop Growth and Development	Agron 501	2		x		
Global Change	Agron 504	3		x		
Crop Physiology and Management	Agron 516	3		x		
Plant Genetics	Agron 527	3				
Forage Quality	Agron 534	2				
Advanced Crop Management	Agron 542	2				
Engineering Quantif. of Biological Processes	A E 409	3		x		
Controls for Agricultural Systems	A E 503	3		x		
Instrumentation for Ag and Biosystems	A E 504	3		x		
Applied Crop Growth Modeling	A E 510	3		x		
Crop Harvesting Dynamics	A E 537	3		x		
Food Process Engineering	A E 551	3			x	
Grain Processing and Handling	A E 569	3		x		
Manure Treatment and Bioconversion	A E 573	3			x	
Post-Harvest Grain Technology	AST 462	2		x		
Biochemistry	BBMB 404	3	x			
Biochemistry	BBMB 405	3	x			
General Biochemistry Res. Techniques	BBMB 411	3	x			
Physical Biochemistry	BBMB 451	2	x			
Comprehensive Biochemistry I	BBMB 501	4	x			
Comprehensive Biochemistry II	BBMB 502	4	x			
Genetic Engineering	BBMB 520	3	x			
Structure and Reactivity of Biomolecules	BBMB 531	1	x			
Carbohydrate Chemistry	BBMB 622	2	x			
Plant Anatomy	Bot 404	4	x			
Plant Metabolism	Bot 513	2	x			
Separations	Ch E 358	4			x	
Chemical Reaction Engineering	Ch E 382	3			x	
Biochemical Engineering	Ch E 415	3			x	

Table 2. (continued)

Core Elective Courses	Course Number	Credit Hours	Plant Science	Plant/Crop Production	Processing	Utilization
Process & Plant Design	Ch E 430	4			x	
Polymers & Polymer Engineering	Ch E 443	3				x
Bioseparations	Ch E 562	3			x	
Special Topics	Ch E 595 A, G	3				x
Instrumental Methods of Chemical Analysis	Chem 316	2			x	
Advanced Quantitative Analysis	Chem 511	3			x	
Analytical Molec. & Atomic Spectroscopy	Chem 513	3			x	
Analytical Separations	Chem 516	3			x	
Spectrometric Identif. of Organic Compounds	Chem 572	3			x	
Selected Topics in Organic Chemistry	Chem 632	1				x
Agricultural Markets	Econ 335	3				x
Urban, Rural & Regional Economics	Econ 376	3				x
Agribusiness Management	Econ 432	3				x
Agricultural, Food and Trade Policy	Econ 460	3				x
Intermediate Envir. & Resource Economics	Econ 480	3				x
Agricultural Marketing	Econ 535	3				x
Agricultural Policy	Econ 560	3				x
Advanced Environmental Economics	Econ 581	3				x
Advanced Topics in Agricultural Economics	Econ 640	3				x
Advanced Resource Economics	Econ 680	3				x
Food Chemistry	FS HN 311	3			x	
Unit Operations in Food Processing	FS HN 351	3			x	
Food Processing	FS HN 471	3			x	
Advanced Food Science-Chemistry	FS HN 502	1			x	
Advanced Food Science-Processing	FS HN 503	1			x	
Advanced Food Science-Microbiology	FS HN 504	1			x	
Food Biotechnology	FS HN 525	3			x	
Intro. to Molecular Biology Techniques	FS HN 542	1			x	
Food Processing Laboratory	FS HN 572	2			x	
Food Enzymology	FS HN 610	3			x	
Food Lipids	FS HN 612	3			x	
Food Proteins	FS HN 613	3			x	
Carbohydrates in Foods	FS HN 614	3			x	
Advanced Food Microbiology	FS HN 626	3			x	
Chemical Conversion of Wood	FOR 481	3				x
Mechanical Properties of Wood	FOR 487	4				x
Molecular Genetics	Gen 411	3	x			
Mole. Biol. for Computational Scientists	Gen 495	3	x			
Biotech. in Ag., Food, and Human Health	Gen 508	3	x			

Table 2. (continued)

Core Elective Courses	Course Number	Credit Hours	Plant Science	Plant/Crop Production	Processing	Utilization
Molecular Genetics	Gen 511	3	x			
Fluidized Bed Processes	M E 539	3			x	
Thermal Systems Optimization	M E 545	3			x	
Advanced Microbiology	Micro 501	3			x	
Microbial Genetics	Micro 502	3			x	
Microbial Physiology	Micro 504	3			x	
Procaryotic Diversity	Micro 530	3			x	
Bacterial-Plant Interactions	Micro 577	3			x	

oversee the program as part of an Program Coordinating committee include: Prof. Robert C. Brown (Mechanical Eng. and Chemical Eng.), Prof. Lawrence Johnson (Food Science and Human Nutrition), Prof. George Kraus (Chemistry.), Prof. Basil Nikolau (Biochemistry, Biophysics, and Molecular Biology), Prof. Tom Richard (Ag & Biosystems Eng.), Prof. Brent Shanks (Chemical Eng.), and Prof. Joe Colletti (Forestry). Their vitae are found in Appendix A.

b. Effects of new courses on work load of present staff:

Only three new courses will be added as a result of the proposed program in Biorenewable Resources & Technology. The seminar course will be integrated with existing seminar series currently offered at ISU; it represents a minor addition to workload of faculty. The laboratory requirement is drawn from four new laboratory courses in biobased products developed by the Department of Chemical Engineering with support from the National Science Foundation; that department has already agreed to teach these courses so no additional faculty time commitment is expected. The foundations course is the only new offering requiring significant new commitment of faculty time. However, we anticipate that instruction of this course will be rotated among several faculty members who will teach it as part of their normal graduate teaching responsibilities. This and other faculty resources for advising and program governance will be reallocated from existing departmental resources.

c. Research facilities:

No research facilities will be directly associated with this new academic program. Instead, existing faculty laboratories and research centers at ISU will support research of graduate students enrolled in the program.

d. Library facilities:

This multi-disciplinary program draws upon journals and books shared by a number of traditional disciplines well represented in the ISU library collection. No new library resources will be required.

e. Supplies, student recruitment, etc.:

The program will be coordinated by the Center for Sustainable Environmental Technologies (CSET), one of the centers managed by the Institute for Physical Research and Technology (IPRT). The center has two administrative staff persons who will assist in maintaining records for the proposed academic program as part of their responsibilities towards the center's current educational mission. The U.S. Department of Energy has supplied sufficient funds to help support the stipends of up to eight graduate students for the first three years of the program. We expect training grants secured by individual faculty will support additional students beyond this initial period of performance. Student recruitment will be accomplished through a Web site, distribution of brochures at professional meetings, and recruitment by participating faculty through their home departments.

10. Relationship to the strategic plans of the university:

The academic program and related research are well aligned with the Land-Grant mission of the university. By training students to develop new uses for agricultural products, the program supports the Land-Grant mission of serving the needs of the people of Iowa (employment, rural development, more profitable and diversified markets for farmers, etc.). Student training in Biorenewable Resources & Technology integrates the two original missions of the Land-Grant colleges: agriculture and the "mechanical arts."

Vitae of Faculty Serving on the Biorenewable Resources Academic Program Committee

Name:	**Robert C. Brown**	
Title(s):	Professor Mechanical Engineering Chemical Engineering	Director Center for Sustainable Environmental Technologies
Office Address:	2020 Black Engineering Bldg. Iowa State University Ames, IA 50011-2161 (Ph) 294-8733	286 Metals Development Bldg. Iowa State University Ames, IA 50011-3020 (Ph) 294-7934

EDUCATION

Ph.D.	Mechanical Engineering, Michigan State University, 1980
M.S.	Mechanical Engineering, Michigan State University, 1977
B.A.	Mathematics, University of Missouri-Columbia, 1976
B.S.	Physics, University of Missouri-Columbia, 1976

ACADEMIC EXPERIENCE

Professor of Mechanical Engineering, Iowa State University, 1993-present
Professor of Chemical Engineering, Iowa State University, 1993-present
Director, Graduate Studies in Mechanical Engineering, Iowa State University, 1991-1997
Associate Professor, Iowa State University, 1987-1993
Assistant Professor, Iowa State University, 1983-1987
Research Assistant, Michigan State University, 1978-1980
Teaching Assistant, Michigan State University, 1976-1978

INDUSTRIAL AND OTHER NON-ACADEMIC EXPERIENCE

Co-Director, Biotechnology Byproducts Consortium, Iowa State University, 1998-present
Director, Center for Sustainable Environmental Technology, Iowa State University, 1996-present
Leader, Fossil Energy Section, Environmental Technology Development Program, Ames Laboratory, 1996-1997
Senior Engineer, Thermodynamics Group, General Dynamics Corporation, Fort Worth, Texas. Lead man in the Advanced Design Department, 1980-1983

RECENT GRANTS AND CONTRACTS

Co-principal Investigator, "Multi-Disciplinary Education and Training in Biobased Products: Graduate Major in Bioresource Engineering," U.S. Department of Energy, $375,000, 2001-2003.
Principal Investigator, "The potential for biomass production and conversion in Iowa," Iowa Energy Center, $125,000, 2001-2002.
Principal Investigator, "Hybrid thermal/biological conversion to industrial chemicals," Iowa Energy Center, $100,000, 2001-2002.

Principal Investigator, “Fuel lean biomass reburning in coal-fired boilers,” U.S. DOE, $150,000, 2000-2001.
Principal Investigator, “The potential for biomass production and conversion in Iowa,” Iowa Energy Center, $125,000, 2000-2001.
Principal Investigator, “Hybrid thermal/biological conversion to industrial chemicals,” Iowa Energy Center, $85,500, 2000-2001.
Co-Principal Investigator, “Effects of fly ash mercury oxidation during post combustion conditions,” U.S. DOE, $17,500, 2000.
Principal Investigator, “Hybrid wind energy systems,” Iowa Wind Energy Institute, $14,315, 2000.
Co-Principal Investigator, “Control of interfacial dust cake in moving bed granular filters,” University Coal Research Program, U.S. DOE, $200,000, 1999-2002.
Principal Investigator, “Biomass Gasification Demonstration in China - Phase I,” ISU Institute for Physical Research and Technology, $15,000, 1999.

RECENT PUBLICATIONS

Brown, R. C., Radlein, D., and Piskorz, J., “Pretreatment Processes to Increase Pyrolytic Yield of Levoglucosan from Herbaceous Feedstocks,” Chemicals and Materials from Renewable Resources, ACS Symposium Series 784, American Chemical Society, Washington, D.C., 2001, pp. 123 - 132.
Pletka, R., Brown, R. C., and Smeenk, J., “Indirectly heated biomass gasification using a latent heat ballast. Part 1: Experimental evaluations,” Biomass and Bioenergy, 20, 297 – 305, 2001.
Pletka, R., Brown, R. C., and Smeenk, J., “Indirectly heated biomass gasification using a latent heat ballast. Part 2: Computational model,” Biomass and Bioenergy, 20, 307 –315, 2001.
Brown, R. C., Liu, Q., and Norton, G., “Catalytic effects observed during the co-gasification of coal and switchgrass," Biomass and Bioenergy 18, 499-506, 2000.
Brown, R. C., Smeenk, J., and Wistrom, C., “Design of a moving bed granular filter for biomass gasification,” Proceedings of the Progress in Thermochemical Biomass Conversion Conference, Tyrol, Austria, September 17-22, 2000.
So, K. and Brown, R.C., "Economic analysis of selected lignocellulose-to-ethanol conversion technologies," Applied Biochemistry and Biotechnology, Vol. 77-79, pp. 633-640, 1999.
Smeenk, J., Brown, R. C. and Eckels, D., “Determination of Vapor Phase Alkali Content During Biomass Gasification,” Proceedings of the Fourth Biomass Conference of the Americas, Volume 2, pp. 961-967, Oakland, CA, August 29-September 2, 1999.
Brown, R. C., "Capturing Solar Energy Through Biomass," Chapter in Principles of Solar Engineering, Second Edition, D. Y. Goswami, F. Kreider, and F. Kreith, Eds., Taylor & Francis, Washington, D.C., 1999.

