Agricultural and Biological Engineering at Illinois

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A HISTORY OF THE UNIVERSITY OF ILLINOIS
DEPARTMENT OF
AGRICULTURAL AND BIOLOGICAL ENGINEERING
1997 – 2009

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CONTENTS

PREFACE

This book is a sequel to the book, Agricultural Engineering on the Prairie: Illinois style. That book, by H. Paul Bateman, William A. Foster, Benjamin A. Jones and Walter D. Lembke, was a comprehensive history of the Agricultural Engineering department from its earliest roots until the year 1997. In contrast, this book only covers the department history in the period, 1997 through 2009. During that period, the name of the department was changed to Agricultural and Biological Engineering (ABE).

The current book came about when department head K.C. Ting asked Ben Jones, Walt Lembke and Carroll Goering to update the department history. Those three men decided to enlist the help of current and retired faculty in writing the various chapters of the book while serving as editors of the complete book. The editors are grateful to the following persons for drafting portions of the book: Carroll Goering drafted Chapter one, Introduction. Loren Bode drafted Chapter two, Changing of the Guard. Kent Mitchell drafted Chapter 3 on Teaching Programs, which included material written by Doug Bosworth on the capstone design course. Prasanta Kalita, Randy Fonner and Kent Rausch drafted Chapter 4 on Student Activities. Chapter 5 on Research Programs includes sections on Bio-Environmental Engineering (BEE) by Yuanhui Zhang; on Food and Biological Engineering (FBE) by Marvin Paulsen,; on Off Road Equipment Engineering (OREE), including USDA research, by Carroll Goering; on Soil and Water (S&W) research by Kent Mitchell; and on Nanotechnology by Irfan Ahmad. Kaustubh Bhalerao, Grace Danao and Luis Rodriguez wrote the section on Biological Engineering (BioE). Carroll Goering drafted Chapter 6 on Extension Programs and Chapter seven on International Programs. Leanne Lucas prepared Chapter 8, profiles of faculty members who retired or left the department between 1997 and 2009. Tony Grift, with help from area leaders, students and some emeritus faculty, drafted Chapter nine, A Glance Ahead. In addition, ABE staff in the main office helped assemble the material included in the appendix. Ronda Sullivan compiled an extensive list of visiting scholars. Robin Fonner was especially helpful and the editors are grateful for the numerous times she helped find needed materials.

INTRODUCTION

The early history of the Department was captured in the book, Agricultural Engineering on the Prairie: Illinois Style, by H. Paul Bateman, William A. Foster, Benjamin A. Jones, Jr. and Walter D. Lembke. That book traced the department history from its early roots through its subsequent development up to the year, 1997. The aim of the present book is to extend that history from 1997 through 2009. Some of the key highlights of the early department history are repeated below.

The roots of the Agricultural and Biological Engineering (ABE) department trace back to the formation of the land grant college system when the Morrill Act was signed by President Lincoln on July 2, 1862. The Illinois Industrial College, later to become the University of Illinois, was formed in 1867. When the College of Agriculture was formed in 1870, Professor S.W. Shattuck was listed as a professor of Agricultural Engineering in the college, while S.W. Robinson was listed as a Professor of Agricultural Mechanics. Nathan C. Ricker, a 1872 graduate of the college, began teaching a rural architecture course in 1876. Thus, the teaching of agricultural engineering related subject matter preceded the formation of the department and of the College of Engineering that was established at Illinois in 1880.

In 1904, the first Bachelor of Science degree in Agricultural Mechanization was awarded to Charles A. Ocock. Initially, the courses in agricultural engineering/farm mechanics were taught in the Department of Agronomy. At the time, that department was housed in Agricultural Hall, now Davenport Hall. In 1906, when space in Agricultural Hall could no longer meet the demand for courses and the need for additional space for farm implements, a new Farm Mechanics Building was opened. That building was later renamed the Agricultural Engineering building.

In 1921, Agricultural Engineering separated from Agronomy when a new Department of Farm Mechanics was formed and housed in the Farm Mechanics building. The first head of the new department was Emil W. Lehman. In 1932, the department name was changed to Agricultural Engineering and an Agricultural Engineering curriculum was approved the same year. The first Bachelor of Science in Agricultural Engineering degrees were awarded in 1934. One of the first graduates, H. Paul Bateman, then joined the department faculty and continued to serve until his retirement in 1968.

The first Master of Science degree was authorized in 1948 and, a year later, the first MS degrees were awarded to Maurice L. Burgener, B. Jack Butler and Herman W. Glover. In 1950, the Agricultural Engineering curriculum was nationally accredited for the first time. In 1955, Frank B. Lanham was named department head and, a year later, the first B.S. Degrees were awarded in a newly formed Agricultural Mechanization degree. The latter degree was renamed Technical Systems Management (TSM) in 1996. The Ph.D. degree was approved in 1964 and, two years later, the first Ph.D. degree was awarded to Roscoe L. Pershing. Roger R. Yoerger became department head in 1978. In 1983, the department left the Agricultural Engineering building to move into the new Agricultural Engineering Sciences Building. Roscoe L. Pershing was named department head in 1985. When Pershing became Associate Dean of Engineering in 1994, Loren E. Bode was named as department head. That year, the department achieved the number one national ranking in a survey published by US News and World Report. For a number of years, the department had been ranked in the top five nationally.

In the economic engine that propels the US economy, agricultural, food, environmental and energy systems play a highly significant role. The discipline, Agricultural and Biological Engineering (ABE), integrates life and engineering for the enhancement of these systems. Agricultural and biological engineering are synergetic and inseparable. Thus, in concert with other former Agricultural Engineering departments across the US, the department name was changed to Agricultural and Biological Engineering (ABE). The name change occurred while Bode was department head.

When Bode stepped down in 2004, K.C. Ting was named department head. Ting set about building the biological component of the department mission by hiring new faculty members trained in that area. After a department retreat, the department developed and published (in October, 2005) the following statement of strategic intent:

Core values:

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, and inclusiveness and collegiality.

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.

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.

Domains:

We contribute to engineering and management of complex food, agricultural and biological systems. Departmental emphases include: Bio-based processing and production systems; biomass and renewable energy; precision and information agriculture; agricultural and bio-systems management; agricultural safety and health; food quality and safety;

environmental stewardship; land and water resources; spatially distributed systems; structures and facilities for living systems; indoor environmental control; bio-sensors, bio-instrumentation, bio-informatics and bio-nanotechnology; intelligent machine systems; automation of biological systems; and advanced life support systems.

Changing the department name to Agricultural and Biological Engineering did not include changing the name of the curriculum, which remained as Agricultural Engineering. In 2004, the course rubrics were changed from AgE to ABE. At the same time, all department courses were renumbered. Freshman-level courses remained at the 100-level, while sophomore courses became 200-level, junior-level courses became 300-level and senior courses became 400-level. A new 500-level was introduced for graduate level courses. In 2006, the Agricultural Engineering curriculum was renamed to Agricultural and Biological Engineering, with four standard areas of study. These were BioEnvironmental Engineering (BEE), Food and Bioprocess Engineering (FBE), Off-Road Equipment Engineering (OREE) and Soil and Water Engineering (S&W). The department continued to have a Technical Systems Management (TSM) curriculum offered through the college of ACES. The department also continued to have a dual-major curriculum that allowed a student to earn a BS through the College of Engineering and a second BS through the College of ACES. The department also continued to offer the MS and PhD degrees in Agricultural and Biological Engineering. At time of writing, the department had just received final approval from the Illinois Board of Higher Education to offer a new MS degree in TSM, to take effect in the fall of 2010. The new MS degree is described in Chapter 3. One option in the new degree program is participation in the Professional Science Masters (PSM), which is similar to the MBA. ABE students participating in the PSM program take 10 semester hours of business courses as well as TSM courses

The chapters that follow provide more information on the teaching, research, outreach and international activities of the department from 1997 to 2009, as well as information on the department students, faculty and staff and on the departmental graduates. A chapter is also included to provide a glance ahead, i.e., science-based predictions of future developments. It is interesting to note that the department vision of being the best agricultural and biological engineering department was realized. In four consecutive years, from 2007 through 2010, the department's undergraduate engineering program was ranked first in the nation in the annual surveys published by US News and World Report. At the time of writing, the undergraduate survey results for 2011 were not yet available, but the department's graduate program had also been ranked number 1.

Departmental students were also winning awards. In 2009, the quarter-scale tractor team won first place in national competition. In the event, sponsored by ASABE, students from universities compete annually in designing and building a quarter-scale tractor to enter into national competition. The Illinois win in 2009 was the first in the competition history. At time of writing, the Illinois team won again in 2010. Also, in 2009, ABE students were part of a University of Illinois team that designed and built a solar house that was displayed on the mall in Washington, DC. The Illinois house won second place in international competition, finishing second to Germany.

As a way of celebrating the department success and building momentum for future success, the department initiated a Celebrate ABE program. The goal was to attract as many department alumni as possible to return to campus for the celebration. The first one was held in September, 2008, the second one was held in September, 2009 and the third one was scheduled to be held in September, 2010. Each event included a meeting of the ASABE Central Illinois Section, campus tours, and a banquet at the I-Hotel on campus. Other events included a golf outing and a demonstration by the student Quarter-Scale tractor pulling team.

K.C. Ting, in an effort to continue building the department, appointed an ABE Futures Committee. The mission of the committee was to work in concert with the ABE Department to enable and stimulate closer bonding of the Department's alumni, friends and potential friends to the ABE Department, the Colleges of Engineering and ACES, and the University of Illinois. Their vision was that every ABE Department alum and friend would feel a sense of ownership and pride in the ABE Department. The initial members of the committee were Roscoe Pershing (Committee chair), Paul Benson, Loren Bode, Doug Bosworth, Phil Buriak, Bob Fry, Carroll Goering, Ben Jones, Walter Lembke, Ronda Sullivan, Kim Meenen and K.C. Ting. The committee made a number of suggestions to the department. These included upgrading the department newsletter, updating the department history and starting a professor for a day program. In the latter program, a distinguished member of the alumni is selected each semester to come to campus to meet with students and to teach a class. The first professor for a day, John Repogle, came to the campus in the spring of 2009, at the time of the ABE spring banquet. The second professor for a day, Jim Steck, came to campus in the fall of 2009, at the time of the Celebrate ABE event. David W. Smith was professor for a day in the spring of 2010, while Gary Wells was scheduled to be professor for a day in the fall of 2010. The department also began a program of recognizing one of its alumni as a Distinguished Alumnus each year. The first one chosen was Douglas Bosworth, the second was Lyle Stephens and the third was Larry Huggins. Each year, the person selected is recognized and invited to make remarks at the ABE spring banquet.

