Department of
Agricultural and Biological Engineering
University of Illinois at Urbana-Champaign

Strategic Plan 2006-2011

June 15, 2006
[updated March 2007]
Version 1.6

"We are in the business of empowering human capacity with knowledge and wisdom."

"Our mission is to integrate life and engineering for enhancement of complex living systems."

Table of Contents

Department of Agricultural and Biological Engineering
University of Illinois at Urbana-Champaign
Strategic Plan 2006-2011
June 15, 2006
[updated March 2007]

Section I: Overview

Agricultural Mechanization has been ranked as one of the greatest engineering achievements of the 20th century by the National Academy of Engineering. Agricultural engineering played a vital role in that transformation. Many other traditional areas of agricultural engineering, such as soil and water, post-harvest and value-added processing, and structures and environment, have also made remarkable impacts to the agricultural production, the food industry, and environmental stewardship. Our department is transforming into a future bio-based engineering and technology mindset and is defining a new culture that will guide our future for the next 25 years.

To build on the past success and to further enhance the ability of the "agricultural engineering" discipline in its contribution to an evolving system including agriculture, food, environment, and energy, the department has made a strategic decision to adopt a more holistic approach as depicted by its relatively new name of *"Agricultural and Biological Engineering (ABE)."* Figure 1 describes this new vision.

In this vision, the land grant functions of teaching, research, and extension education as well as the faculty responsibility of service (including economic development) will continue. The overarching mission is to *"integrate life and engineering for enhancement of complex living systems."* Engineering is a process of design under constraints. The task of design is to systematically and computationally assemble and integrate resources to achieve certain operational and performance goals. Traditionally, engineering design in our discipline has been to enable and facilitate system operations that contain biological processes (this is the task of "bringing engineering to life"). Therefore, the biological processes and the knowledge of life (i.e. biological) sciences have been considered as "constraints" or "requirements." In our new vision, life and engineering sciences are developed, applied, and integrated for analyzing and designing bio-based systems (the concept of "integrating life and engineering," i.e., using life sciences as resources for engineering work and vice versa). The overarching goal of agricultural and biological engineering work is to "*enhance complex living systems*" involving humans, plants, animals, and microorganisms within the context of *agriculture, food, environment, and energy*.

The relevant domains of ABE (as opposed to human health emphasized biomedical engineering) include Bio-Based Processing and Production Systems; Biomass and Renewable Energy; Precision and Information Agriculture; Agricultural and Biosystems Management; Agricultural Safety and Health; Food Quality and Safety; Environmental Stewardship; Land and Water Resources; Spatially Distributed Systems; Structure and Facilities for Living Systems; Indoor Environmental Control; Bio-sensors, Bio-instrumentation, Bio-informatics, and Bio-nanotechnology; Intelligent Machinery Systems; Automation of Biological Systems; and Advanced Life Support Systems. The key to the successful achievement of this vision lies in faculty expertise, as well as research and educational activities in the areas of automation, culture, environment, and systems (i.e. the ACESys paradigm). Therefore, a long-term goal of the department is to build a faculty that will provide the overall department with complete and complementary expertise, as well as conduct research and educational programs following the ACESys paradigm.