LAWRENCE A. JOHNSON
2001

EDUCATION:

Doctor of Philosophy (1978). Food Science. Kansas State University.
Master of Science (1971). Food Science. North Carolina State University.
Bachelor of Science (1969). Food Technology. The Ohio State University.

EXPERIENCE:

1973-1975. Project Leader/Research Chemist, Dwight P. Joyce Research Center. Durkee Foods, SCM Corp., Strongsville, OH.

1978-1985. Assistant and Associate Research Chemist. Food Protein R&D Center. Texas Engineering Experiment Station. Texas A&M University. College Station, TX. 1975-1978

1985-1988. Associate Professor, Department of Food Technology. Professor-in-Charge, Food Crops Processing Research Center. Iowa State University, Ames, IA.

1988-present. Professor, Department of Food Science and Human Nutrition. Director, Center for Crops Utilization Research. Professor, courtesy appointment 1997, Department of Agricultural and Biosystems Engineering. Iowa State University, Ames, IA.

SOCIETY MEMBERSHIPS:

American Oil Chemists' Society: Publications Activities Coordinating Committee, member, 1996-1998, Chair 1998-present; Associate Editor, JAOCS, 1989-present; Interim Editor-in-Chief, INFORM, 1996-present; Governing Board 1996-present.

American Association of Cereal Chemists: Associate Editor, Cereal Chemistry, 1982-present; AACC Foundation Board member, 1995-1998; Protein Division (Secretary/Treasurer, 1980; Vice Chairman, 1981; Chairman, 1982); Engineering and Processing Division (Technical Program Co-Chair, 1991; Secretary, 1992); Scholarship Committee member, 1997-present.

Institute of Food Technologists: Iowa Section; Legislative Liaison, 1986.

American Society of Agricultural Engineers.

HONORS, AWARDS AND RECOGNITION:

United Soybean Board/American Soybean Association Utilization Research Award (1993).
Iowa FFA Association Distinguished Service Award (1995).
Elected Foreign Member of the Royal Swedish Academy of Agriculture and Forestry (1999)

RECENT PEER-REVIEWED SCIENTIFIC JOURNAL PUBLICATIONS

1. Johnson, L.A., C.L. Hardy, C.P. Baumel, T.S. Yu, and J.L. Sell. 1999. Identification of Valuable Corn Traits for Feed. Cooperative Extension Service. Iowa State University, Ames, IA.
2. Johnson, L.A., C.P. Baumel, C.L. Hardy, and P.J. White. 1999. Identification of Valuable Corn Traits for Starch Production. Cooperative Extension Service. Iowa State University, Ames, IA.
3. Johnson, L.A. 1999. Process for Producing Improved Soy Protein Concentrate from Genetically Modified Soybeans. U.S. Patent 5,936,069.

4. Wu, S., P.A. Murphy, L.A. Johnson, M.A. Fratzke, and M.A. Reuber. 2000. Simplified Pilot-Plant Process for Soybean Glycinin and β-Conglycinin Fractionation. J. Agric. Food Chem. 48:2702-2708.
5. Johnson, L.A., and T. Wang. 2000. Effects of Processing on Soybean Meal Quality. Proceedings of the 61st Minnesota Nutrition Conference, Bloomington, MN. September 19-20. University of Minnesota Extension Service. p.5-17.
6. Wang, T., and L.A. Johnson. 2001. Refining High-Free Fatty Acid Wheat Germ Oil. J. Am. Oil Chem. Soc. 78(1):71-78.
7. Wang, C., and L.A. Johnson. 2001. Functional Properties of Hydrothermally Cooked Protein Products. J. Am. Oil Chem. Soc. 78(2): 189-195.
8. Wang, T., and L.A. Johnson. 2001. Survey of Soybean Oil and Meal Qualities Produced by Different Processes. J. Am. Oil Chem. Soc. 78(3): 311-318.
9. King, J.M., S.M. Chin, L.K. Svendsen, C.A. Reitmeier, L.A. Johnson, and W.R. Fehr. 2001. Processing of Lipoxygenase-Free Soybeans and Evaluation in Foods. J. Am. Oil Chem. Soc. 78(4):353-360.
10. Wang, T., and L.A. Johnson. 2001. Natural Refining Extruded-Expelled Soybean Oils Having Various Fatty Acid Compositions. J. Am. Oil Chem. Soc. 78(5): 61-466.
11. Reuber, M.A., L.A. Johnson, and L.R. Watkins. 2001. Dehulling Crambe Seed for Improved Oil Extraction and Meal Quality. J. Am. Oil Chem. Soc. 78(6): 661-664.
12. Singh, S.K., L.A. Johnson, P.J. White, J.-L Jane, and L.M. Pollak. 2001. Thermal, Pasting, and Gelling Properties of Accessions Used in the Germplasm Enhancement of Maize Project. Cereal Chem. 78(3):315-321.
13. Singh, S.K., L.A. Johnson, L.M. Pollak, and C.R. Hurburgh. 2001. Compositional, Physical, and Wet-milling Properties of Accessions Used in the Germplasm Enhancement of Maize Project. Cereal Chem. 78(3): 330-335.
14. Singh, S.K., L.A. Johnson, L.M. Pollak, and C.R. Hurburgh. 2001. Heterosis in Compositional, Physical, and Wet-milling Properties of Adapted X Exotic Corn Crosses. Cereal Chem. 78(3): 336-341.
15. Crowe, T.W., L.A. Johnson, and T. Wang. 2001. Characterization of Extruded-Expelled Soybean Flours. J. Am. Oil Chem. Soc. (accepted).
16. Crowe, T.W., and L.A. Johnson. 2001. Twin-Screw Texturization of Extruded-Expelled Soybean Flours. J. Am. Oil Chem. Soc. (accepted).
17. Yu, T., C.P. Baumel, C.L. Hardy, L.A. Johnson, M.J. McVey, and J.L. Sell. 2001. Impact of Six Genetic Modifications of Corn on Feed Cost and Consumption of Traditional Feed Ingredients. Agribus. J. (accepted).
18. Wang, T., and L.A. Johnson. 2001. Refining Genetically Modified Soybean Oils Obtained by Various Extraction Methods. J. Am. Oil Chem. Soc. (accepted).
19. Miller, K.A., M.P. Hojilla-Evagelista, and L.A. Johnson. 2001. Optimizing the Oil Extraction/Water Adsorption Step in Sequential Extraction Processing of Corn. Trans. ASAE (accepted).
20. Johnson, L.A., C.L. Hardy, C.P. Baumel, and P.J. White. 2001. Identifying Valuable Corn Quality Traits for Starch Production. Cereal Foods World 46(9): 1-6.
21. Johnson, L.A., C.L. Hardy, C.P. Baumel, T.Y. Yu, and J.L. Sell. 2001. Identifying Valuable Corn Quality Traits for Livestock Feed. Cereal Foods World 46(11): 417-423.

George A. Kraus

Professor, Department of Chemistry
http://www.chem.iastate.edu/DeptInfo/Kraus/Kraus.html

Education
B.S. 1972 University of Rochester
Ph.D. 1976 Columbia University

Research Interest

The development of new synthetic methods and their application to the synthesis of biologically active natural products, reactive intermediates, development of environmentally benign organic reactions.

Current Research Funding

USDA, Inhibitors of the Meth reaction in Liquid Ammonia. $198,000
DOE, Gene Expression Measurement by Revealed Aptamer-based Imaging Technology. $1,625,000
2000-2001; co-PI, M. Nilsen-Hamilton, PI)
EPA, Photochemical Alternatives for Pollution Prevention. $400,000 1996-2000.

Recent Publications Relevant to Theme

Kraus, G.A., M. Kirihara. 1992. Quinone Photochemistry. A General Synthesis of Acylhydroquinones, *J. Org. Chem.* 57: 3256.
Kraus, G.A., P. Liu. 1994. Benzophenone Mediated Conjugate Additions of Aromatic Aldehydes to Quinones, *Tetrahedron Lett.* 35: 7723.
Kraus, G.A., H. Maeda. 1994. A Direct Preparation of 1,4-Benzodiazepines. The Synthesis of Medazepam and Related Compounds via a Common Intermediate, *Tetrahedron Lett.* 35: 9189.
Kraus, G.A., P. Liu. 1995. A Direct Route to the Pyrrolo[2,1-c][1,4]benzodiazepine Ring System using Aryl Triflates, *Tetrahedron Lett.* 36: 7595.
Kraus, G.A., M. Kirihara, Y. Wu. 1994. A Photochemical Alternative to the Friedel-Crafts Reaction, ACS Symposium Series 577, Chapter 6, 76-83.
Kraus, G.A., L. Chen. 1991. Photoenolization Reactions in Organic Synthesis. A Direct Synthesis of 4-Deoxyaklavinone, *Syn. Lett.* 51.
Kraus, G.A., Y. Wu. 1992. 1,5- And 1,9-Hydrogen Atom Abstractions. Photochemical Strategies for Radical Cyclizations, *J. Am. Chem. Soc.* 8705.
Kraus, G.A., L. Jun, M. Gordon, J. Jensen. 1993. Regiocontrol by Remote Substituents. An Enantioselective Total Synthesis of Frenolicin B via a Highly Regioselective Diels-Alder Reaction, *J. Am. Chem. Soc*. 115: 5859.

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Education

B.Sc., 1st Class Honors	1977, Massey University, Palmerston North, New Zealand
Ph.D. (Biochemistry)	1982, Massey University, Palmerston North, New Zealand

Employment Experience

1978 - 1982	Research Assistant, Department of Chemistry, Biochemistry & Biophysics, Massey University, Palmerston North, New Zealand
1982 - 1983	Postdoctoral Fellow, Department of Biochemistry and Biophysics, University of California, Davis
1983 - 1985	Postdoctoral Fellow, Department of Cellular, Viral and Molecular Biology, University of Utah, Salt Lake City
1985 - 1988	Senior Scientist, Molecular Biology Department of NPI, Salt Lake City
1988 - 1993	Assistant Professor, Department of Biochemistry and Biophysics, Iowa State University, Ames
1988 - 1993	Assistant Professor, Department of Food Science and Human Nutrition, Iowa State University, Ames
1993 - 1998	Associate Professor, Department of Biochemistry and Biophysics, Iowa State University, Ames
1993 - 1998	Associate Professor, Department of Food Science and Human Nutrition, Iowa State University, Ames
1998 – present	Professor, Department of Biochemistry, Biophysics and Molecular Biology, Iowa State University, Ames
1998 - present	Professor, Department of Food Science and Human Nutrition, Iowa State University, Ames
1999 - present	Interim Director of Center for Designer Crops, Iowa State University, Ames
2001-present	Director of the Metabolomics Research Laboratory, Iowa State University, Ames

Professional Honors

Postgraduate Scholarship, New Zealand University Grants Committee, 1978-1980
Massey University Postgraduate Scholarship, 1981
Massey University Travel Award, 1981
Award for outstanding paper presentation, American Oil Chemists Society Annual Meeting, 1988
American Chemical Society, Herman Frasch Foundation Research Award, 1992
Iowa State University International Travel Award, 1996.
Iowa State University Faculty Improvement Leave, 1997.

Iowa State University International Travel Award, 1998.
Dean of Agriculture's International Research Grant, Iowa State University, 1998.
National Plant Lipid Cooperative Symposium Organizing Committee, 2001.
W.M. Keck Foundation, Research Award (Metabolomics Research Laboratory), 2001.

Recent Refereed Publications

McKean, A.M., P. Che, S. Achenbach, E.S. Wurtele and **B.J. Nikolau.** 2000. Molecular cloning and characterization of the cDNA and gene coding for the nonbiotinylated subunit of 3-methycrotonyl-CoA carboxylase. Journal of Biological Chemistry. **275:** 5582-5590.

Ke, J., T-N. Wen, E.S. Wurtele and **B.J. Nikolau**. 2000. Coordinate regulation of the spatial and temporal expression of the nuclear and chloroplastic encoded genes of the heteromeric acetyl-CoA carboxylase. Plant Physiology. **122:** 1057-1071.