Soon after the ABE futures committee was appointed, they began to discuss the possibility of expanding to include an ABE Futures Council. The mission and vision of the council was identical to that of the ABE futures committee. However, council members are chosen from several geographic areas around the state and later, perhaps from around the nation. Essentially, the council members became the "eyes and ears" of the department in their geographic areas, help with recruiting, help sponsor departmental events in their area, etc. Council members were invited but not required to attend the monthly meetings of the futures committee. However, they were encouraged to participate in a teleconference arrangement in which they could speak at futures committee meetings and also hear the proceedings. The initial members of the futures council were Lynda Cabrales from Kraft, Marcia McCutchan from RHMG, Anthony Rund and Dan Roley from Caterpillar, John Reid and Dave Smith from John Deere, and Brian Wills from Wills Milling.

The ABE department continued the tradition of having an external advisory committee to offer advice to the department head. Members of the advisory committees are listed in the appendix. The work of the external advisory committee was coordinated with that of the ABE futures committee/council by having two members of the external advisory committee serve as liaison members of the futures committee/council. The first two liaison members were John Reid and Anthony Rund.

On the lighter side, many departmental alumni will remember a department tradition that ended in 2003. Starting in 1975, a Fallow Furrow trophy was presented annually at the departmental awards spring banquet. The initial presentation was to Kent Mitchell, who forgot to attend a class he was teaching. In recognition of that oversight, his students designed a trophy and presented it to him at the next awards banquet. The trophy, in the form of an inverted cultivator shovel mounted on a former bowling trophy, was subsequently presented by the current holder to the faculty member who had made the biggest goof during the previous year. Since faculty members work for the department 24/7, the goof could occur any time or place, at work or away from work. Winners demonstrated their collegiality by accepting the trophy gracefully. The trophy presentation became a hilarious hit at each spring banquet but was dropped in 2003 because it was taking attention away from the true purpose of the awards banquet – to recognize achievements of the students.

2 | CHANGING OF THE GUARD

In the period from 1997 to 2009, there was considerable changing of department personnel. A total of 18 faculty members either retired or moved on to new positions. Due to insufficient funding from the state, it was not possible to replace all those who left, but 15 new faculty members were hired. Also 6 faculty members stayed on board from 1997 through 2009. A complete list of departmental faculty can be found in the appendix. A number of academic professionals joined the staff to help with work previously done by faculty members. Several technicians retired and, due to budget constraints, could not be replaced. There was also turnover among the secretarial staff. In the paragraphs below, the personnel changes are described.

In 1997, Dr. Kent Rausch joined the faculty after serving on the faculty at Kansas State University. Rausch's teaching and research were in the Food and Bioprocess Engineering (FBE) area.

In 1998, Dr. Stuart Birrell left to accept a faculty position at Iowa State University. He had joined the ABE faculty in 1996, after an assignment at the University of Missouri. Also in 1998, Dr. John Siemens retired after 30 years on the departmental faculty. His work had been in research and extension regarding farm machinery. Dr. Shufeng Han was hired from Case/IH to replace Siemens. Han's assignment was to do extension work on precision agriculture. When Han was hired by Deere and Company in 2001, there was not enough funding to replace him and the department's extension work in farm machinery came to an end.

There were two departures in 1999. Dr. Bruce Litchfield, who had been teaching and doing research on food engineering, left to take an assistant dean's position in the College of Engineering. Dr. Carroll Goering, who had been teaching and doing research in Off-Road Equipment Engineering (OREE) area, ended his 22 years on the faculty by retiring. Goering was OREE area leader at the time of his retirement. Goering was replaced by Dr. Al Hansen, who previously was on the faculty at the University of Natal in South Africa. Hansen took over Goering's teaching assignments and also did research in the OREE area with emphasis on biofuels.

In 1999, Dr. Prasanta Kalita left Kansas State University to join the ABE faculty at Illinois. His teaching and research appointment was in the Soil and Water (S&W) area. The following year, Dr. Kent Mitchell retired after a 36-year career in the department. Mitchell had been doing teaching and research in the S&W area. Also in 2000, Dr. John Hummel left the department when the USDA transferred him to Columbia, Missouri. Although a USDA employee at Illinois, Hummel had a courtesy faculty appointment in the department and functioned in most respects as a full-fledged faculty member.

Two faculty members departed in 2001 after 15-year careers in the department. Dr. John Reid, who had been doing teaching and research in the OREE area, left to accept a position with Deere and Company. Dr. Gerald Riskowski, who had been doing teaching and research in the BioEnvironmental Engineering (BEE) area, left to become head of the Agricultural and Biological Engineering department at Texas A&M University.

In 2002, there was one departure and three new arrivals. Dr. Paul Benson retired after a 24-year career in the department. Benson's assignment had been in the FBE section, doing extension work. Specifically, Benson worked with the electricity industry, including serving as Executive Director of the Illinois Farm Electrification Council (IFEC). An academic professional, Molly Hall, was hired to take over Benson's work with the IFEC. However, she left in 2007 when IFEC funding to the department ended. Three new assistant professors were hired in 2002. Dr. Tony Grift was hired to do teaching and research in the OREE area. Dr. Xinlei Wang was hired to do teaching and research in the BEE area. Dr. Vijay Singh was hired to do teaching and research in the FBE area.

In 2004, Dr. Loren Bode stepped down as department head. Dr. K.C. Ting, formerly department chair at Ohio State University, was hired to replace Bode as head. Bode continued on a faculty appointment until 2008, when he retired.

IN 2005, there was one departure and three arrivals. Doug Bosworth, a Deere retiree who had been hired in 1995 to teach the capstone design course, retired from the department. Steve Zahos was then hired to teach the capstone design course. Like Bosworth, Zahos had extensive industry experience. Such experience was valuable because students in the design course worked closely with industries on industry-sponsored projects. Two other new faculty members, Dr. Luis Rodriguez and Dr. Kaustab Bhalero, joined the department in 2005 on teaching and research appointments. They were hired by K.C. Ting to build up the biological component of the Agricultural and Biological Engineering department.

There were two departures in 2006. Dr. Marvin Paulsen retired after 31 years in the department on a teaching and research appointment. Also retiring was Dr. Mike Tumbleson. He had transferred into the department from the College of Veterinary Medicine in 2001.

The year 2007 brought three departures and three arrivals. Dr. Phil Buriak retired after leading the TSM program for 19 years. He was replaced by Dr. Joe Harper, who transferred in from the Human and Community Development department. Dr. Les Christiansen retired from his teaching and research appointment after 22 years in the department. Also, Dr. Mike Hirschi took up an assignment as Assistant Dean in the College of Engineering. Hirschi had held a teaching, research and extension appointment in the S&W area. Dr. Lance Schidemann transferred to the department from the Civil Engineering department to do teaching and research in the S&W area. Dr. Grace Danao joined the department as an assistant professor with a teaching and research appointment. She was hired by K.C. Ting to further bolster the biological engineering component of the ABE department.

In 2008, Dr. Angela Green was hired as an assistant professor on a teaching and research appointment. Her work on animal behavior was centered in the BEE area of the department.

In 2009, Dr. Qin Zhang left his teaching and research appointment in the department to accept a position at Washington State University. The UIUC campus provided funding to hire Dr. Richard Gates, previously department head at the University of Kentucky, as a distinguished professor. Gates accepted a teaching and research appointment in the BEE area of the department.

Eight people were granted, courtesy appointments in the department between 1997 and 2009. Persons on such courtesy appointments are not on the department payroll but are granted the appointments in recognition their close cooperation with departmental faculty. In 1997, Dr. Kazimierz Banasik, a Visiting Professor from Poland, was granted a courtesy appointment. He had worked closely with Dr. Kent Mitchell. Also in 1997, Dr. Noboru Noguchi of Kokkaido University in Japan was granted a courtesy appointment. He had been cooperating with members of the ABE department on robotics and automatic guidance research. In 1999, Dr. Irfan Ahmad, an employee at the Beckman Center, was granted a courtesy appointment. In 2002, Dr. Munir Cheryan and Dr. Scott Morris of the Food Science and Human Nutrition (FSHN) department were granted courtesy appointments. Also in that year, Dr. Hao Feng of the Institute for Genomic Biology was granted a courtesy appointment. In 2003, Dr. Shelly Schmidt of the FSHN department was granted a courtesy appointment. In 2007, Dr. Hongbin Ren was granted a courtesy appointment to further increase ties with his university in China.

In 2000, University of Illinois extension agents who were working in various parts of Illinois were given the opportunity to affiliate with a campus department of their choice. That year, George Czapar, Robert Frazee, Duane Friend, Michael Plumer and Stanley Solomon accepted chose to affiliate with the ABE department. In 2002, they were joined by Paul Mariman and Susan Meeker. Both Mariman and Meeker left the university in 2005.

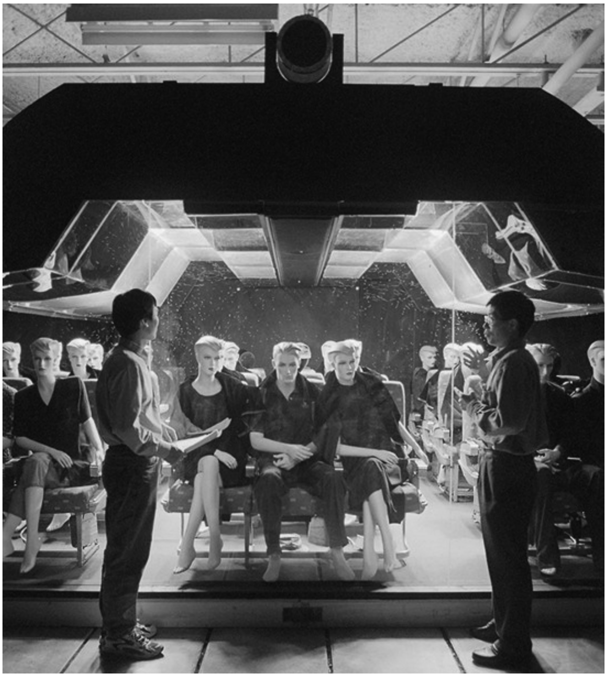
The faculty could not be successful without the help of numerous other people on non-faculty appointments. In the departmental head office, Dini Reid served as Assistant to the Head until she and her husband, John Reid, left the department in 2004. She was replaced by Ronda Sullivan, who had previously worked in the Animal Science department. Mary Beth Munhall served as Administrative Secretary before retiring in 2003. She had earlier served as the secretary in Suite 332. With the increased use of word processors by the faculty, the assignment of suite secretaries was discontinued. When Munhall retired, Robin Fonner was hired as the new Administrative Secretary. Ruth Sattazahn served in Suite 360 as a secretary and research coordinator until 1999. She left to become a fund raiser for the proposed new St. Thomas Moore high school. Also leaving in 1999 was Pamela Warsaw, who had been serving as a secretary in the head office. Patricia Belton, an Accounting Technician, left the department in 2002. The next year, Charlotte Longfellow left her appointment as Chief Clerk after serving the University for 17 years.

Academic professionals are college graduates who work essentially as non-tenured faculty. Three of these handled the state-funded Pesticide Education Safety Program (PESP) for the department. Dr. Bob Wolf held this position until he left in 1993 to join the faculty at Kansas State University. Wolf was replaced by Dr. Mark Mohr, who held the position until 2003. When Mohr left, he was replaced by Dr. Scott Bretthauer, who was still holding the position at time of writing.