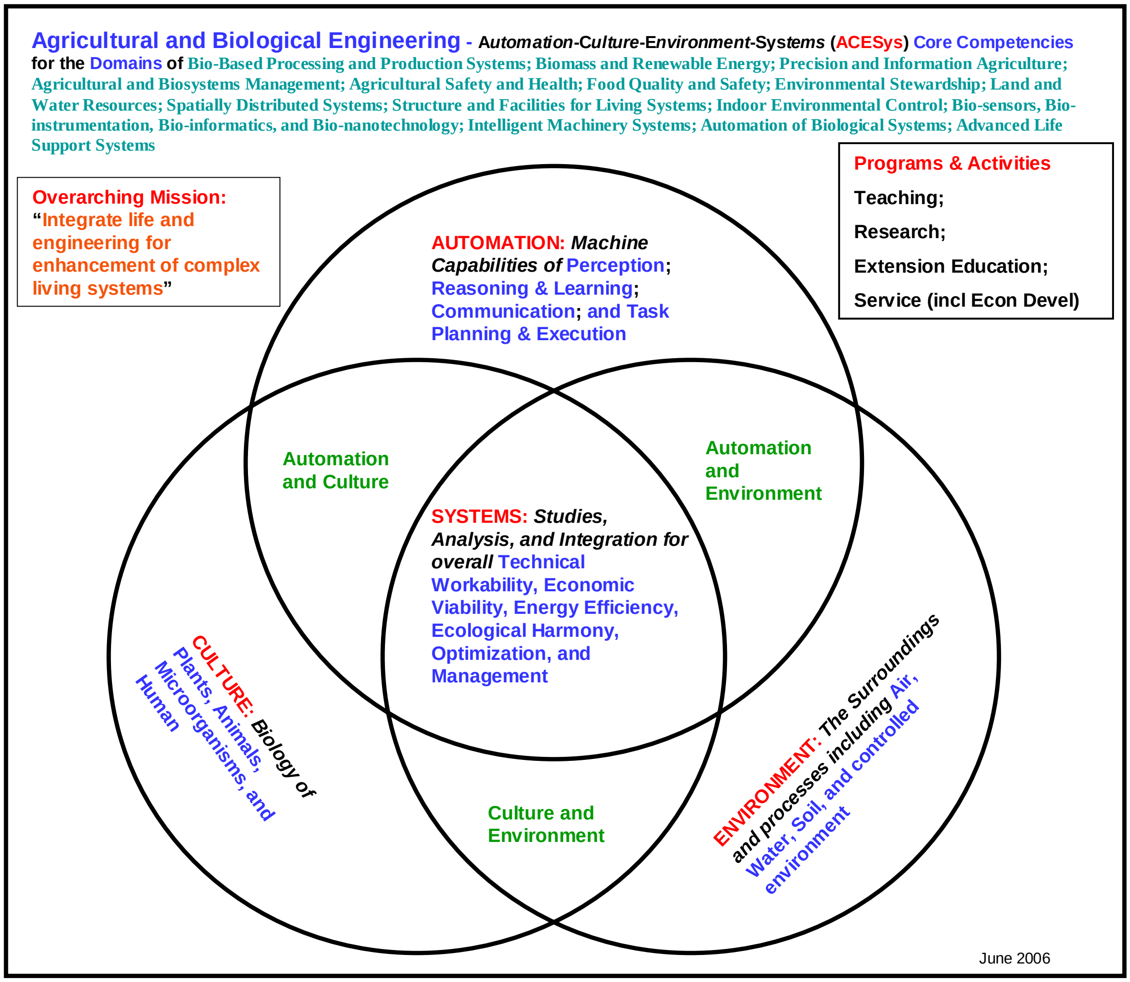

Figure 1. Vision of the future for Agricultural and Biological Engineering.

Automation deals with information processing and task execution related to a system's operation. The purpose of automation is to equip engineering systems with human-like capabilities of perception, reasoning/learning, communication, and task planning/execution. Commonly seen automation topics are instrumentation, control, computerization, mechanization, modeling, machine vision, robotics, artificial intelligence, etc.

Culture includes the factors and practices that can directly describe and/or modify the growth and development of biological objects. The cultural factors, such as morphological and physiological conditions as well as genetic expressions are important in monitoring growth, development, and functions of biological objects. The cultural practices may include operations which directly alter biological states and activities.

Environment encompasses the surroundings and processes of biological objects, which consist of climatic and nutritional, as well as structural/mechanical conditions. Understanding, delivery, and control of environmental factors have been perceived as a major engineering challenge in agricultural production and bio-processing.

Systems analysis and integration is a methodology that starts with the definition of a system and its goals, and leads to the conclusion regarding the system's workability (i.e. technical feasibility and practicality), productivity, reliability, and other performance indicators for decision support purposes. The success of systems analysis relies on the effective use of information. Two key resources in systems analysis are: (1) information about individual system components as well as their interrelationships and (2) methods of information gathering and processing for creating value-added information. In the past, agricultural activities mainly included on-farm production of plants and animals. Recently, systems approach to studying agriculture has required that the entire food system (including the production of fresh materials to the consumption by end-users), the impact to environment, and effective use of energy be taken into consideration. Commonly investigated system level question about the food and agricultural system is the system's impact on the 6 E's: *Economics, Environment, Energy, Ecology, Efficiency, and Education*.

The synergy of the capacities in automation, culture, environment, and systems will position the ABE Department as a major contributor to the achievement of the College of ACES's vision of becoming "globally preeminent and locally relevant," as well as the College of Engineering's vision of being "the standards of excellence by which all other engineering schools measure themselves." Currently, the ABE Department has faculty, with strengths in various aspects of ACESys. The integration of biological, physical, and chemical sciences with engineering and technology provides a powerful platform for addressing systems level issues relevant to an increasingly complex agricultural and food system.

Section II: Strategic Intent: Mission, Vision, Principles, and Themes

Mission

We *integrate life and engineering for enhancement of complex living systems* by providing student-centered educational experiences in engineering and systems management, by conducting high impact research, and by delivering value-added information, knowledge, and wisdom.

Vision

We will *be the best agricultural and biological engineering department* in teaching, research, and outreach, while integrating biology and engineering and maintaining a collegial environment that emphasizes professional and personal development.

Guiding Principles

We are in the business of *empowering human capacity with knowledge and wisdom*. In everything we do, we value:

- Excellence
- Integrity and Ethics
- Creativity and Innovation
- Science-Based Scholarship
- Inclusiveness and Collegiality

Strategic Themes and Intent

We define being “great” and “the best” based on both quantitative and qualitative measures as follows:

- Instructional units (and evaluations) per faculty FTE
- Peer-reviewed journal publications per faculty FTE
- Citations per faculty FTE
- Extramural funds per faculty FTE
- Extension and outreach deliverables and products per faculty FTE
- Do good science and generate long-term sustained impact
- Globally pre-eminent and locally relevant
- Successful implementation of diversity with a solid core
- Students compete favorably in the market place (including faculty and leadership positions)
- High caliber people are interested in joining or being associated with the department
- Strong industry support and clientele satisfaction
- Unique programs that are highly valued
- Leadership in teaching, outreach, research, service, and economic development
- Excellent national and international reputation
- Effective integration of multi-disciplinary, multi-functional, and multi-regional programs and activities

Section III: Department of Agricultural and Biological Engineering Planning Strategy

Competitive Benchmark Analysis

Our benchmark units/institutions are:

Department of Biological and Agricultural Engineering, Texas A&M University
Department of Agricultural and Biological Engineering, Purdue University
Department of Biological and Agricultural Engineering, University of California, Davis
Department of Biological and Environmental Engineering, Cornell University

The undergraduate and graduate programs in the above departments have been highly ranked by the *U.S. News and World Report* in recent years. Our undergraduate and graduate programs have been ranked among the top five for many years. Most recently, our undergraduate program was ranked 1st in the 2007 America's Best Colleges edition of *U.S. News and World Report*.

Strategic Analysis

Change in "Agricultural Engineering" has been a national (and international) trend in recent years. The change has been viewed as inevitable and necessary by the leaders and practitioners in this disciplinary area. Most changes have occurred in academic departments and in our professional societies (such as the American Society of Agricultural and Biological Engineers, ASABE). At this time, in the U.S., there is no academic department that carries the simple name of "Agricultural Engineering." Almost all the new names of academic departments contain the term "biological" or the prefix "bio." The change is still on-going and in large scale. During the process of change, both inspiration and concerns have been generated because the process has brought about both new opportunities and expected confusion.