Ke, J-S., B. Behal, S. Yunkers, **B.J. Nikolau**, E.S. Wurtele and D.J. Oliver. 2000. The role of pyruvate dehydrogenase and acetyl-CoA synthetase in fatty acid synthesis in developing *Arabidopsis* seeds. Plant Physiology. **123:** 497-508.

Dietrich, C., F. Cui, M. Packila, D. Ashlock, **B.J. Nikolau**, P.S. Schnable . 2001. *Mu* transposons target the 5' UTR of the *gl8a* locus. Genetics. In press.

Xu, X., C.R. Dietrich, R. Lessire, **B.J. Nikolau**, P.S. Schnable. 2001. The endoplasmic reticulum-associated maize GL8 protein is one of the components of the acyl-CoA elongase complex involved in the production of cuticular waxes. Plant Physiology. In press.

Recent Invited Publications

Wurtele, E.S., **B.J. Nikolau**. 2000. Characterization of 3-methylcrotonyl-CoA carboxylase from plants. Methods in Enzymology. v324, 280-292.

Nikolau, B.J., Wurtele, E.S., Oliver, D.J., P.S. Schnable. 2000. Molecular biology of acetyl-CoA metabolism. The Proceedings of the 14th International Symposium on Plant Lipids, Cardiff, Wales. Biochem Soc Trans. 28:591-593.

Fatland, B., M. Anderson, **B.J. Nikolau** and E.S. Wurtele. 2000. Molecular biology of cytosolic acetyl-CoA generation. The Proceedings of the 14th International Symposium on Plant Lipids, Cardiff, Wales. Biochem Soc Trans. 28:593-595.

D.J., Oliver, **B.J. Nikolau**, E.S. Wurtele. 2001. Functional Genomics: High throughput mRNA, protein, and metabolite analyses. In press.

THOMAS L. RICHARD

Assistant Professor
Agricultural and Biosystems Engineering
Iowa State University

EDUCATION

Degree	Institution	Major Field of Study	Dates of Degree
Ph.D.	Cornell University	Biological Engineering	1997
M.S.	Cornell University.	Agricultural Engineering	1987
B.S.	U. of California, Berkeley.	Pol. Econ. of Nat. Resources	1978

PROFESSIONAL EXPERIENCE

Employer	Position	Nature of Position	Location	Dates
Iowa State Univ.	Assistant Professor	Research/Teaching	Ames, IA.	1997–present
Cornell Univ.	Sr. Research Spec.	Research/Extension	Ithaca, NY	1987–1996
U.S.G.S.	Hydrologist.	Research	Ithaca, NY	1987
Cornell Univ.	Research Assistant	Research/Teaching	Ithaca, NY	1985–1987
C.A.M.P.	Project Manager	Business Developmt.	Seattle, WA	1981–1983
Seattle Recycling	Operations Manager	Management	Seattle, WA	1978–1981

HONORS AND AWARDS

Korean Rural Development Administration – Honorary Scientist (1996-1999, 1999-2002)
ASAE – Blue Ribbon Awards (1991, 1993, 2001)
ASAE, Iowa Section Newcomer Engineer of the Year (2001)
New York State Assoc. of County Agricultural Agents – Special Citation (1993)
Cornell Community and Rural Development Institute – Innovator Award (1992)
New York State Assoc. of County Agricultural Agents – Award for outstanding new extension publication (1990)
Phi Beta Kappa (1978)

PROFESSIONAL AND SCIENTIFIC ORGANIZATIONS

ASAE – The Society for engineering in agricultural, food, and biological systems
American Society of Engineering Education
Institute Of Biological Engineering (Treasurer, 1998-2001)
International Society for Industrial Ecology
International Solid Waste Management Association
Practical Farmers of Iowa
Soil and Water Conservation Society
Water Environment Federation

RESEARCH INTERESTS

Application of bioprocess engineering to agricultural and environmental challenges. Specific focus is on value-added processing of organic residuals.

SELECTED PUBLICATIONS

Richard, T.L., S. Proulx, K.J. Moore, and S. Shouse. 2001. Ensilage Technology for Biomass Pre-treatment and Storage. ASAE Paper No. 016019. ASAE, St. Joseph, MI.

Hamelers, H.V.M. and T.L. Richard. 2001. The Effect of Dry Matter on the Composting Rate: Theoretical analysis and practical implications. ASAE Paper No. 017004. ASAE, St. Joseph, MI.

Tiquia,S.M., T.L. Richard and M.S. Honeyman. 2001. Carbon, Nutrient and Mass Loss during Composting. *Nutrient Cycling in Agricultural Ecosystems. In press.*

Choi, H.L., T.L. Richard, and H.K. Ahn. 2001. Composting High Moisture Materials: Biodrying Poultry Manure in a Sequentially Fed Reactor. *Compost Sci. and Util.* 9(4):303-311.

Rynk, R. and T.L. Richard. 2001. Commercial composting production systems. Pp. 51-93 in: *Compost Utilization in Horticultural Cropping Systems*, P.J. Stoffella and B.A. Kahn (Editors). Lewis Publishers, Boca Raton, Florida, USA. 414 pp.

Tiquia S.M., T.L. Richard T.L. and M.S. Honeyman. 2000. Windrow Turning and Seasonal Temperatures on Composting of Hog Manure from Hoop Structures. *Environ. Technol.* 20(9):1037-1046..

Kashmanian, R.M., D. Kluchinski, T. L. Richard, and J. M. Walker. 2000. Quantities, Characteristics, Barriers, and Incentives for Use of Organic Municipal By-products. pp. 127-167 In: *Land Application of Agricultural, Industrial, and Municipal By-Products.* SSSA Book Series: 6. J.F. Power and W.A. Dick (Editors). Soil Science Society of America. Madison, WI. 653 pp.

Richard, T.L., and H.L. Choi. 1999. Eliminating Waste: Strategies for Sustainable Manure Management. *Asian-Aus. J. Anim. Sci.* 12(7):1162-1169.

Richard, T.L, L.P. Walker, and J.M Gossett. 1999. The Effects of Oxygen on Solid-State Biodegradation Kinetics. *Proceedings of the Inst. of Biological Engineering* 2:A10-A30. IBE Publications, Athens, GA.

Rosentrater, K.A., R. A. Flores, T. L. Richard, and C. J. Bern. 1999. Characterization of Agribusiness Residues: Physical and Nutritional Properties of Corn Masa Byproduct Streams. *Applied Engineering in Agriculture* 15(5):515-523.

Richard, T.L. and L.P. Walker. 1998. Temperature Kinetics of Aerobic Solid-State Biodegradation. *Proceedings of the Inst. of Biological Engineering* 1:A22-A39. IBE Publications, Athens, GA.

Choi, H.L., T.L. Richard and H.T. Kim. 1996. Composting High Moisture Materials: Bio-drying Poultry Manure in a Sequentially Fed Reactor. *Korean J. of Anim. Sci.* 38(6):649-658.

Brent H. Shanks

Associate Professor
Department of Chemical Engineering
2119 Sweeney Hall
Iowa State University
Ames, Iowa

Education

Ph.D.	Chemical Engineering, California Institute of Technology, 1988.
M.S.	Chemical Engineering, California Institute of Technology, 1985.
B.S.	Chemical Engineering, Iowa State University, 1983.

Appointments

1999-present	Associate Professor, Department of Chemical Engineering, Iowa State University.
1997-1999	Department Manager, Catalysis, Shell Chemical Co., Houston, TX.
1988-1997	Research Engineer, Catalysis, Shell Chemical Co., Houston, TX. 1985 Research Engineer, General Motors Research Lab., Warren, MI.

Professional Awards

1993 and 1997	Shell Special Recognition Award
2000-2003	Shell Faculty Fellow
2000	ISU VEISHEA Engineering Faculty of the Year

Research Interests

Heterogeneous catalytic conversion of biorenewable feedstocks to industrial chemicals; synthesis of heterogeneous catalysts for use in aqueous phase processes; synthesis of nanostructured materials for use in catalytic applications.

Publications and Patents

W. Deng, P. Bodart, M. Pruski, and B.H. Shanks, "Characterization of Mesoporous Alumina Molecular Sieves Synthesized by Nonionic Templating," *Microporous Mesoporous Mater.*, manuscript accepted (2001).

Milam, S.N. and Shanks, B.H., "Dehydrogenation Catalyst and Process," United States Patent, **5,962,757**.

Milam, S.N. and Shanks, B.H., "Restructured Iron Oxide for Use in Iron Oxide Catalysts," United Stated Patent, **5,668,075**.

Cho, B.K., Shanks, B.H., and Bailey, J.E., "Kintecs of NO Reduction by CO over Supported Rhodium Catalysts: Isotopic Cycling Experiments," *J. Catal.*, **115,** 486 (1989).

Shanks, B.H. and Bailey, J.E., "Application of the Feedback-Induced Bifurcation Method to a Catalytic Reaction System," *Chem. Eng. Sci.*, **44**, 901 (1989).

Prairie, M.R., Shanks, B.H. and Bailey, J.E., "Intentional Manipulation of Closed-Loop Time Delay for Model Validation using Feedback-Induced Bifurcation," *Chem. Eng. Sci.*, **44**, 161 (1989).

Shanks, B.H. and Bailey, J.E., "Autonomous Oscillations in Carbon Monoxide Oxidation over Supported Rhodium," *J. Catal.*, **110**, 197 (1988).

Shanks, B.H. and Bailey, J.E., "Modeling of Slow Dynamics in the Oxidation of CO over Supported Silver," *AIChE J.*, **33**, 1971 (1987).

Shanks, B.H. and Bailey, J.E., "Experimental Investigations using Feedback-Induced Bifurcation: Carbon Monoxide Oxidation over Supported Silver," *Chem. Eng. Commun.*, **61**, 127 (1987).

Shanks, B.H., Prairie, M.R., and Bailey, J.E., "Experimental Investigation of Entrainment Phenomena in a Periodically Forced, Autonomously Oscillating Process," *Chem. Eng. Commun.*, **57**, 189 (1987).

Shanks, B.H. and Berglund, K.A., "Contact Nucleation from Aqueous Sucrose Solutions," *AIChE J.*, **31**, 152 (1985).

Home Page

http://www.iastate.edu/~ch_e/faculty/bshanks.html

Jacqueline Vanni Shanks

Professor
Department of Chemical Engineering
2035 Sweeney Hall
Iowa State University
Ames, Iowa 50011

Education

B.S. Chemical Engineering, Iowa State University, Ames, 1983
Ph.D. Chemical Engineering, California Institute of Technology, Pasadena, 1989

PROFESSIONAL EXPERIENCE

1999–present	Professor, Department of Chemical Engineering, Iowa State University
1999	Professor, Bioengineering, Rice University
1999	Professor, Chemical Engineering, Rice University
1997–1999	Associate Professor, Bioengineering, Rice University
1993–1999	Associate Professor, Chemical Engineering, Rice University
1988–1993	Assistant Professor, Chemical Engineering, Rice University

Professional Honors and Affiliations (selected)

Editor of Reviews, Biotechnology Progress (2002 – present)
Co-Editor, Special Issue of Metabolic Engineering on Plant Metabolic Engineering, (2002)
American Chemical Society Chair, BIOT Division, (2001)
Fellow, American Institute of Medical and Biological Engineering, (2000)
Editorial Advisory Board, Biotechnology Progress, (2000-2002)
American Chemical Society Chair-Elect, BIOT Division, (2000)
American Chemical Society Newsletter Editor, BIOT Division, (1998–2001)
American Chemical Society Alternate Councilor, BIOT Division (1995–1998)
National Science Foundation Young Investigator Award (1992–1997)
NRC Committee on Biobased Industrial Products (1994–1995)
Professional Progress in Engineering Award (Alumni Award), ISU (1994)
Tau Beta Pi
Omega Chi Epsilon

Research Interests

Secondary metabolite production in plant tissue culture; metabolic engineering; phytoremediation of organics; NMR spectroscopic techniques for characterization of cellular metabolism *in situ*; bioprocess engineering

Selected Publications (out of >50)

Bhadra, R., Wayment, D., Hughes, J., and Shanks, J.V. "Characterization of Oxidation Products of TNT Metabolism in Aquatic Phytoremediation Systems of Myriophyllum aquaticum." *Environmental Sci. and Tech.*, 33: 3354-3361 (1999).