Computers became a vital part of ABE operations. On any given work day, a visitor visiting nearly any faculty office would find the occupant working at a computer. The department also had a room filled with computers for student use. Thus, an important position in the department was a person to maintain and upgrade the department computers. Dan Vander Ploeg was in that position until his departure in 1998. With the feared Y2K problem looming, two persons shared the position beginning in 1998. They were Shane Thompson and Tom Nelshoppen. Thompson stayed one year and left in 1999. Nelshoppen was still in the position at time of writing.

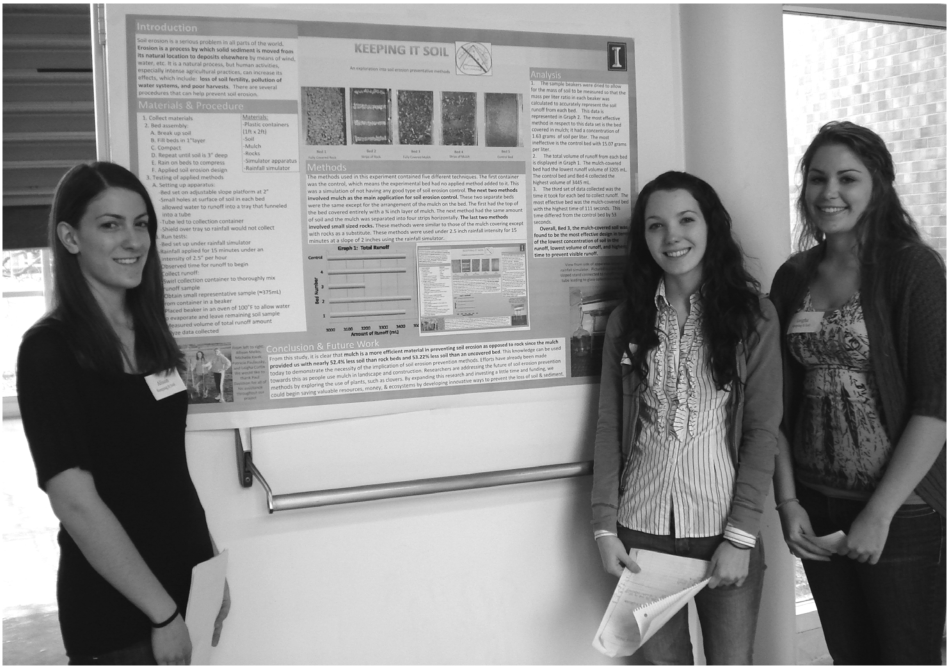
Two academic professionals worked in the FBE area. Rene Denhart left in 2003 and Jennifer Richardson began work in 2004. Anne Marie Boone joined the department in 2007 to help with student recruiting. Jay Davis joined the department in 1999 to work mapping tile drain locations in farm fields using aerial image analysis. Two other academic professionals were in the department during the entire period, 1997 to 2009, but will be mentioned for completeness. Randy Fonner joined the department in 1990 to assist Ted Funk with an extension program on animal waste management. Fonner also became advisor to the student Ag. Mech club. Chip Petrea joined the department in 1987 to assist Bob Aherin with an extension program in farm safety.

Four other department employees and a USDA employee assisted with the physical work of the department. Dennis King, a USDA technician, assisted the work of John Hummel at the Agricultural Engineering farm but retired in 2000. In 2008, Steve Maddock retired as the S&W technician, while Larry Meyer retired as foreman of the Agricultural Engineering farm. In 2009, Larry Pruiett retired after managing the laboratories for the FBE area. Finally, Dennis Mohr retired in 2010 as the OREE technician. Regretfully, because of insufficient funding, none of these five people could be replaced.



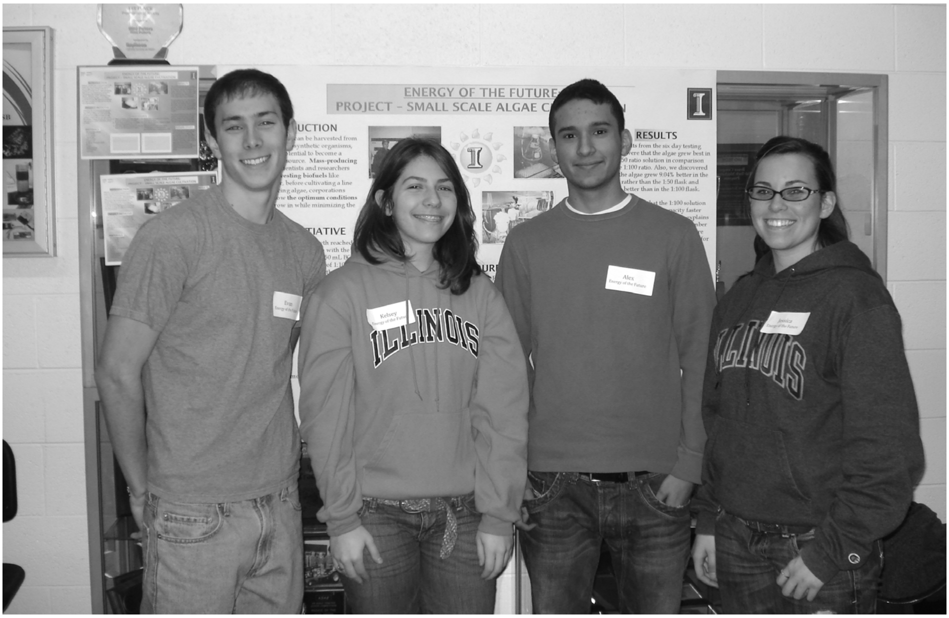
From left, PhD student Yigang Sun and his advisor, Yuanhui Zhang standing in front of a Boeing 767-300 cabin mockup, discussing the volumetric particle tracking velocimetry they developed to measure air flow patterns and pollutant transport.

The ABE quartet at a Quad City section meeting. From left, Dick Coddington, Roscoe Pershing, Don Hunt and Mike Hirschi



From Left, Alison Melko, Patricia Paulausky and Leigha Curtin in front of their ABE 100 project on Soil Erosion and sediment control. Not shown is PhD student Paul Davis, project mentor.

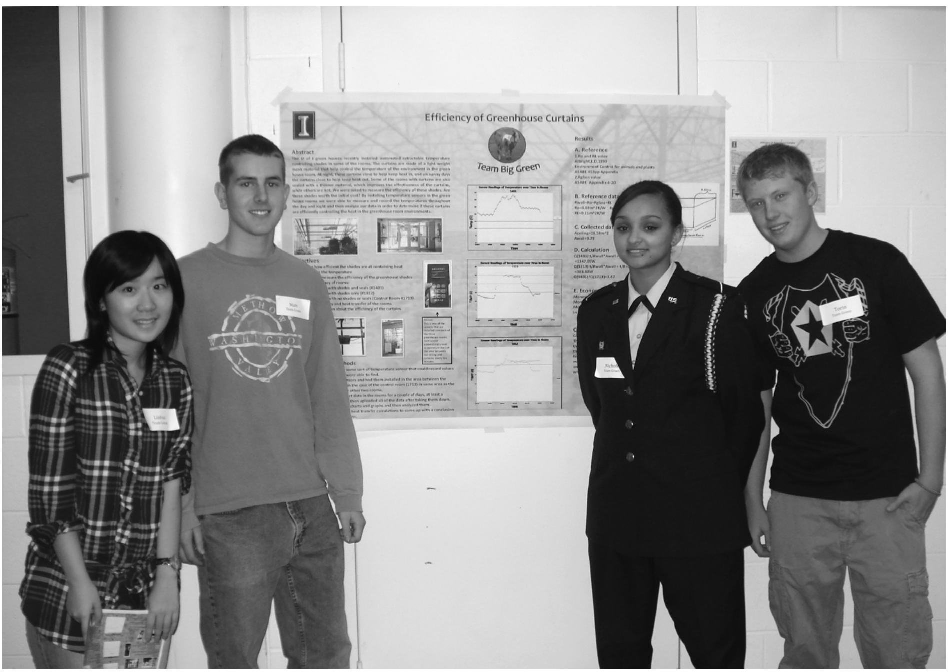
From left, Gage Braley and John "Jack" Berg working on the micro-steam car they designed and built as part of the ABE 100 class.



From left, Evan Wool, Kelsey Green, Alex Salas and Jessica Williams with their ABE 100 small-scale algae fermentation project. Not shown is their project mentor, MS student KRekha Balachandran.

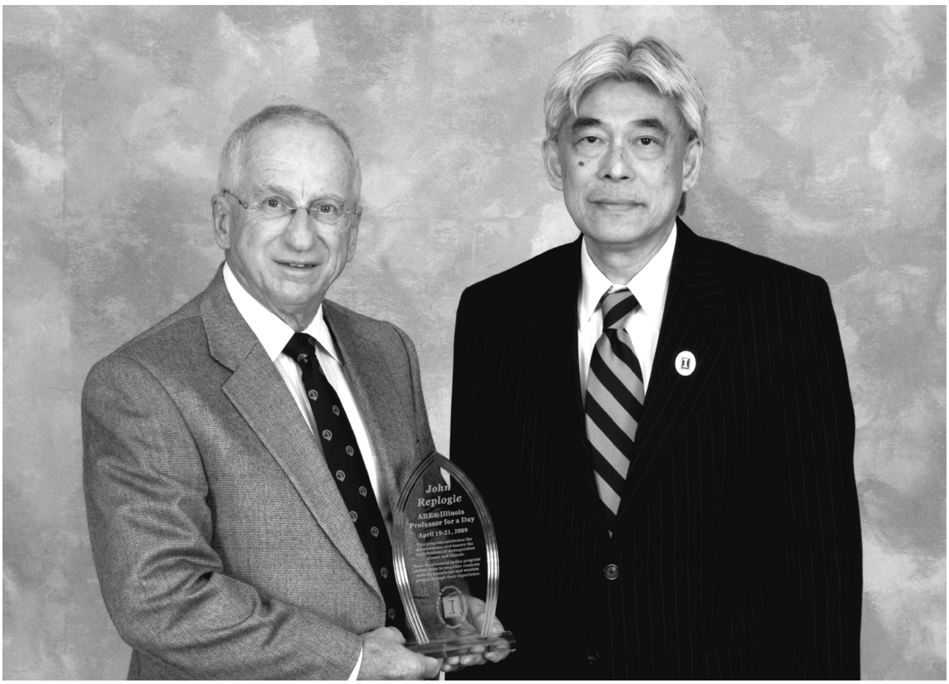
Front row from left: David Murphy, Amanda Corban, George Bozdech, Leigh Ann Kesler, Drew Schilling, Eric Allen
Middle row: Brian Krug, Casey Millard, Stephen Corban, Chris Wilhelmi, Taylor Leahy, Jordan Tate, Kim Heinecke
Back row: Jordan Hammer, Jordan Pitcher, AJ Metzler, Alex Suchko, Nowell Moore, Brian Fehrenbacher and Dennis Sinks with their national champion quarter scale pulling tractor.