For many years in the past, the agricultural engineering discipline was best described by four distinct sub-areas: Power and Machinery, Electrical Power and Processing, Soil and Water, and Structure and Environment. The recent emphases are biology, environment, information, food, resources, automation, systems, and nanotechnology. While these new emphases will continue, visionary leaders in the discipline have started addressing the needs of flexibility, globalization, customer centered approach and satisfaction, multidisciplinary integration, life-long learning, and leadership development.

The factors and environments that influence the change have been:

- Clientele and stakeholders
- Marketplace and industries
- Land Grant missions and government policies
- Accreditation requirements for undergraduate engineering programs
- Professional engineering licensing
- University and College strategic plans
- Accountability and reward systems
- Resource availability and funding decisions
- Centralized decision-making versus grassroot empowerment
- Curriculum and faculty development

The examples of changes that have occurred are as follows:

- Academic department name change
- Curriculum change
- Faculty specialty change
- Professional affiliation change
- Research and professional interest change
- Funding model change

The ABE Department at UIUC has experienced all the changes shown above within the last ten years. The membership of our primary professional society, American Society of Agricultural Engineers (ASAE), voted to change its name to the American Society of Agricultural and Biological Engineers (ASABE) in July 2005. ASABE ED-210 (formerly ASAE P-210) is a committee that consists of academic program administrators. During the annual international meeting of ASAE in July 2005, P-210 held a special meeting to discuss the impact of the current proliferation of academic department and program names. It was decided that the names of educational programs would significantly impact five important issues: (1) curriculum and accreditation, (2) student interest and recruiting, (3) placement/industry recognition, (4) ranking and identity, and (5) professional engineer licensing and professional society membership. A list of action items were generated and discussed. They included: (1) select one common program name, (2) develop core elements and common competencies, (3) influence the change of the program names/definition, (4) avoid bioengineering as a name, (5) name programs that are accredited under the ABET agricultural criteria as agricultural engineering and those programs accredited under the proposed biological engineering criteria as biological engineering, and (6) continue the discussion on names and how to influence local politics to achieve a common name. Before the conclusion of the meeting, a motion was passed that P-210 affirm a goal that departments adopt agricultural engineering or biological engineering as their respective accredited undergraduate engineering program names. Our ACESys paradigm will provide a clear vision for future agricultural and biological engineering academic units and programs.

The steps that were taken to develop our strategic plan included:

1. Performed SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis in Fall 2004

2. Distributed the result of SWOT analysis in March 2005

3. Conducted a brainstorming retreat on April 1-2, 2005

4. Summarized information gathered during the retreat in April and May 2005

5. Formed a writing committee to develop a draft strategic intent document (The writing committee consisted of the members of ABE administrative committee and faculty advisory committee) in Summer 2005

6. Distributed the strategic intent to ABE members and requested input in early Fall 2005

7. Finalized the strategic intent by considering the input in September 2005

8. Prepared, distributed, and publicized the strategic intent in various forms in October 2005

9. Assembled task forces for developing action plans for strategic goals in Fall 2005 and Spring 2006

10. Prioritized action plans in April and May 2006

11. Completed the development of a departmental Strategic Plan for the next five years in June 2006

Section IV: Strategic Goals

The Goal

The ultimate success of an academic department is to continue to produce science-based outcomes of high and sustained impact and empower human capacity with knowledge and wisdom. This defines where we are going to succeed as a unit.

Challenges and Opportunities

We have identified the following issues that will need to be addressed in the next five years in order to achieve our above stated goal:

- Enhance recruitment and retention effort to sustain the quality and increase the quantity of our undergraduate student body, both Agricultural Engineering (AGE) and Technical System Management (TSM).

- Review and update AGE and TSM curricula. The purpose is to provide coordinated educational experience for engineers and technical systems managers of 2020 to effectively serve the agricultural, food, environmental and related industries.

- Develop a sustainable instructional program for AGE senior capstone design course. This course requires in-depth industrial experience in engineering design and close relationship with industrial sponsors. Identifying a qualified instructor and securing funding for the position will require a sustainable management plan.

- Address and improve resources for staff support. The financial resources for office and technical staff support are currently substantially below the effective and desirable level. Revenues have to be generated to improve the situation. A major need is a new position in the main office to handle student related affairs including graduate admissions, student records, and student recruiting at both the graduate and undergraduate levels.

- Generate revenues to mitigate the challenging budget situation. All units on campus have experienced the recent significant reductions of funds from the State. The University is moving towards a “private institution” funding model. Special attention and creative effort will need to be made to increase the level of revenue generation.

- Strengthen relationships with industry partners and advisory board members.

- Increase development and endowment activities.

- Engage stakeholders and clienteles.

- Review and possibly enhance or redesign departmental organization and program names (e.g. change Agricultural Engineering to Agricultural and Biological Engineering for our undergraduate and graduate programs to be consistent with our departmental name and curricula emphasis).

- Explore ways to expand faculty expertise and increase faculty numbers to address the critical needs in undergraduate and graduate teaching (TSM and AGE programs), core and emerging competencies in scholarly activities, development and delivery of extension/outreach education/training, and economic development. The University and College programs for strategic/enhancement faculty hiring (such as TOP and Faculty Excellence) will be actively pursued. Efforts will be made to improve the presence of female faculty in our department.

- Participate in research centers, interdisciplinary/emerging areas.

- Develop proposals for large research, teaching, and extension grants.

- Review and establish future direction and effective delivery methodologies of extension and outreach programs.