Shanks, J. V., and J. Morgan. Plant hairy root culture. *Current Opinion in Biotechnology* 10:151–5. (1999).

Rijhwani, S. K., C.-H. Ho, and J. V. Shanks. In vivo ^{31}P and multilabel ^{13}C NMR measurements for evaluation of plant metabolic pathways. *Metabolic Engineering* 1:12–25. (1999)

Morgan, J. and Shanks, J. V., "Inhibitor Studies of Tabersonine Metabolism in *Catharanthus roseus* Hairy Roots," *Phytochemistry*, **51**, 61-68 (1999).

Morgan, J., Rijhwani, S. K. and Shanks, J. V., "Metabolic Engineering for the Production of Plant Secondary Metabolites," pp. 325-352 in *Metabolic Engineering*, S. Y. Lee and E. T. Papoutsakis, Eds., Marcel Dekker, ©1999.

Rijhwani, S. K., Bhadra, R., Ho, C.-H., Morgan, J., Vani, S. and Shanks, J. V., "Quantification of Metabolic Fluxes for Metabolic Engineering of Plant Products," pp 45-60 in *Plant Cell and Tissue Culture for the Production of Food Ingredients*, T. J. Fu, G. Singh, and W. R. Curtis, Eds., Plenum Publishing Corporation, New York, NY, ©1999.

Committee on Biobased Industrial Products, "Biobased Industrial Products," National Research Council, National Academy Press, August 1999.

Burken, J. G., Shanks, J. V., and Thompson, P. L., "Phytoremediation and Plant Metabolism of Explosives and Nitroaromatic Compounds," in *Biodegradation of Nitroaromatic Compounds and Explosives*, J. Spain, J. Hughes, and H. Knackmuss, Eds., CRC Press, 2000.

Morgan, J. A., Barney, C. S., Penn, A.H. and Shanks, J. V., "The Effect of Buffered Media on Growth and Alkaloid Productivity of *C. roseus* Hairy Root Cultures," *Applied Microbiology and Biotechnology*, **53**, 262-265 (2000).

Bhadra, R., Spanggord, R. J., Wayment, D., Hughes, J. and Shanks, J. V., "Oxidative Metabolism of 2, 4, 6- Trinitrotoluene in Aquatic Phytoremediation Systems of *Myriophyllum aquaticum*," *Wetlands Remediation Int. Conf.*, 127-132 (2000).

Morgan, J. and Shanks, J. V., "Effects of Indole and Terpenoid Precursor Feeding upon Alkaloid Accumulation in a *C. roseus* Hairy Root Culture," *Journal of Biotechnology*, **79**, 137 – 145 (2000).

Shanks, J. V. and Stephanopoulos, G. "Biochemical Engineering: Bridging the Gap between Gene and Product," *Current Opinion in Biotechnology*, **11**, 169 - 170 (2000).

Shanks, J. V. "In Situ NMR Systems," Current Issues in Molecular Biology, 3, 15 – 26 (2001).

Bhadra, R., Wayment, D. G., Williams, R.K., Barman, S.N., Stone, M. B., Hughes, J.B. and Shanks, J. V., "Studies on plant-mediated fate of the explosives RDX and HMX," *Chemosphere*, **44/5**, 1259-1264 (2001).

Hughes, E. and Shanks, J. V. "Metabolic Engineering of Plants for Alkaloid Production," *Metabolic Engineering*, in press.

Hansen, A. and Shanks, J. V. "Plant Metabolic Engineering – Entering the S Curve," *Metabolic Engineering*, in press.

Joe P. Colletti
Associate Professor
Forestry Department
253B Bessey Hall
Iowa State University
Ames, IA 50011-1021

Phone: 515/ 294-4912
e-mail: colletti@iastate.edu

Education
Ph.D. - Forest Economics, Univ. of Wisconsin -Madison, 1978
M.S. - Forest Economics, Univ. of Wisconsin -Madison, 1974
B.S.- Forestry, Humboldt State Univ., 1972

Research Interests
Research emphases: (i) economics of agroforestry systems (shelterbelts, woody crops, riparian buffers) and bio-renewable products, and (ii) optimization of forestry and agroforestry systems.

Academic Experience
1983 -present Associate Professor, Iowa State University
1978 - 83 Assistant Professor, Iowa State University
1977 Instructor, Univ. of Wisconsin - Madison (1 semester)
1972-77 Research Associate, Univ. of Wisconsin - Madison

Professional Associations
Association for Temperate Agroforestry (Past Pres.)
Gamma Sigma Delta, ISU Beta Chapter (Past Pres.
Xi Sigma Pi (Forestry Honorary)
Midwest Forest Economists
Society of American Foresters
Soil & Water Conservation Society

Awards, Honors, & Recognition
College of Agriculture – Outstanding Achievement in Teaching Award, 2002
ISU Foundation Award for Outstanding Achievement in Teaching - 1998
Most Beloved Instructor of the Year, Forestry Club – 1996, 1998, & 2000
Outstanding Club Advisor, Ag. Council, Spring, 1991, 1999, & 2000
College of Agriculture-Louis Thompson Advisor of the Year, 1985

Selected Refereed Journal Puplications
Gan, J., S. Kolison, & J. Colletti. 2001. Optimal Forest Stock & Harvest with Valuing Non-timber Benefits: a case of US Coniferous forests. *Forest Policy and Economics* (2).

Rule, L.C., M. Szymanski, and J.P. Colletti. 2001. The Winnebago Tribe's agroforestry project: Linking indigenous knowledge, resource management planning, and community development. Chapter 13, Pp. 187-209 in C.B. Flora (Ed.) "Interactions Between Agroecosystems and Human Communities" CRC Press. Boca Raton, FL.

Schultz, R.C., J.P. Colletti, T.M. Isenhart, C.O. Marquez, W.W. Simpkins, and C.J. Ball. 2000. Riparian Forest Buffer Practices. Book Chapter 7 – In: North American Agroforestry: An

Integrated Science and Practice. Editors: H.E. (Gene) Garrett, W.J. (Bill) Reietveld and R.F. (Dick) Fisher. American Society of Agronomy, Inc. Madison, Wisconsin. Pp 189.

Szymanski, M. and J. Colletti. 1999. Combining the socio-economic-cultural implications of community owned agroforestry: The Winnebago Tribe of Nebraska. *Agroforestry Systems* 44:227-239.

Han, S.Y, K. Choi, and J. P. Colletti. 1997. Nonparametric Test of Net Economic Benefits by Open-Ended and Closed-Ended Contingent Valuations: An Application to Downhill Skiing in Muju, Korea. *Journal of Korean Forestry Society* 86(1):9 -16.

Schultz, R.C. , J. P. Colletti, T. M. Isenhart, W.W. Simpkins, C.W. Mize, and M. L. Thompson. 1995. Design and Placement of a Multi-Species Riparian Buffer Strip System. *Agroforestry Systems* 29:201-226.

Rule, L.C., J.P. Colletti, R.R. Faltonson, J. Rosacker, and D. Ausborn. 1995. Evaluating Conversion of Cropland to Forests. *Journal of Forest Economics* 1(3):329-346
.
R. A. Robertson, J. P. Colletti. 1994. Off-site impacts of soil erosion on recreation: The case of Lake Red Rock Reservoir in Central Iowa. *Journal of Soil and Water Conservation* 49(6):576-581.

Colletti, J.P., R. C. Schultz, C. W. Mize, R. B. Hall, and C. J. Twarok. 1991. An Iowa Demonstration of Agroforestry: Short-Rotation Woody Crops. *The Forestry Chronicle* 67(3): 258-262.

Relevant Non-refereed publications

Tyndall, John and J. P. Colletti. 2000. Air Quality and Shelterbelts: Odor Mitigation and Livestock Production – A Literature Review. Final Project Report. Department of Forestry, Iowa State University, Ames, IA. Project funded by the USDA National Agroforestry Center, Lincoln, Nebraska. 74 pages.

Colletti, J., M. Thompson, R. Schultz, C. Mize and I Anderson. 1998. Demonstration of an agroforestry system to minimize pollution hazards from land application of treated municipal sludge. Final Report prepared for the Leopold Center for Sustainable Agriculture. Project No.: 95-47.

Colletti, J. 1994. Cost of producing biomass crops in Iowa, Chapter 3 - Part 2. Woody Energy Crops. *In* The Potential for Biomass Production and Conversion in Iowa. Final report to the Iowa Energy Center. Aug. 31, 1994. R. Brown, Principal Investigator. 454 pp.

Colletti, J. 1994. Chapter 2. Survey of Iowa Biomass Resources. *In* The Potential for Biomass Production and Conversion in Iowa. Final report to the Iowa Energy Center. Aug. 31, 1994. R. Brown, Principal Investigator. 454 pp.

PROGRAM GOVERNANCE DOCUMENT

I. Mission Statement

The interdisciplinary Graduate Program in Biorenewable Resources & Technology (GPBR) is intended to integrate knowledge and problem-solving skills needed for bio-based manufacturing, ranging from the plant sciences, through production, processing, and utilization. The program provides advanced training for students and facilitates interdisciplinary research focused on these technologies and their implementation. By emphasizing scientific principles and analytical thinking, the program seeks to prepare students to address challenges involved in transitioning to a bio-based economy in Iowa and other regions of the world. By bringing together faculty from diverse disciplines, the program seeks to promote innovative research that reflects the university's commitment to public service and excellence in scholarship.

II. Faculty

Faculty members from the physical and biological sciences are eligible to serve on the faculty of the GPBR, providing the faculty member is approved to participate by her or his home department. Faculty who participate in the GPBR are expected to periodically chair student POS committees for students seeking degrees in Biorenewable Resources & Technology. A faculty member wishing to serve on the GPBR must submit to the coordinating committee a curriculum vita, a brief statement of interest, and obtain approval from the departmental executive officer of the home department. Admittance to the GPBR faculty is decided by a majority vote of current program faculty members. Individuals who are not members of the ISU faculty may serve as advisors to the program at the discretion of the coordinating committee. Although these individuals may not participate in program votes, they may become adjunct faculty members and serve on graduate committees of GPBR students after following procedures set by the ISU Graduate College.

III. Students

The program seeks high caliber students. Admission is based on a holistic evaluation of the applicant with particular attention paid to evidence of high scholastic aptitude and achievement and demonstrated interest and activity in Biorenewable Resources & Technology. Applicants may come from any disciplinary background. Graduate Record Examination (GRE) scores are required for international students and encouraged for students from U.S. institutions. Although the program sets no minimum grade-point average (GPA) and no minimum GRE scores, students shall typically be expected to have a GPA of 3.3 or better and GRE scores for verbal, quantitative, and analytical tests at or above the 80th percentile. The GPBR encourages applications from students who can demonstrate academic excellence in other ways as well. For international students, a minimum score of 550 on the Test of English as a Foreign Language (TOEFL) exam is required. Qualified applicants must hold undergraduate degrees in the physical or biological sciences. The GPBR may offer provisional admission to students who are judged by the program to need stronger training in fundamentals related to the program areas.

Students who have already been admitted to another graduate program at ISU need only submit application materials to the Office of the GPBR Program Assistant. All other applicants must submit application materials to both the ISU Graduate College Admissions Office and to the Office of the GPBR Program Assistant. Transcripts of all college work, a statement of interest in *Biorenewable Resources & Technology*, and three letters of recommendation are required (a complete list of application requirements can be obtained at the program website, http://csetweb.me.iastate.edu/, under the *Academic Programs* link).

The GPBR has no application deadline. Applications are reviewed periodically during the fall and spring semesters, with competitions for any program assistantship funds meeting deadlines that are posted on the program website at least 1 month in advance.