From left, Zach Brammeier, Delayne Durdle, Austin Roepke, Aaron Schubert, Joseph Monical, Prasanta Kalita and Laura Hahn discussing the project to retrofit a boat for Dr. Kalita for water sample collection from a retention pond on the ABE farm.



From left, Linhui Qi, Matthew Doherty, Nichole Evans and Torin Lacher with their poster on evaluating the energy requirements of a greenhouse. Not shown are project mentors Richard Gates and Drew Schilling.

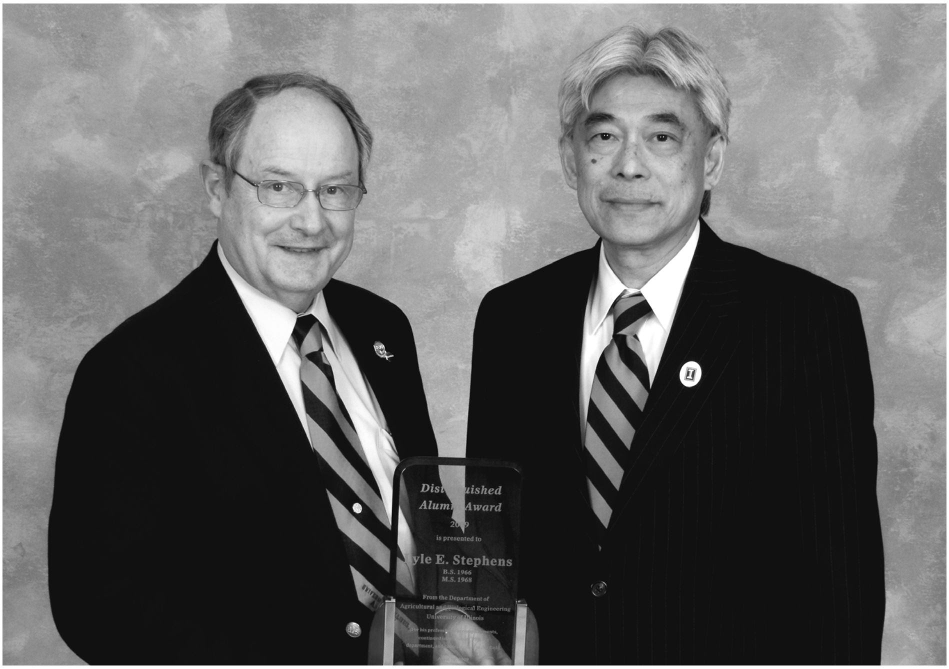
K.C. Ting recognizing scholarship donors, Lola and Larry Huggins.



K.C. Ting recognizing John Repogle as Professor for a Day.

Doug Bosworth with Distinguished Alumni Award.

K.C. Ting recognizing Jim Steck as Professor for a Day.



K.C. Ting presenting Distinguished Alumni Award to Lyle Stephens.

K.C. Ting recognizing Dave Smith as Professor for a Day.

3 | TEACHING PROGRAMS

Since the previous history of the Agricultural Engineering Department at the University of Illinois, which ended in 1997, there have been many changes in the curricula administered by the Department. The University changed the course numbering system, the Department name was changed to Agricultural and Biological Engineering and several official options have been changed. These changes for both the AE/ABE and TSM curricula are described below.

AGRICULTURAL ENGINEERING/AGRICULTURAL AND BIOLOGICAL ENGINEERING CURRICULUM

FROM 1997 TO 2006

The Agricultural Engineering curriculum in the College of Engineering, starting in Fall 1997, was defined in the UI Program of Study as follows:

Exhibit 3.1. Degree of Bachelor of Science in Agricultural Engineering in 1997

For the Degree of Bachelor of Science in Agricultural Engineering

Agricultural engineering is the integration of biological and physical sciences as a foundation for engineering applications in agriculture, food systems, natural resources, the environment, and related biological systems. The goals of the program are to prepare men and women for professional careers in engineering practice or related positions in education and government.

Design experience begins in the freshman year and is integrated throughout the curriculum in the lectures, discussions, homework, and lab assignments of many of the courses dealing with engineering topics. Agricultural engineers are involved in the design of systems that include food and bioprocess engineering, off-road equipment, bioenvironmental engineering of plant and animal facilities, water quality, and systems for the use and protection of soil and water resources. Important design constraints are economics, conservation of materials and energy, safety, and environmental quality. All students complete a major design project in the senior year that draws comprehensively on the knowledge gained in the foundational courses.

Graduates are employed by industry, consulting firms, and government for research, education, and manufacturing. All graduates obtain a four-year ABET-accredited Bachelor of Science degree from the College of Engineering and, in an optional five-year program, may receive a second Bachelor of Science degree in agricultural engineering sciences from the College of Agricultural, Consumer, and Environmental Sciences. By choice of electives, a student may direct his or her program toward specialization in power and machinery, soil and water, structures and environment, or electric power and processing or to a separate food and bioprocess engineering specialization. Individual programs are checked by departmental advisers to ensure that Accreditation Board for Engineering and Technology requirements are met for any chosen specialization.

The curriculum requires 128 hours for gradation except for the specialization in food and bioprocess engineering, which requires 132 hours for graduation.

SPECIALIZATION IN POWER AND MACHINERY, SOIL AND WATER, STRUCTURES AND ENVIRONMENT, OR ELECTRIC POWER AND PROCESSING

First year

HOURS	FIRST SEMESTER
1	AG E 100-Introduction to Agricultural Engineering
4	CHEM 101-General Chemistry
0	ENG 100-Engineering Lecture
3	G E 103-Engineering Graphics and Design
5	MATH 120-Calculus and Analytic Geometry, I
4	RHET 105-Principles of Composition[1]
17	Total

HOURS	SECOND SEMESTER
4	CHEM 102-General Chemistry (Biological or Physical Version)*
3	MATH 130-Calculus and Analytic Geometry, II
2	MATH 225-Introductory Matrix Theory
4	PHYCS 111-General Physics (Mechanics)
4	Biological and natural sciences elective[2]
17	Total

*Biological version recommended.

Second year

HOURS	FIRST SEMESTER
4	AG E 221-Engineering for Agricultural and Biological Systems
3	C S 101-Introduction to Computing with Application to Engineering and Physical Science
3	MATH 242-Calculus of Several Variables
4	PHYCS 112-General Physics (Electricity and Magnetism)
2-3	T A M 150-Introduction to Statics or T A M 152-Engineeering Mechanics, I (Statics)
16-17	Total

HOURS	SECOND SEMESTER
4	AG E 222–Engineering for Bioprocessing and Bioenvironmental Systems
3	MATH 285–Differential Equations and Orthogonal Functions
2	PHYCS 113–General Physics (Fluids and Thermal Physics)
3	T A M 212–Engineering Mechanics, II (Dynamics)
3	Elective in social sciences or humanities[3, 4]
15	Total

Third year

HOURS	FIRST SEMESTER
3	Agricultural engineering technical elective[5]
3	ECE 205–Introduction to Electrical and Electronic Circuits
1	ECE 206–Introduction to Electrical and Electronic Circuits Laboratory
3	T A M 221–Elementary Mechanics of Solids
3–4	STAT 310/MATH 363–Introduction to Mathematical Statistics and Probability, I; or C E 293–Engineering Modeling Under Uncertainty; or I E 230–Analysis of Data
3	Elective in social sciences or humanities[3, 4]
16–17	Total
HOURS	SECOND SEMESTER
3	Agricultural engineering technical elective[5]
1	AG E 298–Undergraduate Seminar
3	ECON 103–Macroeconomic Principles[3]
3–4	M E 209–Thermodynamics and Heat Transfer, or M E 205–Thermodynamics, or CH E 370–Chemical Engineering Thermodynamics
3–4	T A M 235–Fluid Mechanics, or CH E 371–Fluid Mechanics and Heat Transfer, or M E 211–Introductory Gas Dynamics
3	Elective in social sciences or humanities[3, 4]
16–18	Total

Fourth year

HOURS	FIRST SEMESTER
3	Agricultural engineering technical elective[5]
3	Elective in social sciences or humanities[3, 4]
4	Technical elective[5]
3	Free elective[4]
2	AG E 299-Undergraduate Thesis
15	Total
HOURS	SECOND SEMESTER
3	Agricultural engineering technical elective[5]
3	Free elective[4]
3	Technical elective[5]
4	Biological and natural sciences elective[2]
3	Elective in social sciences or humanities [3, 4]
16	Total

1. Students may take SPCOM 111 and 112 in place of RHET 105.
2. Students must complete eight hours from biological and natural sciences approved list.
3. Each student must satisfy the social sciences and humanities requirements of the College of Engineering, including ECON 102 or 103. Students entering in fall 1994 and later must also satisfy the campus general education requirements for social sciences and humanities.
4. One elective course must satisfy the general education Composition II requirement.
5. Students must have 19 hours of technical electives; at least 12 hours must be from AG E courses and the remainder selected from the department-approved list.

Biological and Natural Sciences Electives

HOURS	
8 min	Choose from:
3	CP SC 322-Forage Crops and Pastures
3	AN SCI 202-Domestic Animal Physiology
3	AN SCI 307-Environmental Aspects of Animal Management
3	BIOL 100-Biological Sciences[1]
4	BIOL 101-Biological Sciences[1]

4	BIOL 104–Animal Biology[1]
3	CHEM 231–Elementary Organic Chemistry
2	CHEM 234–Elementary Organic Chemistry Laboratory
3	ENT 120–Introduction to Applied Entomology
4	GEOL 101–Introduction to Physical Geology
3	GEOL 250–Geology for Engineers
3	HORT 227–Indoor Plant Culture, Use, and Identification
4	HORT 345–Growth and Development of Horticultural Crops
3	MCBIO 100–Introductory Microbiology[1]
2	MCBIO 101–Introductory Experimental Microbiology
3	MCBIO 311–Food and Industrial Microbiology
2	MCBIO 312–Techniques of Applied Microbiology
4	PLBIO 100–Plant Biology[1]
4	PHYSL 103–Introduction to Human Physiology
4	SOILS 101–Introductory Soils

1. Students must take at least one of these courses.

Technical Electives

For a total of 19 hours.

Agricultural Engineering Technical Electives

HOURS	
3	AG E 236–Machine Characteristics and Mechanisms
2	AG E 271–Transport Phenomena in Food Process Design
3	AG E 277–Design of Architectural Structures[1]
3	AG E 287–Environmental Control for Plants and Animals1
3–4	AG E 311–Instrumentation and Measurement[2]
3	AG E 315–Applied Machine Vision
3	AG E 336–Engineering Design Projects for Agricultural Industries[1]
3	AG E 346–Tractors and Prime Movers
3	AG E 356–Soil and Water Conservation Structures[1]

3	AG E 357-Land Drainage[1]
3	AG E 383-Engineering Properties of Food Materials
2	AG E 385-Food and Process Engineering Design[1]
3	AG E 387-Grain Drying and Conditioning
3	AG E 389-Process Design for Corn Milling

1. Students must take at least one of these courses. Includes major design experience.
2. This course is strongly recommended.