- Improve and update the quality of laboratories and the utilization of space.

Specific Goals

Goal 1: Enhance Student Recruitment and Retention

Indicators of success:

- Number of recruitment events participated
- Number of faculty involved in recruitment events
- Student numbers and class size
- Retention rate
- Number and value of scholarships and fellowships
- Placement rate
- Level of entrance requirements (ACT and HSPR)
- Number of student applications
- Teaching evaluation scores

Actions:

1. Hire a Student Affairs Coordinator to assist with the recruiting, advising and coordination of student activities.

2. Build a quality website presence for students, counselors, parents, and employers.

3. Identify key high schools and community colleges and develop a coordinated presentation (including video) for web and face-to-face advertisement that would generate interest from Urban Chicago-collar students.

4. Assemble potential employment/job descriptions and graduate testimonials.

5. Develop Spring semester classes for freshman.

6. Consistently advertise our classes in north of Green.

7. Fill second year classes.

8. Integrate curriculum so our students are in the same classes.

9. Co-teach with other departments.

10. Enhance Biological Engineering part of curricula.

11. Conduct major internal on-site events for students to showcase us.

12. Develop TSM masters program.

Who is responsible: Recruiting and Public Relations Committee

Goal 2: Integrate and Enhance Curricula

Indicators of success:

- Time to completion of degree
- Section size in combination with credit hours offered
- Number of courses taught in ABE and TSM
- Results of outcome assessment
- Coordination of subject-matter content among courses
- Measure of bio-content in courses

Actions:

1. Implement a process of curriculum renewal and enhancement in accordance with strategies developed by NSF-based engineering coalitions.

2. Benchmark our curriculum relative to peer institutions.

3. Restructure our program, concentrations and specializations to accommodate a biological engineering emphasis.

4. Review and remap our courses and corresponding knowledge and skills domains to align with our core competencies of automation, culture, environment and systems.

5. Cross listing courses with other programs.

6. Offer applied math, bio-math, and other new exciting courses.

7. Incorporate industrial content in courses.

8. Offer distance education.

Who is responsible: Courses and Curricula Committee

Goal 3: Increase Resources

Indicators of success:

- Grant, contract, and gift dollars per faculty FTE
- Amount of indirect cost return
- Number and value of external support for graduate students
- Number of instructional units
- Number and value of revenue generating activities (e.g. recurring accounts, workshops, short courses, outreach programs, etc)
- Measure of engagement in advancement activities
- Endowed chair professors
- Endowed capstone design instruction
- Endowed student recruitment and retention fund
- Endowed graduate fellowships
- Endowed undergraduate scholarships
- Endowed ABE I^4 Seminar Series
- Endowed support for continuous updating of teaching and research facilities and equipment
- Endowed support for student field instruction and international experience
- Endowed support for alumni awards

Actions:

1. Develop Outstanding Agricultural and Biological Engineering Alumnus Award, using Lehman or Lanham funds as allowable under gift guidelines, to be given annually at some venue appropriate for the award, such as homecoming, open house, or banquet.

2. Re-establish the department Public and Alumni Relations Committee with the following charges:
   a. Coordinate alumni contact opportunities with ACES and Engineering Alumni Associations and the University of Illinois Alumni Association.
   b. Upgrade/update the alumni database using available web-based technologies.
   c. Oversee quarterly department newsletter.

   d. Coordinate press releases and stories with ITCS and UI News Bureau.
   e. Sponsor workshops on Development.
   f. Coordinate annual alumni and friends reception at ASABE.
   g. Facilitate web-based communication and giving by UIUC ABE alumni and friends.
   h. Coordinate alumni awards with department awards committee.
   i. Conduct additional activities that enhance communication with parties interested in ABE at UIUC.

3. Work with UIUC Office of Sponsored programs and Research Administration; along with ACES Fiscal Office and ACES Office of Research to streamline grant proposal procedures.

4. Offer short professional courses.

5. Establish a Center of Excellence.

6. Encourage inter-disciplinary proposals (more teams).

7. Create a greater public presence.

8. Establish seed dollars for development of new relationships.

9. Assemble an influential external advisory committee.

10. Increase dollars from commercialized technology

Who is responsible: Advancement and Development Committee

Goal 4: Design Organization to Advance Strategic Thrusts

Indicators of success:

- Frequency of review and revision of organizational structure and administrative processes
- Number of cross sectional proposals
- Number of co-taught courses
- Number of co-advising
- Evaluation of changed administrative structure

Actions:

1. Have each faculty and subject area academic professional fill out an ACESys form on themselves each year, see Table 1 for example form. It is also beneficial for graduate students and some upper classmen to fill out the ACESys form. The competencies may be expanded to include all of the sub-level competencies as shown in Figure 1.

2. Outreach (extension) fits into all competencies, areas, and domains. More effort must be made to teach graduate students about the outreach mission and on ways to integrate graduate students into outreach as broadly defined, working with the general public, and with governmental groups, trade associations, or industry.

Table 1. ACESys Table for developing a relational data base of competencies and domains

ACESys Table
Your Name: ___________________________
% Research ___ % Teaching ____ % Outreach ____
Dept.: Agricultural & Biological Engineering
Date: _____________

Academic Year	2005-06	2006-07	
Competency			
Automation			
Culture			
Environment			
Systems			
Area			
BEE			
BIO			
FBE			
OREE			
SW			
Domain			
Bio-Based Processing and Production Systems			
Biomass and Renewable Energy			
Precision and Information Agriculture			
Agricultural and Biosystems Management			
Agricultural Safety and Health			
Food Quality and Safety			
Environmental Stewardship			
Land and Water Resources			
Spatially Distributed Systems			
Structure and Facilities for Living Systems			
Indoor Environmental Control			
Bio-sensors, Bio-instrumentation, Bio-informatics, and Bio-nanotechnology			
Intelligent Machinery Systems			
Automation of Biological Systems			
Advanced Life Support Systems			

ACESys table to self select competencies, areas, and domains that you feel you predominantly work in. Select as many areas as you like. You may denote your highest priorities with a 1, lower priority with a progressively higher number or leave blank. Changes with time are probable.