Selection of students eligible for admission shall be by an admissions committee, which shall be appointed and approved by the coordinating committee. Admission of eligible students will be contingent upon agreement by a GPBR faculty member to chair the POS committee. Typically faculty members shall serve on the admissions committee for no more than three consecutive years. The chair of the admissions committee shall be selected by admissions committee members and shall be responsible for coordinating the committee's activities in a timely and just manner. The admissions committee is responsible for insuring that students admitted to the program (1) meet the academic requirements of the ISU Graduate College, (2) shall have an academic supervisor who is a member of the GPBR faculty, and (3) shall have adequate financial support from grant funds, university assistantships, or other sources.

Students enrolled in the GPBR will find a home in the department of the Chair of the student's POS Committee. Because students derive benefits from the department in which they are housed (usually the department of the Chair of the student's POS committee), use facilities and other departmental resources, and may apply for departmental financial assistance, students are expected to meet the normal requirements and obligations of the participating department (i.e., teaching assistance, seminar participation, etc.). To establish a department affiliation, such students must submit the form "Request to Establish a Home Department for Students Admitted to Interdepartmental Majors," available at the department office or on the Graduate College web site at www.grad-college.iastate.edu/forms/forms.html.

IV. Program Coordinating Committee

All participating departments will have one representative on the Program Coordinating Committee. The departments will select their representatives.

V. Program Changes

The list of courses for core electives (Table 2, Page 5) is only an initial list, but courses to be counted against the core elective requirements must come from the list. Courses may be added or deleted by majority vote of the Program Coordinating Committee. Within the first six months of program approval participating departments will be invited to nominate additional courses. Every two years when preparing the ISU Catalog of Graduate Courses and Programs, participating departments will have the opportunity to nominate additional courses, as well as the

current courses will be reviewed for continued inclusion. In order to make the list a justification must be provided about how the course relates to Biorenewable Resources & Technology (chemicals, fuels, materials and energy from agricultural products) and to fostering a Biobased Economy.

VI. Administration

A chair and an associate chair shall administer the program, and each shall be elected separately to three-year terms by the entire faculty of the program. The staff of the Center for Sustainable Environmental Technologies, which will provide day-to-day management of this academic program, will assist the chair and associate chair. The academic home of this program, however, will be the Graduate College.

The chair is responsible for coordinating the activities of the program coordinating committee and serving as the Director of Graduate Education. The associate chair assists the chair in carrying out administrative duties and represents the program when the chair is unavailable. After the chair's three-year term is completed, the associate chair typically is expected to assume the chair's position. Nevertheless, to become chair, the associate chair must be confirmed by a new election (see section VI). Rotation of the chair and associate chair positions among departments participating in the program is desirable.

The Program Coordinating Committee shall set program policies. The coordinating committee consists of the program chair, the program associate chair, and one representative from each of the participating departments. At the inception of the program, half of the departmental representatives shall be appointed to three-year terms, and half shall have two-year terms. The initial composition of the committee will include Prof. Robert C. Brown (Mechanical Eng. and Chemical Eng.), Prof. Lawrence Johnson (Food Science and Human Nutrition), Prof. George Kraus (Chemistry.), Prof. Basil Nikolau (Biochemistry, Biophysics, and Molecular Biology), Prof. Tom Richard (Ag & Biosystems Eng.), Prof. Brent Shanks (Chemical Eng.), and Prof. Joe Colletti (Foresty).

Meetings of the coordinating committee may be convened regardless of numbers of attendees, although every effort will be made to schedule meetings to maximize attendance. A simple majority of the coordinating committee is required for a quorum on any vote. Each member of the coordinating committee, including the chair and associate chair, shall have one vote. The decisions of the chair and associate chair may be overridden by a majority of the coordinating committee. Ties do not constitute an override. Cases of disagreement between the program faculty and either the chair, associate chair, or the coordinating committee shall be handled through referenda (see section VI, below).

VI. Meetings

The chair shall be responsible for convening meetings of the coordinating committee and the program faculty on a regular basis during the fall and spring semesters. Typically, the coordinating committee will meet monthly and the program faculty will meet once each semester.

VII. Elections and Referenda

All members of the GPBR faculty are eligible to vote for the chair and associate chair. Election to the chair and associate chair positions requires that at least 60% of the program faculty vote. Election decisions are determined by the majority of votes cast. In the event that no candidate receives a majority, a run-off election will be held between the two candidates for each position who received the highest number of votes. If no candidate receives a majority and the number two and number three candidates are tied for votes, then lots will be drawn by candidates two and three to decide who will run against the number one candidate.

All elections shall be held in the spring semester.

In the event of major disagreements between the program faculty and either the chair, associate chair, or coordinating committee, issues may be decided by a referendum vote. A referendum may be brought forth to the program faculty at any time if at least three members of the program faculty communicate their support for it, in writing, to the coordinating committee. The referendum must be posted to the program faculty within one week of it being brought to the coordinating committee by the minimum of three program faculty members, with a time limit for response of not more than two weeks. A majority of those voting must approve of a referendum for it to pass, and at least 60% percent the program faculty must vote for the results of a referendum to be valid.

VIII. Changes in the Governance Document

Changes to the governance document of the GPBR shall be proposed in writing to the faculty at least two weeks before a meeting of the GPBR faculty at which they will be considered. Provision shall be made for electronic ballots to be cast during a two-week balloting period. A valid vote on proposed changes to the governance document shall require that at least 60% of the GPBR faculty cast a ballot. A majority of those voting at the meeting and electronically must approve of a proposed change for it to pass.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Department of Agricultural and Biosystems Engineering
Davidson Hall
Ames, Iowa 50011-3080

December 27, 2002

Robert C. Brown
Professor, Departments of Mechanical Engineering and Chemical Engineering
Director, Center for Sustainable Environmental Technologies
Iowa State University
286 Metals Development Bldg.
Ames, IA 50011

Dear Dr. Brown:

I have reviewed the proposed graduate major in Biorenewable Resources that you and your colleagues are developing at Iowa State University. I believe it will be an excellent complement to the undergraduate program we are proposing in Biological Systems Engineering in our department, which is designed to train engineers fully grounded in the science of biology for the bio-based industries of the future. I anticipate that many of these undergraduates may like to pursue graduate studies at Iowa State University and could go on into the Biorenewable Resources area. In addition, the Biorenewable Resources graduate study program would be an excellent program in attracting high quality students from outside our university. This program appears to be a great complement to several of the other existing and proposed initiatives in this area, further strengthening our national and international reputation through this new venue of interdisciplinary collaboration.

Our department has several faculty that anticipate being involved in this program through their teaching, research and advising graduate students. They look forward to sharing expertise in each of the areas emphasized, from plant science (seed and grain technology) through production (crop modeling, harvest technology), processing (bioconversion, process engineering), utilization (product design and evaluation) and environmental quality (air and water). As you have indicated in the proposal, we teach several courses which will support this new interdisciplinary degree, and look forward to the expanded demand for these courses.

I enthusiastically endorse the proposed program and look forward to working with you toward its successful implementation.

Sincerely yours,

R. Kanwar

Ramesh Kanwar
Professor and Chair

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Mechanical Engineering Department
2025 Black Engineering Building
Ames, Iowa 50011-2161
515/294-1423

Interoffice Communication

DATE: Wednesday, February 13, 2002

TO: Robert Brown, Professor of Mechanical and Chemical Engineering

FROM: Warren R. DeVries, Professor and Chair of Mechanical Engineering

Warren R. DeVries

SUBJECT: Endorsement of Biorenewable Resources & Technology Graduate Degree Program

The Department of Mechanical Engineering strongly endorses the proposed "Biorenewable Resources & Technology" graduate degree program. I believe this program has at its core, research and discovery in a multidisciplinary area - biorenewables- that is "logical" for Iowa. The proposal has the endorsement of the Mechanical Engineering Curriculum Committee. It has been reviewed and commented on by the Department's Graduate Program Committee with their recommendation to proceed.

This opportunity area will significantly enhance the academic excellence of the University and the Mechanical Engineering Department. Energy - its conversion and efficient use - is one of the two strong limbs of mechanical engineering, and this is an opportunity to grow the strength and reach of this important national and human need. I also believe that this initiative addresses the multidisciplinary opportunities for research that will be key for the success of mechanical engineers in the profession and involved in research, our ME Department at Iowa State, and will provide important benefits to the state and nation.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Chemical Engineering Department
2114 Sweeney Hall **Phone 515-294-0270**
Ames, Iowa 50011-2230 **Fax 515-294-2689**

Interoffice Communication

DATE: January 30, 2002

TO: Robert C. Brown
Chair, Biorenewables Resource Graduate Program Development Committee
Mechanical Engineering Dept.
Black Engineering

FROM: Charles E. Glatz, Professor and Chair
Chemical Engineering
2114 Sweeney

SUBJECT: Departmental approval of proposed graduate program in Biorenewable Resources & Technology

The Chemical Engineering Department and its Curriculum Committee has reviewed and approved the proposed graduate program in Biorenewable Resources & Technology. We have several faculty who are interested in participating in this program. From the description of the program, graduate students from Chemical Engineering would be participating in the Ph.D. minor portion of the program. The proposed program requests no resources from our department beyond those that we currently allocate for teaching existing courses of relevance to the new program. However, our department is exclusively contributing to the teaching of the required laboratory portion of the program (ChE/BR 515L, ChE/BR 525L, ChE/BR 543L, ChE/BR562L). On occasion, we anticipate that one or more of our faculty participating in the program may choose to teach a portion of the fundamentals course in Biorenewable Resources & Technology (BR 501) as part of their usual opportunity to teach graduate courses of interest to them.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Agriculture
Department of Forestry
253 Bessey Hall
Ames, Iowa 50011-1021
Phone 515 294-1458
FAX 515 294-2995

February 8, 2002

Dr. Robert C. Brown
Professor, Mechanical and Chemical Engineering
Director, Center for Sustainable Environmental Technologies
Iowa State University

Dr. Brown:

The department of Forestry strongly endorses the proposed Biorenewable Resources graduate program. If enacted this program will lead the nation in terms of education and research associated biorenewable resources and products.

We are very excited about the program objectives, expected student learning outcomes, and associated research. Forestry is prepared to assist in the development, operation, and growth of this graduate program.

Iowa State University is uniquely qualified to take the lead in this emerging educational program and research area because of its existing products-oriented research entities, excellent staff, and available biorenewable materials.

This graduate program will offer an excellent opportunity to co-join various disciplines in the pursuit of a superior, systems-oriented graduate program in the production and marketing of products such as chemicals, materials, fuels and energy derived from biobased feedstock.

Sincerely,

Steven E. Sunpt
joe

J. Mike Kelly, DEO
Forestry

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Department of Food Science & Human Nutrition
Food Sciences Building

Interoffice Communication

TO: Robert C. Brown, Chair, Biorenewable Resources Graduate Program

CC: Lawrence A. Johnson, FSHN Representative to the Biorenewable Resources Graduate Program

Jean Andersen, FSHN Curriculum chair

FROM: Diane Birt, FSHN Chair

DATE: April 4, 2002

RE: Interdepartmental Biorenewable Resources Graduate Program

The Department of Food Science and Human Nutrition (FSHN) faculty and the FSHN Curriculum Committee have discussed the proposal to establish an interdepartmental graduate program in Biorenewable Resources in dialogues led by Larry Johnson. We completed a formal written vote on the proposal on March 27. Our faculty overwhelmingly voted in favor of the proposal and enthusiastically support the establishment of the interdepartmental program.

Our faculty believes that the proposed M.S. and Ph.D. degrees will be of interest to our students and will provide new and innovative research opportunities for both FSHN faculty and students. We expect several of our faculty to participate in and direct students in this program. Furthermore, we foresee students in the program directed by faculty in other departments to enroll in our courses because our department has a large variety of courses that support this program. We recognize that biorenewable resources is a new dimension of agriculture and it offers considerable promise for improving the economics if Iowa and the nation. It is critical that we train students for employment opportunities in this new field.