Other Technical Electives

Choose the remainder of the 19 hours from:

4	C E 201-Engineering Surveying
3	C E 241-Environmental Quality Engineering
3	C E 255-Introduction to Hydrosystems Engineering[1]
3	C E 261-Introduction to Structural Engineering[1]
3	C E 263-Behavior and Design of Metal Structures, I
3	C E 264-Reinforced Concrete Design, I
3	C E 280-Introduction to Soil Mechanics and Foundation Engineering
3	C E 350-Surface Water Hydrology
3	C E 361-Matrix Analysis of Frame Structures
4	CHEM 323-Applied Electronics for Scientists
3	CH E 261-Introduction to Chemical Engineering
3	CH E 370-Chemical Engineering Thermodynamics
4	CH E 371-Fluid Mechanics and Heat Transfer
4	CH E 373-Mass Transfer Operations
3	G E 288-Engineering Economy and Operations Research
4	M E 231-Engineering Materials
4	M E 270-Fundamentals of Mechanical Design[1]
3	M E 285-Design for manufacturability
3	M E 307-Solar Energy Utilization
3	MFG E 210-Introduction to Manufacturing Systems
3	MFG E 350-Information Management for Manufacturing Systems

Any 200- or 300-level engineering course approved by an adviser.
1. One of these courses is strongly recommended.

SPECIALIZATION IN FOOD AND BIOPROCESS ENGINEERING

Food and bioprocess engineering is the application of engineering principles to produce, preserve, process, package, and distribute foods. Food and bioprocess engineers develop, design, and construct new machinery, processes, and plants; they develop and test new products; they preserve and distribute foods; and they manage environmental factors, waste products, and energy. Food and bioprocess engineers participate in nearly every phase of food processing. Graduates are prepared for positions in a variety of industries, including food, pharmaceutical, and biotechnology industries. Job opportunities also exist with the government, universities, and consulting firms. Career possibilities include research and development; project, process, and plant engineering, which can include design, optimization, and construction; technical sales and service; and supervision and management. Those who continue their education in graduate school will have a strong background for further study in the sciences or engineering.

First year

HOURS	FIRST SEMESTER
1	AG E 100–Introduction to Agricultural Engineering
4	CHEM 101–General Chemistry
0	ENG 100–Engineering Lecture
3	G E 103–Engineering Graphics and Design
5	MATH 120–Calculus and Analytic Geometry, I
4	RHET 105–Principles of Composition[1]
17	Total
HOURS	SECOND SEMESTER
4	CHEM 102–General Chemistry (Biological or Physical Version)
3	C S 101–Introduction to Computing with Application to Engineering and Physical Science
3	MATH 130–Calculus and Analytic Geometry, II
2	MATH 225–Introductory Matrix Theory
4	PHYCS 111–General Physics (Mechanics)
16	Total

Second year

HOURS	FIRST SEMESTER
3	CHEM 231-Elementary Organic Chemistry
3	ECON 103-Macroeconomic Principles[2]
3	MATH 242-Calculus of Several Variables
3	MCBIO 100-Introductory Microbiology
2	PHYCS 113-General Physics (Fluids and Thermal Physics)
2-3	T A M 150-Introduction to Statics or T A M 152-Engineering Mechanics, I (Statics)
16-17	Total

HOURS	SECOND SEMESTER
4	AG E 222-Engineering for Bioprocessing and Bioenvironmental Systems
3	MATH 285-Differential Equations and Orthogonal Functions
2	MCBIO 101-Introductory Experimental Microbiology
4	PHYCS 112-General Physics (Electricity and Magnetism)
3	T A M 212-Engineering Mechanics, II (Dynamics)
17	Total

Third year

HOURS	FIRST SEMESTER
3	CH E 261-Introduction to Chemical Engineering
4	F S H N 314-Food Chemistry and Nutrition, I
3	T A M 221-Elementary Mechanics of Solids
2	Technical elective3
6	Electives in social sciences or humanities[2, 4]
18	Total

HOURS	SECOND SEMESTER
1	AG E 298-Undergraduate Seminar
3	CH E 370-Chemical Engineering Thermodynamics
3	ECE 205-Introduction to Electrical and Electronic Circuits
3	MCBIO 311-Food and Industrial Microbiology
3	Free elective4

3	Elective in social sciences or humanities[2, 4]
16	Total

Fourth year

HOURS	FIRST SEMESTER
3	AG E 383–Engineering Properties of Food Materials
4	CH E 371–Fluid Mechanics and Heat Transfer
3	F S H N 361–Food Processing, I
3	Technical elective[3]
3	Elective in social sciences or humanities[2, 4]
16	Total
HOURS	SECOND SEMESTER
2	AG E 299–Undergraduate Thesis
2	AG E 385–Food and Process Engineering Design
4	CH E 373–Mass Transfer Operations
3	F S H N 362–Food Processing, II
3	Free elective4
3	Elective in social sciences or humanities[2, 4]
17	Total

1. Students may take SPCOM 111 and 112 in place of RHET 105.
2. Each student must satisfy the social sciences and humanities requirements of the College of Engineering, including ECON 102 or 103. Students entering in fall 1994 and later must also satisfy the campus general education requirements for social sciences and humanities.
3. Students select technical electives from the approved list for food and bioprocess engineering.
4. One elective course must satisfy the general education Composition II requirement.

Food and Bioprocess Engineering Electives

HOURS	TECHNICAL ELECTIVES
1	AG E 284–Scale-Up of Food Processes
3–4	AG E 311–Instrumentation and Measurements
3	AG E 315–Applied Machine Vision
3	AG E 387–Grain Drying and Conditioning
3	AG E 389–Process Design for Corn Milling
3	AG E 396–Special Problems (Package Engineering)

3-4	C E 293-Engineering Modeling Under Uncertainty, I E 230-Analysis of Data, or STAT 310/MATH 363-Introduction to Mathematical Statistics and Probability, I
3	CH E 389-Chemical Process Control and Dynamics
3	G E 288-Engineering Economy and Operations Research or I E 203-Engineering Economics
.4	M E 270-Fundamentals of Mechanical Design
3	M E 261-Introduction to Instrumentation, Measurement, and Control Fundamentals
2	MCBIO 312-Techniques of Applied Microbiology

A dual program between the College of ACES and the College of Engineering was also available. It was essentially the curriculum for the College of Engineering with additional Agricultural coursework as described as follows in the Program of Study. Although several students start their program under the dual major, few finish with both degrees.

Exhibit 3.2. Dual Major in Agricultural Engineering and in Agricultural Engineering Sciences in 1997

Dual Major In Agricultural Engineering And In Agricultural Engineering Sciences

For the Degree of Bachelor of Science and the Degree of Bachelor of Science in Agriculture in Agricultural Engineering-Agriculture Science

This is a five-year program that results in a B.S. degree from the College of Engineering and a B.S. degree from the College of Agricultural, Consumer and Environmental Sciences. The 158 hour curriculum meets the requirements for both degrees.

Agricultural engineering is the integration of biological and physical sciences as a foundation for engineering applications in agriculture, food systems, natural resources, the environment, and related biological systems. Agricultural engineers are involved in the design of systems which include food and bioprocess engineering, off-road equipment, bioenvironmental engineering of plant and animal facilities, water quality and systems for the utilization and protection of soil and water resources. Important design constraints are economics, conservation of materials and energy, safety, and environmental quality. Graduates are employed by industry, consulting firms, and government for research, education, and manufacturing. By choice of electives, a student may direct his or her program toward specialization in power and machinery, soil and water, structures and environment, electrical power and processing, or to a separate food and bioprocess engineering specialization. Individual programs are checked by departmental advisers to insure that national engineering accreditation (ABET) requirements are met for any chosen specialization.

PRESCRIBED COURSES INCLUDING CAMPUS GENERAL EDUCATION

HOURS	COMPOSITION I AND SPEECH
4-3	RHET 105-Principles of Composition or equivalent (see college Composition I requirement)
3	SPCOM 101-Principles of Effective Speaking
HOURS	COMPOSITION II
	Select from campus approved list.
HOURS	QUANTITATIVE REASONING
3	C S 101-Introduction to Computing with Application to Engineering
5	MATH 120-Calculus and Analytic Geometry I
3	MATH 130-Calculus and Analytic Geometry II
3	MATH 225-Introductory Matrix Theory
3	MATH 242-Calculus of Several Variables
3	MATH 285-Differential Equations & Orthogonal Functions
HOURS	NATURAL SCIENCES
4	CHEM 101-General Chemistry
4	CHEM 102-General Chemistry
4	PHYCS 111-Mechanics
4	PHYCS 112-Electricity and Magnetism
2	PHYCS 113-Fluid and Thermal Physics
HOURS	BIOLOGICAL SCIENCE
10	Ten hours of biological sciences are required from biology, entomology, microbiology, plant biology, physiology and zoology. Select at least eight of the ten

hours from the following:
BIOL 100*-Biological Sciences
BIOL 101*-Biological Sciences
BIOL 104*-Animal Biology
CPSC 322-Forage Crops and Pastures
ANSCI 202-Domestic Animal Physiology
ANSCI 307-Environmental Aspects of Animal Management
GEOL 101-Introduction to Physical Geology
GEOL 250-Geology for Engineers
HORT 227-Indoor Plant Culture
HORT 345-Growth and Development of Horticultural Crops
MCBIO 100*-Introduction to Microbiology
MCBIO 101-Introduction to Experimental Microbiology
MCBIO 311-Food and Industrial Microbiology
MCBIO 312-Techniques of Applied Microbiology
PLBIO 100*-Plant Biology or Agronomy 121
PHYSL 103-Introduction to Human Physiology
SOILS 101-Introductory Soils
CHEM 231-Elementary Organic Chemistry
CHEM 234-Elementary Organic Chemistry Lab
ENTOM 120-Introduction to Applied Entomology

* Students must take at least one of these courses.

HOURS	HUMANITIES[1] AND SOCIAL SCIENCE[1]
18	To include ACE 100-Economics of Resources, Agriculture and Food, or ECON 102-Microeconomic Principles, or ECON 103-Macroeconomic Principles.
	CULTURAL STUDIES[2]
	One western culture and one non-western/US minority culture course.

1. Students must complete ACE 100, ECON 102 or ECON 103 and 15 additional hours of social sciences or humanities courses that satisfy the requirements of approved lists for the College of Engineering, the College of Agricultural, Consumer and Environmental Sciences, and the campus general education requirement. The College of Engineering requires one six-hour sequence in social science and one six-hour

sequence in humanities from approved courses. Since these may differ, students should carefully select approved courses that meet the requirements for all of the lists.