If you would like to serve as a rotating chair of a competency or domain, indicate by "R C" in the column.

3. Redo office arrangements to allow increased interactions.

4. Provide incentives for teamwork.
5. Add a Biological Engineering section.

Who is responsible: Administrative Committee

Goal 5: Strengthen Faculty Capacity

Indicators of success:

- Number of endowed chairs
- Number of under-represented faculty hires (through TOP and regular search)
- Number of Faculty Excellence hires
- Time and funding progress to create bio-faculty
- Number of faculty participating in two-way externships
- Number of faculty participating in sabbatical leaves
- Number of faculty participating in professional and leadership development activities

Actions:

1. Revise our curriculum to more efficiently use our faculty teaching time including combining courses, eliminating overlaps, and teaching more concepts.

2. Enhance grantsmanship, individually and collectively.

3. Emphasize impactful scholarship in research (including quality publications and graduates).

4. Encourage mentorship among faculty and collective core competence.

5. Increase gender diversity.

6. Re-tool faculty expertise in biological areas.

7. Encourage sabbaticals.

8. Encourage externships (2-way).

9. Develop faculty teaching skills.

10. Identify and promote international grant opportunities.

11. Nominate faculty for special awards and recognition including National Academy of Engineering and similar positions.

12. Encourage faculty (and student) exchange and research collaboration with other international peer institutions.

Who are responsible: Administrative and Advisory Committees

Section V: Strategic Initiatives

The Agricultural and Biological Engineering Department will continue to be globally preeminent and locally relevant in its research, teaching, and outreach programs. We have been recognized for constantly providing leadership in exploring new technical areas relevant to our discipline. We have also been valued as contributing members on interdisciplinary teams. In the next five years, we will direct our effort towards the following technical areas. Each focus area incorporates systems management and safety/health dimensions.

Initiative 1: Agricultural Automation

Farming and related activities will continue to rely on intelligent machines to be productive and competitive. Automated systems are equipped with human like intelligence and capabilities. Information, electrical/electronic, and mechanical technologies need to be integrated to create automated machines. Fundamental understanding and enabling technologies that are necessary for advancing the functions of agricultural automation are as follows:

Perception: concept of measurement, sensors and sensing techniques, data collection devices, data processing methods/software, and analog and digital instrumentation.

Reasoning and Learning: mathematical, statistical, logical, and heuristic analysis of information for decision support, as well as data mining, modeling, simulation, intelligent inference and optimization, and experiential learning by machines.

Communication: real-time data sharing, wired and wireless transmission of data, networking, and cyberspace.

Task Planning and Execution: process control, environmental control, materials handling, actuators, intelligent machines, and robotics.

The specific challenges faced by automation in agriculture are: making return on investment attractive; optimizing systems by properly integration of automation; culture, and environment; balancing fixed automation and flexible automation (i.e. identifying appropriate level of necessary machine intelligence); considering multiple use of machines or parts of machines; dealing with the limited market demand and acceptance; and continuously improving research, development, and education capabilities. On the other hand, the following opportunities do exist today: a higher technology readiness level; past success of agricultural mechanization to be built upon; excellent communication systems and platforms for sharing of technical advances; an improved economic viability for automated systems; better market acceptance; and potential spin-off technologies; and ability to facilitate implementation of emerging technologies. This is an opportune and exciting time to further advance the positive impact that automation will bring to agriculture.

Initiative 2: Bio-Energy and Bio-Products

Bio-energy (and related bio-products) is one of the strategic areas of UIUC. Our department has been a major leader/contributor in bio-energy research including ethanol production from corn, conversion of biomass to crude oil, and characteristics of bio-diesel and their effects on engine performance.

Renewable energy produced from Illinois crops such as corn, soybeans and biomass is an extremely important and timely research need for Illinois and the U.S. The fuel ethanol industry is undergoing rapid growth. By the end of 2006 ethanol production is estimated to reach 6 billion gallons per year, up from U.S. production of about 3,425 million gallons per year in 2004. New ethanol plants are in the news and are springing up every day. However, if the entire U.S. corn crop (~11 billion bushels) produced annually were converted to ethanol, it would supply less than 25% of the liquid fuel needed in the U.S. This makes it imperative that more research be conducted on process conversions and monitoring of fermentation processes to improve conversion efficiencies of corn to ethanol, and on conversion of other biomass materials into alcohol fuels. Most ethanol plants now produce about 2.75 gallons of ethanol from a bushel of corn. However, this yield ranges from about 2.5 to a theoretical maximum of about 3.0 gallons /bu. The increase in ethanol production has an accompanying increase in distillers dried grain with solubles (DDGS) and other co-products.

Research is needed to modify the dry-grind corn process to increase efficiencies of conversions, to create DDGS with higher protein quality with lower fiber content and to develop other co-products, such as phytosterols and corn fiber oil. Additional work is needed to reduce the required energy inputs in converting biological materials into ethanol and high valued co-products. While the efficiency of converting a bushel of corn into ethanol has improved greatly since the 1980s, many co-products from corn processing (e.g., DDGS and corn gluten feed) use large amounts of energy while having low value.

Research efforts on bioprocessing should focus on (1) process design, (2) evaluation for process efficiency, and (3) evaluation of co-products for industrial and human and animal food uses. UIUC and other land grant universities are uniquely positioned to provide unbiased information on these focus areas.