We look forward to participating in this important new program and thank you for developing the proposal for this program that will be of interests to students wanting careers in this new field of science and engineering.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Center for Crops Utilization Research
1041 Food Sciences Building
Ames, Iowa 50011-1061
515 294-0160
FAX 515 294-6261

Dr. Robert Brown
Director and Professor
Center for Sustainable Environmental Technologies
Iowa State University
286 Metals Development Bldg.
Ames, IA 50011

13 December 2001

Dear Dr. Brown:

I have reviewed the proposed graduate program in Biorenewable Resources that you and several other faculty have proposed and developed over the last year. I am certain that the graduate studies program in biorenewable resources will be a strongly positive influence on the mission of the Center for Crops Utilization Research (CCUR).

Currently, CCUR supports a number of biorenewable-resource-related research programs, many of which conduct research within our pilot-plant facilities, or are supported by our staff and faculty, or through cost-sharing initiatives. The proposed graduate studies program will directly incorporate ISU students into these projects, increasing student participation in this important and expanding research field. The benefit to the students is hands-on experience with state-of-the-art equipment in cutting-edge facilities. The benefit to CCUR researchers and our funding agencies is the attraction of young minds to this increasingly important area of science, and increasing their participation in projects that work to address many of our society's most pressing problems through the establishment of new, sound technologies. The multi-disciplinary experience will be invaluable to all concerned.

I fully endorse the proposed program and look forward to working with you toward its implementation.

Sincerely,

Lawrence A. Johnson

Dr. Lawrence Johnson
Director and Professor
Center for Crops Utilization Research

IOWA STATE UNIVERSITY
University Extension

Center for Industrial Research
and Service (CIRAS)
College of Engineering
2272 Howe Hall, Suite 2620
Ames, Iowa 50011-2272
515 294-3420
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Email: info@ciras.iastate.edu

Affiliated with
Iowa Manufacturing Extension Partnership

26 December, 2001

Dr. Robert Brown
Director and Professor
Center for Sustainable Environmental Technologies
Iowa State University
286 Metals Development Bldg.
Ames, IA 50011

Dear Dr. Brown,

I have reviewed the proposed graduate program in Biorenewable Resources that you and several other faculty have been developing over the past year and would like to offer CIRAS support to the effort. As you know, CIRAS is managing the Department of Energy's state Industries of the Future (IOF) program. Of the nine targeted industries in the DOE effort, agriculture is the largest sector in Iowa. The primary focus of the agriculture IOF is to develop an Iowa vision and roadmap for biorenewables. Scientists and engineers trained in biorenewables will be critical to this industry if the goals of the program are to be reached in Iowa and in the entire country.

CIRAS is actively working with a number of ag-based companies, providing both training and technical assistance. I believe there is great potential to weave the work of these companies into the biorenewables program. CIRAS also manages the College of Engineering's distance education program. This might be a useful vehicle to extend the program to nontraditional students, both within and out of state.

I endorse the proposed program and look forward to working with you toward its implementation.

Sincerely,

Ronald A. Cox, Ph.D.
Director

Regents Program Review Questions (Majors)

M.S., Biorenewable Resources & Technology
Ph.D., Biorenewable Resources & Technology

1. Need
   a. How will this proposed program further the education and curriculum needs of the students in the discipline?

      A graduate program in *Biorenewable Resources& Technology* will be established that offers students advanced study in the use of plant and crop-based resources in the production of biobased products (fuels, chemicals, materials, and energy). Traditional academic disciplines are not well organized to train engineers and scientists in the emerging biobased products industry. Students must acquire knowledge outside traditional academic disciplines, gain an appreciation of system-level research and development, hone skills for working on teams and communicating with diverse groups of people, and understand the culture of market-driven companies.

   b. How does it further the educational and curriculum needs of other units in the college or university?

      The program is multi-disciplinary and will serve students from a variety of disciplines including engineering, chemistry, agronomy, food science, biochemistry, and microbiology, to name a few. The program is specifically designed to encourage students to obtain co-major graduate degrees in Biorenewable Resources & Technology and a more traditional academic discipline. Thus, students can use the Biorenewable Resources& Technology program to diversify their academic training.

2. Other programs

   a. What programs in this field of study are available in other colleges and universities in Iowa?

      As recently as last year, no comparable programs existed at other universities in the United States. In anticipation of growing national need for engineers and scientists to develop biobased products, the U.S. Department of Energy has recently launched a grants program to encourage formation of such programs at U.S. universities. Iowa State has won two awards to launch training programs in biobased products (the money supports research assistantships). Most other schools are only proposing certificate programs or minor degree programs as cautious entries into this new field, giving us an opportunity to provide academic leadership. No such programs exist at the other Iowa Regent Universities.

b. With what representatives of these programs have you consulted in developing this proposal? Provide a summary of the reactions of each institution consulted as well as the complete text of the response.

Only the three Regent universities in Iowa have science and technology graduate programs that might contemplate adding a comparable program. Representatives from the other two Regent schools were consulted on this issue. Summaries are given below. Full text is provided in Appendix A.

John Rosazza, University of Iowa – no comparable degree program
Rex Montgomery, University of Iowa – no comparable degree program
Alec Scranton, University of Iowa – no comparable degree program
Bill Stigliani, University of Northern Iowa - no comparable degree program

c. In what ways is this proposed program similar to those mentioned in 2a? In what ways is it different or does it have a different emphasis?

No comparable programs with which to compare.

d. How does the proposed program supplement the current programs available?

No comparable programs with which to compare.

e. Has the possibility of some kind of inter-institutional program or other cooperative effort been explored? What are the results of this study?

No. The effort would be premature as the field is in its infancy.

f. List the Iowa institutions in which articulation agreements are being developed for the proposed program.

N/A.

g. Provide the Classification of Instructional Program (CIP) code for the proposed program.

30.9999 Multi/Interdisciplinary Studies

3. Please estimate the enrollment in this program for the next five years as follows:

	1	2	3	4	5
a. Undergraduate	----------not applicable----------				
b. Graduate	5	8	15	25	30

c. On what basis were these estimates made?

Based on preliminary interest expressed by faculty at ISU in our biorenewable resources initiative, we expect up to 30 faculty members to be contributing to this field at its maturity. On average, productive faculty members support about four graduate students. As a conservative estimate, we think one-fourth of these students will opt for a major or co-major in Biorenewable Resources & Technology. Thus, a mature program will probably have about 30 students enrolled (most expected to be enrolled in co-major programs). Growth will depend on availability of extramural funding. Extramural funding is immediately available to help support eight students.

d. What are the anticipated sources of these students?

Students will be recruited among students working with faculty members in traditional academic departments who have research programs related to biorenewable resources. A recruitment program will be put in place designed to recruit additional students to ISU.

4. Please provide any available data or information on employment opportunities available to graduates of this program in Iowa and nationally.

A recent study released by the National Research Council (Biobased Industrial Products, National Academy Press, Washington, D.C., 2000) estimates that one million new jobs would be created in the biobased chemicals industry alone (excludes fuels, materials, and energy) in the next twenty years. Assuming that 2% of this new workforce is technical and managerial, as many as 1000 new jobs appropriate to graduates of this program will become available each year.

5. Are there accreditation standards for this program? If so, please provide a copy of the Accreditation standards.

No.

a. What is the accreditation organization?

N/A.

b. What accreditation timetable is acceptable?

N/A.

6. Does the proposed program meet minimal national standards for the program, e.g., Council of Graduate Schools or other such bodies?

The Council has not reviewed this proposal.

7. Please report any reactions of the Iowa Coordinating Council for Post-High School Education.

   The proposal was submitted to the ICCPHSE on 5/23/02; there were no objections.

Additional Resource Needs

Either question one or question two requires a "yes" answer. In addition to a "yes" response to one of the first two questions, question three and question four should be answered. If applicable, question five should be answered.

1. Will the program require <u>new</u> resources? Yes __X_ No ___
   If "yes," what is the plan to obtain new resources?

   The U.S. Department of Energy has granted ISU funds to support the first three years of this new academic program. Although most of the direct costs of this $375,000 grant are allocated to support graduate students in the program, $21,000 is available to support administration of the program.

   Administrative demands from this graduate program are considerably less than for an academic department because students in this multi-disciplinary program will be assigned home departments in traditional academic departments, which will handle research appointments and most other graduate student matters. The Center for Sustainable Environmental Technologies, one of the centers within the Institute for Physical Research and Technology, will be responsible for program specific forms and procedures.

   Only three new courses will be added as a result of the proposed program in Biorenewable Resources & Technology: a seminar course, a lab course, and a foundations (lecture) course. The seminar course will be integrated with existing seminar series currently offered at ISU; it represents a minor addition to workload of faculty. The laboratory requirement is drawn from four new laboratory courses in biobased products developed by the Department of Chemical Engineering with support from the National Science Foundation; no new faculty time commitment is expected. The foundations course is the only new offering requiring significant new commitment of faculty time. However, instruction of this course will be rotated among several faculty members who will teach it as part of their normal graduate teaching responsibilities. No new faculty resources are sought to support the Biorenewable Resources & Technology Program.

2. Will the program require <u>reallocated</u> resources? Yes ___ No _X__
   If "yes," what is the university's reallocation plan to fund this program?

3. At what <u>level of enrollment</u> will additional resources be required for the program?

   Program enrollment would have to exceed 30 students before current administrative resources would require additional support.

4. Estimate the total costs (or *incremental increases in expenditures*) that may be necessary as a result of the new program for the next three years.

	First Year	Second Year	Third Year
a. Faculty			
b. Graduate Assistants	$79,000	$79,000	$79,000
c. General Expense (supplies)	$800	$800	$800
d. Equipment			
e. Library Resources			
f. New Space Needs (estimated amt. & cost of new and/or remodeled space)			
g. Computer use			
h. Other resources (staff support)	$6,200	$6,200	$6,200
TOTAL(S)	$86,000	$86,000	$86,000

These funds will come from the recent U.S. Department of Energy grant.

5. For programs planning to use external grants, what would be the effect of the grant termination?

The major impact would be loss of support for graduate student stipends. However, opportunities for student support to study biorenewable resources through individual faculty grants and contracts are increasing rapidly. Both the U.S. Department of Energy and the U.S. Department of Agriculture are expanding their research efforts in this new field; ISU has been particularly successful in attracting new funds in this field. The impact on administering this program would be minimal as the Center for Sustainable Environmental Technologies already has both research and educational missions in biorenewable resources, which gives it some flexibility in use of its current administrative resources.

Responses from other Regent Institutions

Date: Thu, 1 Nov 2001 09:11:46 -0800
To: Robert C Brown <rcbrown@iastate.edu>
From: John Rosazza <john-rosazza@uiowa.edu>
Subject: Re: program duplication question
Cc: rex-montgomery@uiowa.edu, alec-scranton@uiowa.edu

Robert:

Likewise, it was good seeing you two days ago in Des Moines at the BioCycle conference and the BBC symposium. I know of no official, multi-disciplinary graduate program in biorenewable resources. Perhaps the closest thing would be in the Center for Biocatalysis and Bioprocessing training programs supported by NIH, NSF Training Grants and CBB Fellowships. The focus is broader - encompasing many aspects of biocatalysis, biotransformation and bioremediation - the B-3! We offer no academic degree in my opinion specifically targeted towards training students in biobased products. I am copying this to Rex Montgomery and Dr. Alec Scranton, who is Head of Chemical and Biochemical Engineering too. These are two other individuals on our campus who could likely comment to your request.

I hope that this and other responses from Alec and Rex will be useful. Good luck as you develop your program.

Jack

From: "Montgomery, Rex" <rex-montgomery@uiowa.edu>
To: Robert C Brown <rcbrown@iastate.edu>
Cc: alec-scranton@uiowa.edu
Subject: RE: program duplication question
Date: Fri, 2 Nov 2001 09:58:25 -0600
X-Mailer: Internet Mail Service (5.5.2650.21)

Gentlemen,
I am responding to the memos of Bob and Jack as well as posing some questions to them concerning the BBC, so Alex may get more than he needs. I know of no Regential UI program that covers the areas of study proposed for ISU. This is not to say that the UI should not propose such a graduate track to represent this valuable biotechnology area. The CBB has this in practice but not Regential approval of a track. Has anyone thought of the advantages of both universities having a single track with students benefiting from the expertise of a combined UI and ISU faculty?