2. Work with adviser to select courses that also satisfy the social sciences and humanities requirements.

HOURS	AG E PRESCRIBED
1	1 AG E 100-Introduction to Agricultural Engineering
4	AG E 221-Engineering for Agricultural and Biological Systems
4	AG E 222-Engineering for Bioprocess and Bioenvironmental Systems
1	AG E 298-Undergraduate Seminar
3	AG E 299-Undergraduate Thesis
HOURS	OTHER PRESCRIBED
0	ENG 100-Engineering Lecture
3	ECE 205-Introduction to Electrical & Electronic Circuits
1	ECE 206-Lab to ECE 205
3	G E 103-Engineering Graphics & Design
3-4	M E 209-Thermodynamics & Heat Transfer, or M E 205-Thermodynamics, or CH E 370-Chemical Engineering Thermodynamics
3-4	STAT 310-Statistics, or MATH 363-Intro to MATH Statistics and Probability, I, or C E 293-Engineering Modeling Under Uncertainty, or I E 230-Analysis of Data
2-3	TAM 150-Analytical Mechanics or TAM 152-Engineering Mechanics, I
3	TAM 212-Engineering Mechanics, II
3	TAM 221-Elementary Mechanics of Solids
3-4	TAM 235-Fluid Mechanics, or CH E 371-Fluid Mechanics and Heat Transfer, or M E 211-Introductory to Gas Dynamics
AGRICULTURAL SCIENCE ELECTIVES	
15	Fifteen hours of agricultural sciences with courses from at least two departments other than Agricultural Engineering and approval of advisors are required.
HOURS	TECHNICAL ELECTIVES

19 Technical electives are upper level engineering courses. Students can choose from the recommended list below or by consent of adviser.

AGRICULTURAL ENGINEERING TECHNICAL ELECTIVES

At least 12 hours from:

AG E 236-Machine Characteristics and Mechanics
AG E 271-Transport Phenomena in Food Process Design
AG E 277*-Design of Agricultural Structures
AG E 287*-Environmental Control for Plants and Animals
AG E 311#-Instrumentation and Measurements
AG E 315-Applied Machine Vision
AG E 336*-Design of Agricultural Machinery
AG E 346-Tractors and Prime Movers
AG E 356*-Soil and Water Conservation Structures
AG E 357*-Land Drainage
AG E 383-Engineering Properties of Food Materials
AG E 385*-Food and Process Engineering Design
AG E 387-Grain Drying and Conditioning
AG E 389-Process Design for Corn Milling

*Students must take at least one of these courses. Includes major design experience.

#This course is strongly recommended.

OTHER TECHNICAL ELECTIVES

Remainder of the 19 hours from:

C E 201-Engineering Surveying or C E 205
C E 241-Air and Water Quality
C E 255*-Introduction to Hydrosystems Engineering
C E 261*-Introduction to Structural Engineering
C E 262-Intermediate Structural Analysis
C E 263-Behavior and Design of Metal Structure
C E 264-Reinforced Concrete Design
C E 280-Introduction to Soil Mechanics and Foundation Engineering
C E 350-Surface Water Hydrology
CHEM 323-Applied Electronics for Scientists

CH E 261-Introduction to Chemical Engineering
CH E 370-Chemical Engineering Thermodynamics
CH E 371-Fluid Mechanics and Heat Transfer
CH E 373-Mass Transfer Operations
G E 288-Engineering Economy and Operations Research
M E 270*-Fundamentals of Mechanical Design
M E 231-Processing and Structure of Materials
M E 285-Design for Manufacturability
M E 307-Solar Energy Utilization
M E 313-Computer Controls of Mechanical Engineering Systems
MFG E 210-Introduction to Manufacturing Systems
MFG E 350-Information Management for Manufacturing Systems
or any 200 or 300 level engineering course approved by adviser

*One of these courses is strongly recommended.

HOURS	OPEN ELECTIVES
11-14	Sufficient open electives selected to total minimum curriculum requirement of 158 hours. All requirements of the combined curriculum must be completed to satisfy the requirements for both degrees.
158	Total hours required to receive a B.S. in Agricultural Engineering and a B.S. in Agricultural Sciences.

In 1999 the following changes were made in course offerings:

1. Chem 101 - General Chemistry, 4 hrs, was replaced by Chem 102 - General Chemistry 3 hrs and Chem 106 - General Chemistry Laboratory, 1 hr.
2. Chem 102 - General Chemistry, 4 hrs, was replaced by Chem 102 - General Chemistry 3 hrs and Chem 106 - General Chemistry Laboratory, 1 hr.
3. ME 209 was discontinued as a thermodynamics alternative.
4. Hort 227 was discontinued as a Biological and Natural Science Elective.
5. ME 271 - Mechanical Engineering, I, 3 hrs. was added as an Other Technical Elective.

In 2001 the following changes were made in course offerings:

1. AgE 271 - Transport Phenomena in Food Process Design, 2 hrs, was discontinued.
2. AgE 360 - Indoor Air Containment Measurement and Control, 3 hrs, was added as an Ag Technical Elective.

In the Fall of 2004 a new system of course numbering was initiated. However, as a follow-up to the previous history that ended in 1997, following is a list of AgE courses from 1997 to 2004. Following the course name and number is the instructor that developed the course and date (if new), names of other instructors of the course, and date when discontinued.

Table 3.1. Courses in Agricultural Engineering prior to 2004

AG E 100: "Introduction to Agricultural Engineering, L.E. Bode.

AG E, 199: "Undergraduate Open Seminar", Faculty.

AG E , 221: "Engineering for Agricultural and Biological Systems", J.F. Reid, P. Kalita.

AG E, 222: "Engineering for Bioprocessing and Bioenvironmental Systems", S.R. Eckhoff, P. Kalita, Y. Zhang.

AG E, 236: "Machine Characteristics and Mechanisms".

AG E, 271: "Transport Phenomena in Food Process Design", Discontinued 2001.

AG E, 277: "Design of Agricultural Structures", G.L. Riskowski, Discontinued 2003.

AG E, 282: "Food Packaging Technology" 97, Discontinued 1999.

AG E, 284: "Scale-up of Food Processes" '97, '99, Discontinued 2000.

AG E, 287: "Environmental Control for Plants and Animals", L.L. Christianson.

AG E, 293: "Off-Campus Internship", 2002, Faculty.

AG E, 295: "Undergraduate Research or Thesis", 2002, Faculty.

AG E, 296: "Honors Project", Faculty.

AG E, 298: "Undergraduate Seminar", L.L. Christianson, Discontinued 2002.

AG E, 299: "Undergraduate Thesis", Faculty, Discontinued 2002.

AG E, 311: "Instrumentation and Measurements", Q. Zhang.

AG E, 315: "Applied Machine Vision", J.F. Reid.

AG E, 320: "Kinematics and Dynamics of Mechanical Engineering".

AG E, 324: "Agricultural Engineering Project Management", 2002.

AG E, 336: "Engineering Design Projects for Agricultural Industries", D.L. Bosworth.

AG E, 399: "Seminar", 2003, Faculty.

AG E, 340: "Applied Statistical Methods".

AG E, 345: "Statistical Methods".

AG E, 346: "Tractors and Prime Movers", A.C. Hansen.

AG E, 356: "Soil and Water Conservation Structures", J.K. Mitchell, P. Kalita.

AG E, 357: "Land Drainage", R.A.C. Cooke.

AG E, 360: "Indoor Air Contaminant Measurement and Control", 1999, Y. Zhang.

AG E, 377: "Design of Agricultural and Bioenvironmental Structures", 2003.

AG E, 382: "Package Engineering", 2001.

AG E, 383: "Engineering Properties of Food Materials", K.D. Rausch.

AG E, 385: "Food and Process Engineering Design", K.D. Rausch.

AG E, 387: "Grain Drying and Conditioning", M.R. Paulsen.

AG E, 389: "Process Design for Corn Milling", S.R. Eckhoff.

AG E, 396: "Special Problems", Faculty.

AG E, 400: "Research Orientation", Graduate Faculty.

AG E, 434: "Computer Aided Kinematics" not in '01, Discontinued prior to 2001.

AG E, 436: "Dynamics of Farm Machine Elements" not in '01, Discontinued prior to 2001.

AG E, 446: "Mechatronic Systems of Off-Road Vehicles", Q. Zhang.

AG E, 490: "Seminar", Graduate Faculty.

AG E, 496: "Topics in Agricultural Engineering", Graduate Faculty.

AG E, 499: "Thesis Research", Graduate Faculty.

The extensive project of renumbering courses to match campus directives and the change of name of the Department resulted in a new list of courses in 2004. Although the Department name was changed in

2004, the engineering curriculum remained Agricultural Engineering. The request to change the curriculum name to Agricultural and Biological Engineering was initiated in 2006 and approved for the 2009 program year. Following are the courses available from 2004 to present in Agricultural and Biological Engineering with the entries containing:

a) Course Number
b) Previous course number in parenthesis
c) Course title
d) Date course was started, if new
e) Faculty member who revised the course for the new system
f) Faculty who have taught the course
g) Date course discontinued

FROM 2006 TO 2010

The result of these changes was a Program of Study until 2010 as follows:

Exhibit 3.3. The Degree of Bachelor of Science in Agricultural and Biological Engineering, 2006 to 2010

For the Degree of Bachelor of Science in Agricultural and Biological Engineering

Agricultural and biological engineering is the application of mathematics, physical and biological science, and engineering to agriculture, food systems, energy, natural resources, the environment, and related biological systems. This program has special emphasis on environmental protection and the biological interface of plants, animals, soils, and microorganisms with the design and performance of environments, machines, mechanisms, processes, and structures.

Areas of Study

The agricultural and biological engineering program provides four standard Areas of Study.

Table 3.2. Courses in ABE from 2004

ABE	100	(100)	Intro Agric & Biological Engrg	L.E. Bode, A.C. Hansen, M. Danao, A. Green, R.S. Gates.
ABE	199	(199)	Undergraduate Open Seminar	Faculty.
ABE	221	(221)	Agric & Biological Engrg I	P. Kalita, T.E. Grift.
ABE	222	(222)	Agric & Biological Engrg II	Y. Zhang, S.R. Eckhoff, L.F. Rodriguez.
ABE	293	(293)	Off-Campus Internships	Discontinued 2007.
ABE	295	(295)	Independent Study	Discontinued 2007.
ABE	361	(236)	Off-Road Machine Design	A.C. Hansen, L. Tian.
ABE	374	(287)	Environ Control for Buildings	X. Wang, A. Green.
ABE	396	(296)	Honors Independent Study	Faculty.
ABE	397		Independent Study	Faculty.
ABE	398		Special Topics	Faculty.
ABE	420	(320)	Kinem & Dynamics of Mech Syst	Faculty of MIE.
ABE	425	(311)	Engr Measurement Systems	Q. Zhang, T.E. Grift.
ABE	426	(315)	Applied Machine Vision	T.E. Grift, discontinued 2009.
ABE	430	(324)	Project Management	L.E. Christianson, S.C. Zahos, L. Schideman.
ABE	436		Renewable Energy Systems	2007, X. Wang.
ABE	440	(340)	Applied Statistical Methods I	NRES Faculty.