Conversion of soybean oil and other renewable vegetable oils into biodiesel fuel is also emerging as a very important research area. The diesel engine is the primary power source for the transportation sector and, therefore, diesel fuel is vital to the economy. As much as alternatives are being sought for gasoline with ethanol being the forerunner, alternatives to petrodiesel must also be developed. Even though blends of biodiesel are already commercially available, research is needed to evaluate the compatibility of this renewable fuel with the engine. Opportunities exist to exploit the unique properties of these fuels by modifying the engine or optimizing performance and reducing emissions when consuming such fuels. In addition, a wide array of renewable source materials are suitable for the production of biodiesel, which presents some challenges in terms of fuel quality, but also opportunities for genetically modifying the source materials to arrive at a renewable fuel source that has optimized properties for combustion, emissions reduction, stability, and operability. While there is a tension related to whether edible oils should be used for food or fuel, some of the efforts to achieve more acceptable edible oil from a nutritional standpoint may favor diesel fuel quality, but others may work against it. For example, nutritionists tell soybean breeders that soybeans used for food should have lower saturated fats (lower stearic and palmitic fatty acids); however, we are finding that soybean oil used for fuel use would actually benefit from higher saturated fats because it would increase the Cetane Number for the biodiesel fuel. Faculty in ABE have accumulated knowledge and experience in renewable diesel fuels that is impacting on the decisions being made at both the state and federal government level, as well as in the corporate sector. Research is carried out in close collaboration with other disciplines at UIUC, particularly mechanical engineering, where fundamental research into biofuel combustion processes is being pursued.

Our Department is in a unique position to lead the development of economical and holistic technology to convert livestock manure and crop residuals into bio-fuel and other value-added byproducts. Billions of dollars are spent annually on manure transportation, treatment and land application. Regulations that continue to become more stringent and cost-intensive have been imposed to satisfy our desire for a clean, safe environment. It is vitally important to develop innovative solutions to treat livestock waste. Meanwhile, we have a growing need for bio-fuels that reduce our dependence on foreign oil and the world's finite supply of petroleum. We mimic Mother Nature's thermochemical conversion (TCC) formation of petroleum, which is a product of deceased hydrocarbons (such as animals) under high temperature and pressure (underneath ground) in millions of years. TCC is a chemical reforming process of organic polymers, or biomass, in a heated enclosure, typically under anoxic or very low oxygen conditions. Depending upon the operating parameters of the system, the products of this process can be liquid oil, char or mineral solids, gases, and post-process water. This TCC process offers an appealing solution to the livestock manure problems.

Initiative 3: Sustainable Environment

Maintaining, and potentially improving, environmental quality and sustainability is a critical need for the future. While much is known about individual processes that are occurring and are influenced by our resource use and lifestyle decisions, less is known about interactions and system-wide processes. Our ability to assess the impact of resource use decisions, whether related to land, water, plant, animal or people, has greatly improved over the past few decades but, again, interactions, unforeseen impacts, and system-wide response are not nearly as well understood. Those shortcomings may lead us to make policy decisions that are appropriate at the individual process scale, but counterproductive when broader scale impact is evaluated. In essence, we need to enhance our abilities to understand, and base decisions, on processes and impact at the ecosystem scale.

Information: One of the most important thrusts in the environmental area is the collection of data that can be used for planning and decision-making. Our ability to quickly assess impact and/or make environmentally beneficial decisions will depend upon the quantity and quality of information we have and the tools we have to consider those data separately and in combination. Resource data varies both spatially and temporally, so geospatial location of data and tools to utilize that information is a necessary tool for students, staff and faculty. The perception and communication descriptions in Initiative 1 feed into this area quite well.

Processes: The continual refinement of our understanding of the processes that influence environmental quality and sustainability is critical to the overall goal of improved environment. As processes are identified and examined in one portion of the environment, they must be considered again in others to see if there are additional influences in different contexts. Additionally, the matter of scale again comes into play, as processes that are critical at a finer scale may have little observable impact at a broader scale. The "one-size-fits-all" approach is not likely to be applicable.

Simulation: Given the potentially vast spatial and temporal nature of environmental processes, computer simulation models will continue to be important tools for prediction and assessment. However, each model requires extensive testing and refinement for the situation it was intended to represent. Unfortunately, models have been, and continue to be, used outside their originally intended application and context. We must continue to develop, refine, and verify simulation models that enhance our understanding.

Socioeconomic Considerations: As one might expect, resource use decisions are influenced by the knowledge, attitudes, values and abilities of those making the decisions. It is critical that environmental process assessments that involve people making decisions consider socioeconomic characteristics and influences of the decision-makers.

The challenges faced by those attempting to increase our capacity to be environmentally-friendly in our decision-making include the vast amount of information becoming available and the lack of user-friendly tools to utilize that information for decision making. Further, as described earlier, fine scale decisions and the best decisions based on limited information/understanding may, in fact, be ineffective at broader scales and detrimental when assessed in the broader context with fuller information and understanding. We must recognize that decisions will be made in the absence of complete information and understanding, but a decision made with 50 percent of the information is likely to be better than one made with 20 percent, so we must seek to improve understanding without hindering decisions that must be made before all the potential knowledge is developed/discovered.

An additional challenge is in the area of data shortage, specifically for evaluating computer simulation models. Recent policy changes have moved long-term data collection, indeed data collection itself, to a much lower priority for funding agencies. Unfortunately, it is that data collection process that likely teaches us the most about the processes we study and the context in which we must evaluate recommendations based on model simulations. Additionally, given the vast temporal and spatial scales of some environment processes and the potential that such processes, such as the hydrologic cycle, are temporally cyclical and may be influenced by man's activities, it is the long-term processes that may well be most important in considering resource use impact.