Rex

Rex Montgomery.BSc PhD DSc MRSC
Professor of Biochemistry.
University of Iowa,
Iowa City, IA 52242
Phone 319-335-7897
FAX 319-335-9570
rex-montgomery@uiowa.edu

Date: Fri, 02 Nov 2001 15:20:24 -0600
From: Alec Scranton <abscran@engineering.uiowa.edu>
Organization: University of Iowa
X-Mailer: Mozilla 4.78 [en] (Windows NT 5.0; U)
X-Accept-Language: en
To: John Rosazza <john-rosazza@uiowa.edu>
CC: Robert C Brown <rcbrown@iastate.edu>, rex-montgomery@uiowa.edu,
alec-scranton@uiowa.edu
Subject: Re: program duplication question

Jack, Robert, Rex:

As you have all indicated, a number of graduate students at the University of Iowa do, of course, complete research projects in the production of chemicals, polymers, *etc* which are derived from renewable and natural resources, although they do not get a degree with the title "Biorenewable Resources". A multidisciplinary activity such as this can survive and thrive within the context of the existing departments, without the creation of a new graduate program, and I have not heard of any movement to create a new degree program here. I hope that the lack of a degree program would not imply a low level of activity since the production of chemical and materials from renewable feedstocks is a major theme in many departments at the University of Iowa.

There is a department and a degree program entitled "Medicinal and Natural Products Chemistry" at the University of Iowa would have some overlap with the proposed biorenewable resources program since it deals with chemicals and pharmaceuticals derived from natural products.

I hope that my comments are useful.

Alec

Date: Tue, 06 Nov 2001 16:02:31 -0600
From: William Stigliani <william.stigliani@uni.edu>
Subject: Re: comparable programs at UNI
To: Robert C Brown <rcbrown@iastate.edu>
X-Mailer: Mozilla 4.76 [en] (Win98; U)
X-Accept-Language: en

Hello Bob:
You are correct; UNI does not offer academic degrees in the multi-disciplinary field of biorenewable resources. Thus, you may go forward with the Regents as planned.

Best wishes,
Bill Stigliani
Director, CEEE

APPENDIX B. EVALUATION RUBRIC AND IAB RESPONSES

Rubric used by committee to evaluate BRT graduate program.

Category	Metric	Exceeds Expectations	Meets Expectations	Needs Improvement
Curriculum	Graduation Requirements	Students obtain course work that provides both breadth and depth in subjects relevant to biobased products.	Students obtain course work that significantly expands their knowledge beyond traditional curricula	Students obtain course work in biorenewables that is only marginally superior to traditional curricula
	Core Required Courses	Core courses offered every semester.	Core courses regularly offered.	Core courses not regularly offered.
	Core Technical Electives	One or more new courses offered every year.	Selection of specialized courses in biorenewables.	Only traditional courses are available to meet this requirement.
	Seminar Program	Regular seminars cross many disciplines.	Regular offering of relevant seminars.	Limited offering of relevant seminars.
	Faculty participation	Courses are being taught by faculty from COE, COA, and LAS.	Broad but unevenly distributed across colleges.	Teaching burden falls to one or two faculty.
Students	Growth of Program	Number of students increasing by >10% per year	Number of students increasing by 5-10% per year	Number of students stagnant or declining
	Interdisciplinary	Students are well represented from COE, COA, and LAS.	Students from many disciplines although weighted toward one college.	Students come mostly from two or three departments.
	Quality of Work	With few exceptions, both Ph.D. and M.S. graduates have submitted papers for publication.	Virtually all Ph.D. graduates and most M.S. graduates have submitted papers for publication.	Few instances of graduating students publishing their research results.
	Relevance of Theses/ Dissertations	Virtually all research topics readily identifiable as relevant to biorenewables.	Most research topics readily identifiable as relevant to biorenewables.	Topics difficult to differentiate from those expected from traditional disciplines.
Administration	Management	In addition to faculty leader and staff support, wider participation of faculty in oversight of program.	Faculty leader and staff support associated with graduate program.	Little evidence of faculty and staff time devoted to managing graduate program.
	Student Recruitment	Multiple approaches to student recruitment.	Plan for recruitment with evidence that it is being executed.	No plan in place to recruit students.
	Communication	Website updated frequently. Students receive added-value through communication network.	Communication tools include website and regular e-mail. contact.	No mechanism for connecting faculty and students to program.
	Program Sustainability	New avenues for program growth being developed.	Funds available for sustaining program.	Insufficient funds for student recruitment or support of staff.

Committee feedback for each metric.

Category	Metric	Exceeds Expectations	Meets Expectations	Needs Improvement	TOTAL
Curriculum	Graduation Requirements	30.8%	69.2%	0.0%	**100.0%**
	Core Required Courses	14.3%	78.6%	7.1%	**100.0%**
	Core Technical Electives	25.0%	75.0%	0.0%	**100.0%**
	Seminar Series	38.5%	61.5%	0.0%	**100.0%**
	Faculty Participation	41.7%	58.3%	0.0%	**100.0%**
Students	Growth of Program	45.5%	36.4%	18.2%	**100.0%**
	Interdisciplinary	23.1%	69.2%	7.7%	**100.0%**
	Quality of Work	0.0%	30.8%	69.2%	**100.0%**
	Relevance of Theses/Dissertation	46.2%	53.8%	0.0%	**100.0%**
Administration	Management	41.7%	58.3%	0.0%	**100.0%**
	Student Recruitment	50.0%	50.0%	0.0%	**100.0%**
	Communication	75.0%	25.0%	0.0%	**100.0%**
	Program Sustainability	30.0%	40.0%	30.0%	**100.0%**

Course Title	Course Number	Credit Hours	Prerequisites	Technical Barrier Area			
				Pl Sci	Prod	Proc	Util
CORE REQUIRED COURSES							
Fundamentals of Biorenewable Resources	BRT 501	3		X	X	X	X
Fundamentals of Biorenewable Resources	BRT 501	3		X	X	X	X
Biobased Products Seminar	BRT 506A	1		X	X	X	X
Biobased Products Seminar	BRT 506B	R		X	X	X	X
Thermochemical Processing of Biomass	BRT 535L	1				X	X
Special Topics in Biorenewable Resources	BRT 590	var.		X	X	X	X
Biorenewable Resources Laboratory	BRT 591L	var.		X	X	X	X
Research	BRT 699	var.		X	X	X	X
CORE ELECTIVE COURSES							
Modeling and Controls for Agricultural Systems	A E 403/503	3	A E 363, Math 267		X		
Instrumentation for Agricultural and Biosystems Engineering	A E 404/504	3	A E 363 or Cpr E 210		X		
Food Process Engineering	A E 551	3	Ch E 357 or M E 436			X	
Grain Processing and Handling	A E 569	3	A E 216		X		
Microbial Systems Engineering	A E 573	3	Chem 167, Ch E 356 or E M 378			X	
Forage Crop Management	Agron 334	3	Agron 114		X		
Global Change	Agron 404/504	3	Four courses in physical or biological sciences or engineering				X
Introduction to Plant Breeding	Agron 421	3	Agron 320 or Biol 313	X			
Soil Microbial Ecology	Agron 485/585	3	Agron 154 or 402, Micro 201			X	
Crop Growth and Development	Agron 501	3	Agron 114, Math 140, Chem 163, Biol 101		X		
Crop Physiology	Agron 516	3	Biol 330		X		
Plant Genetics	Agron 527	3	Gen 410	X			
Advanced Crop Management	Agron 542	2	Agron 230		X		
Biochemistry of Procaryotes	BBMB 403	3	Micro 302 , Chem 332, BBMB 301	X			
Biochemistry I	BBMB 404	3	Chem 332	X			
Biochemistry II	BBMB 405	3	BBMB 404	X			
Techniques in Biochemical Research	BBMB 411	3	BBMB 404 or 501, Chem 210 or 211	X			
Physical Biochemistry	BBMB 451	2	Chem 331, Phys 112 or 222	X			
Comprehensive Biochemistry I	BBMB 501	4	Chem 210 or 211 and 322 and 332	X			
Comprehensive Biochemistry II	BBMB 502	4	BBMB 501	X			
Structure and Reactivity of Biomolecules	BBMB 531	1	Chem 332	X			
Carbohydrate Chemistry	BBMB 622	2	BBMB 404 or 501	X			
Plant Anatomy	Biol 454	4	Biol 212L	X			
Principles of Environmental Engineering	C E 326	3	Chem 167 or 178, Math 166, E M 378				X
Environmental Engineering Chemistry	C E 420/520	3	Chem 177 and 178, Math 166				X
Environmental Biotechnology	C E 421/521	3	C E 326			X	
Water Pollution Control Processes	C E 522	3	C E 521			X	

** Plant Science, Production, Processing, Utilization*

Course Title	Course Number	Credit Hours	Prerequisites	Technical Barrier Area			
				Pl Sci	Prod	Proc	Util
Air Pollution	C E 524	3	Two of: Phys 221, Chem 178, and either Math 166 or 3 credits in Stat				X
Industrial Wastewater and Resource Recovery	C E 525	3	Two courses in Chem, Math 166			X	
Separations	Ch E 358	3	Ch E 310 and 357			X	
Chemical Reaction Engineering	Ch E 382	3	Ch E 310, 381 and 357			X	
Biochemical Engineering	Ch E 415/515	3	Ch E 357, 382			X	
Process and Plant Design	Ch E 430	4	Ch E 358 and 382			X	
Polymeric Biomaterials	Ch E 542	3	Chem 331 or a polymers class				X
Bioseparations	Ch E 562	3	Ch E 357			X	
Special Topics	Ch E 595	2 or 3	Permission of instructor			X	X
Instrumental Methods of Chemical Analysis	Chem 316	2	Chem 211, 211L and Math 166			X	
Bioinorganic Chemistry	Chem 503	2	Chem 402 or BBMB 405			X	
Advanced Quantitative Analysis	Chem 511	3	Chem 316 and 316L			X	
Analytical Molecular and Atomic Spectroscopy	Chem 513	3	Chem 316, 316L, 322 and 322L			X	
Analytical Separations	Chem 516	3	Chem 316, 316L, 322 and 322L			X	
Spectrometric Identification of Organic Compounds	Chem 572	3	Chem 332			X	
Selected Topics in Organic Chemistry	Chem 632	1 or 2	Chem 537				X
Rural, Urban and Regional Economics	Econ 376	3	Econ 101				X
Firms, Markets and Industry Structure	Econ 415	3	Econ 301				X
Managerial Economics	Econ 431	3	Econ 301				X
Agricultural, Food and Trade Policy	Econ 460/560	3	Econ 301 or 501				X
Intermediate Environmental and Resource Economics	Econ 480/580	3	Econ 301				X
Advanced Environmental Economics	Econ 581	3	Econ 501 or 601				X
Advanced Topics in Agricultural Economics	Econ 640	3	Econ 603				X
Advanced Resource Economics	Econ 680	3	Econ 603				X
Environmental Systems	EEOB 581	4	Biol 212 or Micro 201, Chem 164, 167 or 178, Math 165 or 181				X
Environmental Biogeochemistry	EEOB 583	4	Biol 381 and EnSci 402 or Ia LL 402I				X
Natural Resource Conservation Engineering	EnSci 531	3	E M 378 or Ch E 356		X		
Environmental Impact Assessment	EnSci 574	3	Four courses in natural, biological, or engineering sciences and senior or above classification				X
Ecosystem Ecology	EnSci 584	3	Combined 12 credits in biology and chemistry		X		X
Energy and the Environment	Env S 324	3					X
Issues in Sustainable Agriculture	Env S 450	2			X		
Food Chemistry	FS HN 311	4	FS HN 203, Chem 231 and 231L or 331 and 331L; BBMB 301			X	
Unit Operations in Food Processing	FS HN 351	3	A course in calculus and Phys 106			X	
Food Processing	FS HN 471	3	Micro 201 or 302; Chem 163; Phys 106			X	
Food Processing Laboratory	FS HN 472/572	2	FS HN 351, 471 / FS HN 503 or equivalent			X	
Advanced Food Science - Chemistry	FS HN 502	1	3 credits in organic chemistry			X	
Advanced Food Science - Processing	FS HN 503	1	3 credits each in physics and mathematics			X	