ABE	445	(395)	Statistical Methods	AnSci Faculty.
ABE	446		Biological Nanoengineering	2009, K. Bhalerao.
ABE	455		Erosion and Sediment Control	2007, M.C. Hirschi.
ABE	456	(356)	Land & Water Resources Engrg	P. Kalita.
ABE	457		NPS Pollution Processes	2009, P. Kalita.
ABE	458		NPS Pollution Modelling	2009, R.A.C. Cooke.
ABE	459	(357)	Drainage and Water Management	R.A.C.Cooke.
ABE	463		Electrohydraulic Systems	2008, Q. Zhang, T.E. Grift.
ABE	466	(346)	Engineering Off-Road Vehicles	A.C. Hansen.
ABE	469	(336)	Industry-Linked Design Project	A.C. Hansen, S.C. Zahos, L. Schideman.
ABE	476	(360)	Indoor Air Quality Engineering	Y. Zhang.
ABE	479		Light Frame Structure Design	X. Wang, Discontinued 2008.
ABE	482	(382)	Package Engineering	S. Morris.
ABE	483	(383)	Engrg Properties of Food Matls	K.D. Rausch.
ABE	485	(385)	Food & Process Engrg Design	K.D. Rausch.
ABE	487	(387)	Grain Drying and Conditioning	M.R. Paulsen.
ABE	488		Bioprocessing Grains for Fuels	2006, V. Singh.
ABE	489	(389)	Corn Milling Process Design	S.R. Eckhoff.

ABE	497		Independent Study	2007, Faculty.
ABE	498	(396)	Special Topics	Faculty.
ABE	501	(400)	Graduate Research I	L.E. Bode, Y. Zhang.
ABE	502	(490)	Graduate Research II	S.R. Eckhoff.
ABE	594		Graduate Seminar	2006, M.R. Paulsen, L.E. Bode, P. Kalita, Y. Zhang, S.R. Eckhoff.
ABE	561	(446)	Off-Road Vehicle Mechatronics	Q. Zhang.
ABE	597	(496)	Independent Study	Graduate Faculty.
ABE	598		Special Topics	2008, Graduate Faculty.
ABE	599	(499)	Thesis Research	Graduate Faculty.

Specializations

- Bioenvironmental Engineering: the application of engineering principles to design, manufacture, and test systems that provide the desired environmental conditions for animals, human housing, crop storage structures, greenhouses, and other biological systems. Bioenvironmental engineers design equipment for heating, ventilating, air-conditioning, air-quality control, and develop systems to handle and treat biowaste.
- Off-Road Equipment Engineering: the application of engineering knowledge and skill to design, manufacture, and test equipment for the agricultural, construction, forestry, and mining industries. Off-road equipment engineers develop precision machine systems that rely on advanced information and sensing technologies and a high level of automation and control.
- Soil and Water Resource Engineering: the application of engineering principles and practices to design and develop systems for natural resources and environmental protection and utilization. Soil and water engineers design systems to control soil erosion and flooding, and develop ways to handle stormwater and control the movement of sediment into water systems.

Concentration

- Food and Bioprocess Engineering: the application of engineering principles to produce, process and package foods and bioproducts. Food and bioprocess engineers design, develop, and construct new processes, machines, and plants; they develop and test new products; and they manage environmental factors, waste products, and energy conservation.

Overview of Curricular Requirements

The curriculum requires 128 hours for graduation, except for the Concentration in Food and Bioprocess Engineering, which requires 132 hours. The curriculum is organized as follows.

Orientation and Professional Development

These courses introduce the opportunities and resources your college, department, and curriculum can offer you as you work to achieve your career goals. They also provide the skills to work effectively and successfully in the engineering profession.

Hours	Requirements
1	ABE 100-Agric & Biological Engrg[1]
0	ENG 100-Engineering Orientation[1]
1	Total

1. External transfer students take ENG 300-Engrg Transfer Orientation instead.

Foundational Mathematics and Science

These courses stress the basic mathematical and scientific principles upon which the engineering discipline is based.

Hours	Requirements
3	CHEM 102-General Chemistry I
1	CHEM 103-General Chemistry Lab I
3	CHEM 104-General Chemistry II
1	CHEM 105-General Chemistry Lab II
4	MATH 221-Calculus I[1]
2	MATH 225-Introductory Matrix Theory
3	MATH 231-Calculus II
4	MATH 241-Calculus III
3	MATH 285-Intro Differential Equations
4	PHYS 211-University Physics: Mechanics
4	PHYS 212-University Physics: Elec & Mag
2	PHYS 213-Univ Physics: Thermal Physics
34	Total

1. MATH 220-Calculus may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

Agricultural and Biological Engineering Technical Core

These courses stress fundamental concepts and basic laboratory techniques that comprise the common intellectual understanding of agricultural and biological engineering and the background for the technical courses and electives in each student's specialization or concentration.

For all Specializations and the Concentration

Hours	Requirements
4	ABE 222-Agric & Biological Engrg II
2	ABE 430-Project Management
4	ABE 469-Industry-Linked Design Project
3	CS 101-Intro Computing: Engrg & Sci
3	ECE 205-Elec & Electronic Circuits
3	GE 101-Engineering Graphics & Design
2	TAM 210-Introduction to Statics or TAM 211-Statics1
3	TAM 212-Introductory Dynamics
3	TAM 251-Introductory Solid Mechanics
27	Subtotal for all specializations and the concentration. See additional technical core requirements below.

1. The extra hour of credit for this course may be used to help meet free elective requirements.

For the Specializations in Bioenvironmental Engineering, Off-Road Equipment Engineering, or Soil and Water Resource Engineering

Hours	Requirements
4	ABE 221-Agric & Biological Engrg I
3	CEE 202-Engineering Risk & Uncertainty or IE 300-Analysis of Data or ABE 440-Applied Statistical Methods I[1] or STAT 400-Statistics and Probability I[1]
1	ECE 206-Elec & Electronic Circuits Lab
3	ME 300-Thermodynamics or CHBE 321-Thermodynamics[1]
4	TAM 335-Introductory Fluid Mechanics or CHBE 421-Momentum and Heat Transfer or ME 310-Introductory Gas Dynamics
15	Subtotal
42	Total for the Specializations in Bioenvironmental Engineering, Off-Road Equipment Engineering, or Soil and Water Resource Engineering

1. The extra hour of credit for this course may be used to help meet free elective requirements.

For the Concentration in Food and Bioprocess Engineering

Hours	Requirements
3	ABE 483-Engrg Properties of Food Matls
3	CHBE 221-Principles of CHE
4	CHBE 321-Thermodynamics
4	CHBE 421-Momentum and Heat Transfer
4	CHBE 422-Mass Transfer Operations
3	CHEM 232-Elementary Organic Chemistry I
3	FSHN 414-Food Chemistry
3	FSHN 461-Food Processing I
3	FSHN 462-Food Processing II
3	FSHN 471-Food & Industrial Microbiology
3	MCB 100-Introductory Microbiology
2	MCB 101-Intro Microbiology Laboratory
38	Subtotal
65	Total for the Concentration in Food and Bioprocess Engineering

Technical Electives

This elective course work must be completed to fulfill each Specialization or Concentration. The subjects build upon the agricultural and biological engineering technical core.

For the Specializations in Bioenvironmental Engineering, Off-Road Equipment Engineering, or Soil and Water Resource Engineering

Hours	Requirements
7	Biological and natural sciences electives chosen from a departmentally approved list of Biological and Natural Sciences Electives
16	Technical electives in one or more of the three Specializations chosen in consultation with an advisor. At least 8 hours must be Agricultural and Biological Engineering Technical Electives and the remainder approved Other Technical Electives.
23	Total

For the Concentration in Food and Bioprocess Engineering

Hours	Requirements
4	Technical electives chosen from a departmentally approved list of Food and Bioprocess Engineering Electives

Social Sciences and Humanities

The social sciences and humanities courses, as approved by the College of Engineering, ensure that students have exposure in breadth and depth to areas of intellectual activity that are essential to the general education of any college graduate.

Hours	Requirements
3	ECON 103-Macroeconomic Principles[1]
15	Electives in social sciences and humanities approved by the College of Engineering and satisfying the campus general education requirements for social sciences and humanities, including cultural studies western and non-western.
18	Total

1. ECON 102 or ACE 100 may be substituted by petition.

Composition

These courses teach fundamentals of expository writing.

Hours	Requirements
4	RHET 105-Principles of Composition
	Advanced Composition. May be satisfied by completing a course with the Advanced Composition designation in either the social sciences and humanities or the free elective categories.
4	Total

Free Electives

These unrestricted electives, subject to certain exceptions as noted at the College of Engineering advising Web site, give the student the opportunity to explore any intellectual area of unique interest. This freedom plays a critical role in helping students to define research specialties or to complete minors.

Hours	Requirements
6	Free electives. Additional unrestricted course work, subject to certain exceptions as noted at the College of Engineering advising Web site, so that there are at least 128 credit hours earned toward the degree, except for the Concentration in Food and Bioprocess Engineering, which requires132 hours.

Suggested Sequence

The schedule that follows is illustrative, showing the typical sequence in which courses would be taken by a student with no college course credit already earned and who intends to graduate in four years. Each individual's case may vary, but the position of required named courses is generally indicative of the order in which they should be taken. The first year of the Suggested Sequence is the same for all agricultural and biological engineering students. The second through fourth years vary with the Specialization or Concentration chosen. Refer to the appropriate sequence continuation below.

First year

Hours	First Semester
1	ABE 100-Intro Agric & Biological Engrg
3	CHEM 102-General Chemistry I
1	CHEM 103-General Chemistry Lab I
0	ENG 100-Engineering Orientation
3-4	GE 101-Engineering Graphics & Design or RHET 105-Principles of Composition[1]
4	MATH 221-Calculus I[2]
3	Elective in social sciences or humanities[3,4]
15-16	Total
Hours	Second Semester
3	CHEM 104-General Chemistry II*
1	CHEM 105-General Chemistry Lab II*
2	MATH 225-Introductory Matrix Theory
3	MATH 231-Calculus II
4	PHYS 211-University Physics: Mechanics

4-3	RHET 105-Principles of Composition or GE 101-Engineering Graphics & Design[1]
17-16	Total

*Biological version recommended.