Of course, the challenges described are also opportunities to develop tools and processes that can have widespread impact, such as developing ways to provide extra information for decision-making. The development of data sets for use by computer simulation developers from historical data is an important opportunity, as is the development of techniques to utilize the vast array of imagery that is becoming available from satellite and airborne platforms. The challenge is to make data available in a timely manner for feasible cost so that more-informed decisions can be made.

Targeted areas of thrust in environmental sustainability research include improving and protecting environmental quality pertaining to surface and groundwater, air and soil; developing technologies to provide productive environments for animals, workers, plants, and desirable microorganisms; and reducing the adverse environmental impact from biological production facilities.

Initiative 4: Biological Engineering

Traditionally, the field of agricultural engineering, like many other engineering disciplines, has been heavily based on physical and chemical sciences in its activities. However, unlike many other engineering disciplines, agricultural engineering has mainly been targeting its applications to bio-processing and bio-production. Biological science has been included in agricultural engineering work mostly as a “constraint.” It is now an opportune time to proactively consider biological science as an integral part of our discipline and utilize it as a resource in our work. The integration of biological, physical, and chemical sciences with engineering and technology provides a powerful platform for addressing systems level issues relevant to agricultural and food production. The biological engineering program in our department emphasizes bioenvironmental, bioprocessing, bioresources, and biosystems issues as related to agricultural and food production systems.

The intersection between the life sciences and engineering sciences has created unprecedented opportunities and challenges in what is now considered Biological Engineering. There is much to be gained from applying engineering to understand and control biological processes as well as to develop new engineering paradigms and technologies inspired by biological processes such as self-assembly and self-healing. We also recognize that the interface between engineering and biological systems is very broad and ranges from engineering at the nanometer scale (biotechnology and nanobiotechnology) to ecological and life support systems scales. Research and educational programs will be created in the following focus areas:

Biological Nanotechnology: Using nanoscale biological components such as proteins and nucleic acids to create devices or systems of devices that provide functions not natively seen in nature (e.g., biosensors, nanotherapeutics with functional biological nanocomponents etc).

Programmable Biotechnology: Using tools from computer sciences and molecular genetics to implement intelligent functionality and reasoning in living organisms at the molecular or genetic level. This field is also sometimes known as synthetic biology (e.g., whole-cell biosensors, metabolic engineering, tools for molecular biosciences etc.)

Biological Device Design: Using living, biological components in an engineering design, be it at the nano scale or at the ecosystem scale is accompanied with very specific challenges. We recognize that engineering with biological components requires the development of specifications on the allowable environmental states for the biological components. We will strive to elucidate and codify the principles behind engineering using biological components. This also involves the development of mathematical and information-based tools on the analysis and simulation of biological systems.

Biological engineering is a vast multidisciplinary field that stands to benefit from nearly all of engineering and biology. It is a relatively new field with different people having disparate opinions and very little standardization in its pedagogy. This is both the challenge and the opportunity. The impact of biotechnology, manipulation of biological processes within organisms resulting in increased productivity and profitability is widely apparent. Biological engineering must build upon the success of biotechnology. At least at the nano scale, biological nanotechnology may be considered an extension of biotechnology, with the additional input of condensed matter physics. Visible contributions in the above areas of opportunity will establish ABE and UIUC in a position of global leadership and set the tone for how biological engineering will be perceived in the future.

Initiative 5: Systems Informatics and Analysis

Information is no doubt one of the most valuable resources in many of our activities. While the quantity and quality of information are of great importance, knowing the methods of its usage can actually enhance the usefulness of the information. With today's communication technologies, it is relatively easy to access a vast amount of information. The variety of information we encounter everyday is as diverse as its source. One real challenge is how to sort and synthesize the information for "beneficial" use.

The integration of information is by no means a new activity. Everyone does it to some extent everyday intuitively. On the other hand, there is a formal field of study, namely systems analysis, dealing with scientific methods of information synthesis and application. A system is defined as a set of (physical or informational) objects united together for achieving certain objectives. Regardless of what methodologies employed (whether it is a science or an art), the purpose is to be able to integrate information and knowledge from focused research activities to enable the understanding and delivery of functional systems that integrate various components. A series of activities in systems studies of biobased systems have been conducted in recent years. The ultimate goal is to develop and sustain an information system and computational platform, namely Concurrent Science and Engineering (CS&E), for biobased systems. The purposes of CS&E are: (1) integrate information and knowledge related to the systems under study from various sources in a real-time fashion, (2) perform systems analysis, (3) evaluate systems level performance, and (4) deliver the results of analysis based on the most current information, also in a real-time fashion.

The overall objective of this initiative is to create necessary infrastructure to allow the analysis, optimization, and control to occur for emerging biological systems. Thus for the next five years the emphases will be:

Complex Design Techniques will be developed to understand the interactions in biological systems that make them inherently variable, though resilient in nature.

Decision Support will be provided to bring the results of modeling and analysis research on systems ready for delivery to the user community in a means easily tractable and transparent enough for easy implementation.

Early Reliability Measurement Techniques will be made available for a wide array of applications where the feasibility of life testing may not be readily available due to cost related, ethical, or time constraints.

Holistic Agro-Ecosystem Perspectives will be investigated to enhance the study of such systems at the ecosystem scale, especially as they become more complex.

Multi-Scale Modeling will be conducted to provide the fluid motion of data and information from models describing activity across a wide array of detail spanning from the nano- to the ecosystem-scales.

Sustainable Development will be bolstered by the consideration of systems from a holistic perspective and the use of innovative control and decision-making techniques, especially in areas where constraints are tight.