** Plant Science, Production, Processing, Utilization*

Course Title	Course Number	Credit Hours	Prerequisites	Technical Barrier Area			
				Pl Sci	Prod	Proc	Util
Advanced Food Science - Microbiology	FS HN 504	1	3 credits each in microbiology and organic chemistry			X	
Food Enzymology	FS HN 610	3	FS HN 311 or 411 or 502 or BBMB 404			X	
Food Lipids	FS HN 612	3	FS HN 311 or 411 or 502 or BBMB 404			X	X
Food Proteins	FS HN 613	3	FS HN 311 or 411 or 502 or BBMB 404			X	X
Carbohydrates in Foods	FS HN 614	3	FS HN 311 or 411 or 502 or BBMB 404			X	X
Advanced Food Microbiology	FS HN 626	3	FS HN 420 or 421 or 504			X	
Wood Anatomy and Fiber Analysis	FOR 480	3	For 280	X			
Chemical Conversion of Wood	FOR 481	3	For 280			X	X
Wood Deterioration and Preservation	FOR 483	3	For 280			X	X
Lignocellulosic Composite Materials	FOR 485	3	For 280			X	X
Moisture Interactions of Lignocellulosic Materials	FOR 486	3	For 280			X	
Physical Properties of Wood	FOR 487	4	For 280			X	
Molecular Genetics	Gen 411	3	Biol 314	X			
Molecular Biology for Computational Scientists	Gen 495	3		X			
Biotechnology in Agriculture, Food, and Human Health	GDCB 508	3	Biol 211 and 212			X	X
Transmission Genetics	GDCB 510	3	Gen 410	X	X		
Molecular Genetics	GDCB 511	3	Biol 313 and BBMB 405	X	X		
Plant Metabolism	GDCB 513	2	Biol 330, Phys 111, Chem 331	X	X		
Genetic Engineering	GDCB 520	3	Gen 411 or BBMB 405	X			
Introduction to Molecular Biology Techniques	GDCB 542	1	Graduate classification			X	
Systems Engineering and Analysis	I E 565	3	Graduate classification in engineering				X
Applied Systems Engineering	I E 566	3	I E 565				X
Internal Combustion Engines	M E 445	3	M E 332, credit or enrollment in M E 436				X
Fluidized Bed Processes	M E 539	3	M E 436 or Ch E 357			X	
Advanced Combustion	M E 542	3	M E 332 or Ch E 381				X
Thermal Systems Design	M E 545	3	M E 436			X	
Microbial Genetics	Micro 402/502	3	Micro 302, Biol 313			X	
Procaryotic Diversity and Ecology	Micro 430/530	3	Micro 302			X	
Bacterial-Plant Interactions	Micro 477/577	3	3 credits in microbiology or plant pathology			X	
Controversies in Renewable Resource Management	NREM 460	3	NREM 120 and A Ecl 312 or NREM 301		X		
Landscape Change and Conservation	NREM 465/565	3	L A 202		X		
Agroecosystem Analysis	SusAg 509	3	6 credits in social sciences, 6 credits in natural, biological or engineering sciences and senior or above classification		X		
Integrated Crop and Livestock Production Systems	SusAg 515	3	Sus Ag 509		X		
Ecologically Based Pest Management Strategies	SusAg 530	3	Sus Ag 509		X		
Organizational Strategies for Diversified Farming Systems	SusAg 546	3	Sus Ag 509		X		
Society and Technology in Sustainable Food Systems	SusAg 610	3	Sus Ag 509		X		

** Plant Science, Production, Processing, Utilization*

APPENDIX D. LIST OF CURRENT BRT STUDENTS

Last Name	First Name	MI	Degree Sought	Degree Option	Major Professor	Home Dept	1st Major	2nd Major	BRT Classification	Term Enrolled in BRT	Expected Graduation
Aerts	Dirk		NA	NA	Nikolau	BBMB	AgSp	BRT	Exchange student	F 2005	NA
Bennett	Albert	S	Ph.D.	Thesis	Anex	A B E	A E	BRT	Co-Major	S 2004	S 2007
Bents	Scott	C	M.S.	Thesis	Brown	M E	M E	BRT	Co-Major	1 2005	1 2006
Bootsma	Jason	A	Ph.D.	Thesis	Shanks, B.	C B E	CH E		Minor	F 2003	F 2005
De Baere	Miet	I	NA	NA	Wurtele	GDCB	AgSp	BRT	Exchange student	F 2005	NA
Deza	Mirka		M.S.		Nelson	M E	M E	BRT	Co-Major	S 2005	TBD
Duangmanee	Thanapong		Ph.D.	Thesis	Sung	CCE E	C E	BRT	Co-Major	S 2003	F 2006
Hancock	Abigail	S	M.S.		Anex	C B E	CH E	BRT	Co-Major	F 2004	TBD
Ho	Jae Ho		Ph.D.	Thesis	Sung	CCE E	C E	BRT	Co-Major	S 2003	F 2005
Isci	Asli		Ph.D.		Anex	A B E	A E	BRT	Co-Major	S 2005	TBD
Johnson	Carter	D	Ph.D.	Thesis	Stokke	NREM	FOR	BRT	Co-Major	F 2003	F 2005
Jones	Samuel	T	Ph.D.	Thesis	Heindel	M E	M E	BRT	Co-Major	S 2005	S 2007
Kaplan	Sara		Ph.D.		Anex	A B E	SusAg	BRT	Co-Major	F 2005	TBD
Li	Ke		Ph.D.		Brown	M E	M E	BRT	Co-Major	F 2004	TBD
Lysenko	Steven	G	M.S.	Thesis	Brown	M E	M E	BRT	Co-Major	S 2005	S 2006
Mbaraka	Isa	K	Ph.D.		Shanks, B.	C B E	CH E		Minor	1 2003	F 2005
Nelson	Nathan		M.S.		Brown	M E	M E	BRT	Co-Major	1 2005	TBD
Oshel	Reed	E	Ph.D.		Verkade	CHEM	CHEM	BRT	Co-Major	F 2004	TBD
Schmitz	John	F	M.S.	Thesis	Myers	FSHN	F S	BRT	Co-Major	S 2005	F 2006
Timmer	Kevin	J	Ph.D.	Thesis	Brown	M E	M E	BRT	Co-Major	F 2004	1 2006
Vermoesen	Elke		NA	NA	Ellis	CCE E	EngSp	BRT	Exchange student	F 2005	NA
Wallace	Mark	G	M.S.		Brown	M E	M E	BRT	Co-Major	F 2005	TBD
Xu	Ming		Ph.D.	Thesis	Brown	M E	M E	BRT	Co-Major	F 2003	F 2006

APPENDIX E. LIST OF BRT GRADUATES

Last Name	First Name	MI	Degree Sought	Degree Option	Major Professor	Home Dept	1st Major	2nd Major	BRT Classification	Term Enrolled in BRT	Term of Graduation
Brown	Nathan	R	M.S.	Thesis	Brown	M E	M E	BRT	Co-Major	S 2003	S 2004
Brue	Colin	A	M.S.	Non-thesis	Brown	M E	M E	BRT	Co-Major	F 2003	S 2005
Emsick	Nathan	A	M.S.	Thesis	Brown	M E	M E	BRT	Co-Major	S 2003	1 2004
Lahr	Daniel	G	Ph.D.	Thesis	Shanks, B.	C B E	CH E		Minor	F 2003	F 2004
Matthews	Tom	A	Ph.D.	Dissert	Richard	A B E	BRT		Major	F 2003	S 2004
Ogletree	Alison	L	M.S.	Thesis	Anex	C B E	CH E	BRT	Co-Major	F 2003	1 2004
Riggs	Seth	S	M.S.	Thesis	Heindel	M E	M E	BRT	Co-Major	F 2003	1 2004
Ritzert	Joseph	A	M.S.	Thesis	Brown	M E	M E	BRT	Co-Major	S 2003	S 2004

Last Name	First Name	MI	Title	Home Department	College
Anex	Robert	P.	Associate Professor	Agricultural & Biosystems Engineering	AG / ENGR
Battaglia	Francine		Associate Professor	Mechanical Engineering	ENGR
Bobik	Thomas	A.	Associate Professor	Biochemistry, Biophysics & Molecular Biology	AG / LAS
Brown	Robert	C.	Professor	Mechanical Engineering	ENGR
Brumm	Thomas	J.	Assistant Professor	Agricultural & Biosystems Engineering	AG / ENGR
Burns	Robert	T.	Associate Professor	Agricultural & Biosystems Engineering	AG / ENGR
Colletti	Joe	P.	Associate Professor	Natural Resource Ecology & Management	AG
DiSpirito	Alan	A.	Associate Professor	Biochemistry, Biophysics & Molecular Biology	AG / LAS
Duffy	Michael	D.	Professor	Economics	AG / LAS
Ellis	Timothy	G.	Associate Professor	Civil, Construction & Environmental Engineering	ENGR
Fales	Steven	L.	Professor	Agronomy	AG
Gallagher	Paul	W.	Associate Professor	Economics	AG / LAS
Glatz	Charles	E.	Professor	Chemical & Biological Engineering	ENGR
Haddad	Monica		Assistant Professor	Community & Regional Planning	DES
Hall	Richard	B.	Professor	Natural Resource Ecology & Management	AG
Hammond	Earl	G.	University Professor Emeritus	Food Science & Human Nutrition	AG
Heindel	Theodore (Ted)	J.	Associate Professor	Mechanical Engineering	ENGR
Henning	Stanley	J.	Assistant Professor	Agronomy	AG
Hurburgh	Charles	R.	Professor	Agricultural & Biosystems Engineering	AG / ENGR
Jane	Jay-Lin		Professor	Food Science & Human Nutrition	AG
Johnson	Lawrence	A.	Professor	Food Science & Human Nutrition	AG
Khanal	Samir	K.	Clinician / Collaborating Faculty	Civil, Construction & Environmental Engineering	ENGR
Kong	Song-Charng		Assistant Professor	Mechanical Engineering	ENGR
Kraus	George	A.	University Professor	Chemistry	LAS
Larock	Richard	C.	University Professor	Chemistry	LAS
Liebman	Matthew	Z.	Professor	Agronomy	AG
Lummus	Rhonda	R.	Associate Professor	Logistics Operations & Management Information Systems	BUS
Miranowski	John	A.	Professor	Economics	AG / LAS

Last Name	First Name	MI	Title	Home Department	College
Moore	Kenneth	J.	Professor	Agronomy	AG
Myers	Deland	J.	Professor	Food Science & Human Nutrition	AG
Nelson	Ron	M.	Professor	Mechanical Engineering	ENGR
Nikolau	Basil	J.	Professor	Biochemistry, Biophysics & Molecular Biology	AG / LAS
Olafsson	Sigurdur		Assistant Professor	Industrial & Manufacturing Systems Engineering	ENGR
Pometto	Anthony	L.	Professor	Food Science & Human Nutrition	AG
Reilly	Peter	J.	Distinguished Professor	Chemical & Biological Engineering	ENGR
Shanks	Brent	H.	Associate Professor	Chemical & Biological Engineering	ENGR
Shanks	Jacqueline	V.	Professor	Chemical & Biological Engineering	ENGR
Stokke	Douglas	D.	Assistant Professor	Natural Resource Ecology & Management	AG
Sundararajan	Sriram		Assistant Professor	Mechanical Engineering	ENGR
Sung	Shih-wu		Associate Professor	Civil, Construction & Environmental Engineering	ENGR
van Leeuwen	Johannes (Hans)		Professor	Civil, Construction & Environmental Engineering	ENGR
Verkade	John		University Professor	Chemistry	LAS
Wang	Tong		Assistant Professor	Food Science & Human Nutrition	AG
Wurtele	Eve	S.	Professor	Genetics, Development & Cell Biology	AG / LAS