Section VI: Maintain Facilities

The instructional and research facilities in the Department of Agricultural and Biological Engineering are as follows:

Bioenvironmental Engineering

BioEnvironmental Structures and Systems (BESS) Laboratory
Air Quality Laboratory
Animal Environment Research Laboratory
Building Environmental Control Laboratory
Bioenergy and Waste Management Laboratory

Bioprocessing Engineering

Wet Milling Laboratory
Dry Milling Laboratory
Nutrient Separations Laboratory
Dry Grind Corn Processing Laboratory
NIR Spectroscopy Laboratory

Off-Road Equipment Engineering

Bruce Cowgur MidTech Mechatronic Systems Laboratory
Chemical Application Laboratory
Engine Testing and Emissions Measurement Laboratory
Illinois Laboratory for Agricultural Remote Sensing
Off-Road Machinery Laboratory
Agricultural Automation and Robotics Laboratory

Soil and Water Resources Engineering

Hydraulics Laboratory
Soil Properties Laboratory
Water Quality Laboratory

Biological Engineering

Biological Modeling Analysis and Systems Simulation (BioMASS) Laboratory
LAB-NANO (Laboratory for Agricultural and Biological NANOtechnology)
Bio-Sensing and Instrumentation Laboratory (under planning)

Agricultural and Biological Engineering Research Farm

The research farm consists of 80-acres with an additional 20 acres of research land on the edge of campus. This includes more than 10,000 ft^2 of office, laboratory, grain storage and other space on the research farm.

We need to continue to provide upgraded facilities, quality space, and technical support for departmental programs. In addition, the following enhancements will be pursued:

- Develop a state-of-the-art pilot scale bioprocessing facility by continuing to upgrade and remodel space in Burnsides and/or in a new location. This may be accomplished in collaboration with other academic units.
- Secure additional space for the expansion of the Air Quality Laboratory.
- Provide increased electronic and machine fabrication technical support.
- Develop an attractive entrance and display cases to the AESB at the north end and breezeway entrances that illustrate our programs in agricultural and biological engineering.
- Enclose the covered storage in the courtyard and develop adequate and accessible interior spaces for storage of seasonally used equipment.
- Prepare a program statement for a new two-story addition connecting AESB to the Wood Engineering Lab across the north end of the courtyard.

Section VII: Garner and Allocate Resources to Achieve Strategic Goals

It has been a challenging time in terms of available financial resources for new initiatives. We had a sizable list of needs for enhancement of our programs. But, we have not been able to identify comparable levels of resources to implement new activities. What we have done was to prioritize our expenditures and redirect, to the extent possible, our resources to cover the most urgent needs.

The potential methods for generating revenues to enhance our programs and advance our strategic goals and initiatives are as follows:

- Student credit hour generation (enrollment, major courses, graduate courses, service courses).

- Workshops, short courses, conferences, and continuing education activities.
- Self-supporting revolving accounts.
- Advancement and development activities targeting alumni and industry sponsors.
- Grants and contracts with special attention to indirect cost return.
- Endowments and gifts.
- Income generating international activities such as 2+2 and/or 3+2 undergraduate programs and collaborative research and instructional activities.
- On-campus competitive resources.
- Creative investment of our resources.

Appendix: Strengths, Weaknesses, Opportunities, Threats (SWOT) Analysis

Questionnaires:

To prepare for the brainstorming session, the following information will be collected and summarized:

1. What have been ABE Department's **major accomplishments** over the past five years?
2. What have been ABE Department's **major shortfalls** over the past five years?
3. What are ABE Department's **major strengths**? How can ABE Department capitalize on these strengths strategically and operationally?
4. What are ABE Department's **major weaknesses**? How can ABE Department correct them or minimize their impact?
5. What are the **major external factors** (administrative, economic, political, regulatory, clientele, demographic, competitive, etc.) that will affect ABE Department over the next five to ten years? What actions can ABE Department take to effectively deal with them?
6. What are the **major opportunities** that lie before ABE Department in the next five to ten years? What can ABE Department do to capitalize on these opportunities?
7. What are the **major threats** or risks to ABE Department's continued growth over the next five to ten years? What can ABE Department do to resolve them or contain their impact?
8. What are ABE Department's **clienteles (markets)** now served? Are there additional clienteles (markets) that should be served? If so, which markets and why?
9. What must ABE Department **do** to achieve continuing vitality and growth? Are new directions required? What are they? Why are they needed?
10. What are the **three most important tasks** that ABE Department faces over the next ten years? Why are they important?

Results: We conducted a SWOT analysis during December 2004 and January 2005. Twenty-two typed pages worth of input was received from faculty. The following is a summary of the input:

Strengths:

- High quality people
- Participating in two top-ranked colleges
- Quality of teaching and care of the students
- International presence and reputation

- Good research and teaching capabilities
- Systems approach to solving complex problems
- Ability to solve difficult problems
- Ability to lead and participate in multidisciplinary activities
- Many promising “early” career faculty members

Weaknesses:

- Biological engineering components
- Practical understanding of industry needs
- Competitive grants and visibility at Federal level
- Funding in general (especially endowments)
- Gender diversity among faculty
- Student recruitment
- Lack of super-stars
- Lack of quality laboratory space
- Our organizational structure

Opportunities:

- Expanded biological aspect in our discipline
- Geographical location close to major related industries
- Funding for agriculture/biology/health/environment
- Encouragement for technology commercialization and entrepreneurship
- Alumni relationship and support
- Multi-disciplinary, multi-institutional projects
- Targets of Opportunity and Faculty Excellence programs
- International activities
- Distance learning and continuing education
- Demand for M.S. program in TSM
- Recruitment of students from urban areas

Threats:

- Eroding completeness of core competencies due to a “shrinking” faculty size
- Decline of relative importance of agriculture
- Lack of state support
- Low undergraduate student enrollment
- Lack of a clear guidance in balancing research/teaching/outreach responsibilities
- Ability (or inability) to sustain our high ranking