Specializations in Bioenvironmental Engineering, Off-Road Equipment Engineering, or Soil and Water Resource Engineering

Second year

Hours	First Semester
4	ABE 221-Agric & Biological Engrg I
3	CS 101-Intro Computing: Engrg & Sci
4	MATH 241-Calculus III
4	PHYS 212-University Physics: Elec & Mag
2	TAM 210-Introduction to Statics or

TAM 211-Statics5

17	Total
Hours	Second Semester
4	ABE 222-Agric & Biological Engrg II
3	MATH 285-Intro Differential Equations
2	PHYS 213-Univ Physics: Thermal Physics
3	TAM 212-Introductory Dynamics
4	Biological and natural sciences elective[6]
16	Total

Third year

Hours	First Semester
2	Agricultural and biological engineering technical elective[7]
3	ECE 205-Elec & Electronic Circuits
1	ECE 206-Elec & Electronic Circuits Lab
3	TAM 251-Introductory Solid Mechanics
3	CEE 202-Engineering Risk & Uncertainty or IE 300-Analysis of Data or ABE 440-Applied Statistical Methods I[5] or STAT 400-Statistics and Probability I[5]

3	Elective in social sciences or humanities[3,4]
15	Total
Hours	Second Semester
3	Agricultural and biological engineering technical elective[7]
3	ECON 103–Macroeconomic Principles[3]
3	ME 300–Thermodynamics
4	TAM 335–Introductory Fluid Mechanics or CHBE 421–Momentum and Heat Transfer or ME 310–Introductory Gas Dynamics
3	Elective in social sciences or humanities[3,4]
16	Total

Fourth year

Hours
First Semester

2	ABE 430–Project Management
3	Agricultural and biological engineering technical elective[7]
3	Elective in social sciences or humanities[3,4]
4	Technical elective[7]
3	Free elective[4]
15	Total
Hours	Second Semester
4	ABE 469–Industry-Linked Design Project
3	Free elective4
4	Technical elective[7]
3	Biological and natural sciences elective[6]
3	Elective in social sciences or humanities[3,4]
17	Total

Concentration in Food and Bioprocess Engineering

Second year

Hours	First Semester
3	CHEM 232–Elementary Organic Chemistry I

3	CS 101-Intro Computing: Engrg & Sci
4	MATH 241-Calculus III
3	MCB 100-Introductory Microbiology
2	PHYS 213-Univ Physics: Thermal Physics
2	TAM 210-Introduction to Statics or

TAM 211-Statics5

17	Total
Hours	Second Semester
4	ABE 222-Agric & Biological Engrg II
3	MATH 285-Intro Differential Equations
2	MCB 101-Intro Microbiology Laboratory
4	PHYS 212-University Physics: Elec & Mag
3	TAM 212-Introductory Dynamics
16	Total

Third year

Hours	First Semester
3	CHBE 221-Principles of CHE
3	FSHN 414-Food Chemistry
3	TAM 251-Introductory Solid Mechanics
3	ECON 103-Macroeconomic Principles[3]
3	Electives in social sciences or humanities[3,4]
2	Technical elective[8]
17	Total
Hours	Second Semester
4	CHBE 321-Thermodynamics
3	ECE 205-Elec & Electronic Circuits
3	FSHN 471-Food & Industrial Microbiology
3	Free elective[4]
3	Elective in social sciences or humanities[3,4]
16	Total

Fourth year

Hours	First Semester
2	ABE 430-Project Management
3	ABE 483-Engrg Properties of Food Matls
4	CHBE 421-Momentum and Heat Transfer

3	FSHN 461-Food Processing I
2	Technical elective[8]
3	Elective in social sciences or humanities[3,4]
17	Total
Hours	Second Semester
4	ABE 469-Industry-Linked Design Project
4	CHBE 422-Mass Transfer Operations
3	FSHN 462-Food Processing II
3	Free elective[4]
3	Elective in social sciences or humanities[3,4]
17	Total

1. RHET 105 may be taken in the first or second semester of the first year as authorized. The alternative is GE 101. Students may take SPCM 111 and 112 in place of RHET 105.

2. MATH 220-Calculus may be substituted with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

3. Each student must satisfy the 18-hour social sciences and humanities requirements of the College of Engineering, including ECON 103 (or either ECON 102 or ACE 100 by permission), and the campus general education requirements for social sciences and humanities.

4. One elective course must satisfy the General Education Advanced Composition requirement.

5. The extra hour of credit for this course may be used to help meet free elective requirements.

6. Students in the Specializations of Bioenvironmental Engineering, Off-Road Equipment Engineering, and Soil and Water Resource Engineering must complete seven hours from the approved list of Biological and Natural Sciences Electives.

7. Students in the Specializations of Bioenvironmental Engineering, Off-Road Equipment Engineering, and Soil and Water Resource Engineering must have 16 hours of technical electives chosen in consultation with an advisor. At least 8 hours must be from the approved list of Agricultural and Biological Engineering Technical Electives and the remainder selected from the approved list of Other Technical Electives.

8. Students in the Food and Bioprocess Engineering Concentration must select 4 hours of technical electives from the approved list of Food and Bioprocess Engineering Electives

As described previously, there is a dual degree program available which is described by the following Program of Study.

Exhibit 3.4. Dual Major in Agricultural and Biological Engineering Sciences, 2006 to 2010

Dual Major in Agricultural and Biological Engineering Sciences

Students who successfully complete this five-year academic program receive the Bachelor of Science with a major in Agricultural and Biological Engineering from the College of Engineering as well as Agricultural and Biological Engineering Sciences from the College of ACES. Students first enroll in the College of ACES and then transfer to the College of Engineering after two years. The suggested program of study that follows fulfills graduation requirements for both the College of Engineering and the College of ACES. Graduates are employed by industry, consulting firms, and government for research, education, and manufacturing. Departmental advisors ensure that national engineering accreditation (ABET) requirements are met by advisees.

Prescribed Courses Including Campus General Education

Hours	Composition I and Speech
4	RHET 105 - Principles of Composition or equivalent (see college Composition I requirement)
3	CMN 101 - Public Speaking
Hours	Advanced Composition
	One elective course must satisfy the Advanced Composition requirement.
Hours	Cultural Studies
	One Western culture and one non-Western/US minority culture course must be completed as part of the Social and Behavioral Sciences and/or Humanities and the Arts General Education coursework
Hours	Foreign Language: Coursework at or above the third level is required for graduation.
Hours	Quantitative Reasoning I
4	MATH 221 - Calculus I
Hours	Quantitative Reasoning II

3	MATH 231 – Calculus II
Hours	Natural Sciences and Technology
3	CHEM 102 – General Chemistry I
1	CHEM 103 – General Chemistry Lab I
3	CHEM 104 – General Chemistry II
1	CHEM 105 – General Chemistry Lab II
4	PHYS 211 – Univ Physics Mechanics
4	PHYS 212 – Univ Physics Elec and Mag
2	PHYS 213 – Univ Physics, Thermal Physics
Hours	General Education Coursework
6	Six hours of Social and Behavioral Science courses that must include ACE 100 or ECON 102 or ECON 103 and that satisfy the campus general education requirements.
6	Six hours of Humanities and the Arts courses that satisfy the campus general education requirements.
6	Six hours of either Social and Behavioral Science or Humanities and the Arts courses that satisfy the requirements of approved lists for the College of Engineering and the campus general education requirements.
Hours	Biological Sciences Coursework
10	Ten hours of biological sciences are required from biology, entomology, microbiology, plant biology, physiology, and zoology. Select at least seven of the ten hours from the following: ANSC 362 – Princ of Animal Physiology ANSCI 467 – Applied Animal Ecology CHEM 232 – Elementary Organic Chemistry I CHEM 233 – Elementary Organic Chemistry Lab I CPSC 112 – Introduction to Crop Sciences CPSC 270 – Applied Entomology CPSC 414 – Forage Crops and Pasture Eco GEOL 101 – Introductory Physical Geology GEOL 250 – Geology for Engineers IB 101–Biological Sciences or 103*–Introduction to Plant Biology or 104*–Animal Biology MCB 100* – Introductory Microbiology

	MCB 101* – Intro Microbiology Laboratory
	MCB 103-Intro to Human Physiology
	MCB 312 – Applied Microbiology Methods
	MCB 434 – Food & Industrial Microbiology
	NRES 201 – Introductory Soils

* Students must take at least one of these courses.

Hours	Agricultural Engineering Required
1	ABE 100 – Intro to Agr Engineering
4	ABE 221 – Agr & Bio Engineering I
4	ABE 222 – Agr & Bio Engineering II
2	ABE 430–- Project Management
4	ABE 469 – Industry-Linked Design Project
3	CS 101– Intro to Computing, Eng & Sci
0	ENG 100 – Engineering Lecture
3	ECE 205 – Intro Elec & Electr Circuits
1	ECE 206 – Intro Elec & Electr Ckts Lab
3	GE 101 – Engineering Graphics & Design
3-4	ME 300 – Thermodynamics or CHBE 321 – Thermodynamics
2	MATH 225 – Introductory Matrix Theory
4	MATH 241 – Calculus III
3	MATH 285 – Intro Differential Equations
3-4	ABE 440-Applied Statistical Methods I, or STAT 400 – Statistics and Probability I, or CEE 202 – Engineering Risk & Uncertainty, or IE 300 – Analysis of Data
2-3	TAM 210 – Intro to Statics or TAM 211 – Statics
3	TAM 212 – Introductory Dynamics
3	TAM 251 – Introductory Solid Mechanics
4	TAM 335 – Introductory Fluid Mechanics, or CHBE 421 – Momentum and Heat Transfer, or ME 310 – Introductory Gas Dynamics

Hours	Agricultural Sciences Coursework
15	Fifteen hours of agricultural sciences with courses from at least two departments other than Agricultural and Biological Engineering and approval of advisers are required.

Hours	Technical Coursework
16	A total of 16 hours of technical electives are required.

At least 8 hours must be from the following list of Agricultural and Biological Engineering Technical Electives and at least eight hours selected from the list of "Other Technical Electives" in the next section.

Agricultural Engineering Technical Electives

At least 12 hours from:
ABE 361 - Princ of Off-road Machines
ABE 374 - Env Control for Bio Buildings
ABE 397-Independent Study
ABE 420-Kinem & Dynamics of Mech Syst
ABE 425# - Eng Measurement Systems
ABE 426 - Applied Machine Vision
ABE 436-Renewable Energy Systems
ABE 455-Erosion and Sediment Control
ABE 456 - Land and Water Resources Eng
ABE 459 - Drainage and Water Management
ABE 463-Electrohydraulic Systems
ABE 466 - Engineering Off-Road Vehicles
ABE 476 - Indoor Air Quality Engineering
ABE 479* - Design of Agr & Bio Structures
ABE 482 - Package Engineering
ABE 483 - Eng Properties of Food Mat
ABE 485 - Food and Process Eng Design
ABE 487 - Grain Drying and Conditioning
ABE 488 - Bioprocessing Grains for Fuels
ABE 489 - Process Des for Corn Milling
ABE 497-Independent Study

Hours Other Technical Electives

Choose at least eight hours from:
CEE 311- Engineering Surveying or CEE 312- Route Surveying
CEE 330- Environmental Engineering
CEE 350- Water Resources Engineering
CEE 360- Structural Engineering
CEE 380- Geotechnical Engineering
CEE 450- Surface Hydrology

CEE 460- Steel Structures, I
CEE 461- Reinforces Concrete Design, I
CHBE 221- Principles of CHE
CHBE 421- Momentum and Heat Transfer
CHBE 422- Mass Transfer Operations
GE 330- OR Methods for Profit & Value Eng
ME330- Engineering Materials
ME 350- Design for Manufacturability
ME 370- Mechanical Design, I
ME 461- Computer Ctrl of Mechanl Sys
MFGE 310- Intro to MFG Systems
MFGE 450- Info Mgmt for MFG Systems
PHYS 214 - Univ Physics, Quantum Physics
TAM 324-Behavior of Materials
or any 300 or 400 level engineering course approved by advisor

Hours Open Electives

Sufficient open electives selected to total minimum curriculum requirement of 158 hours. All requirements of the combined curriculum must be completed to satisfy the requirements for both degrees.

158 Total hours required to receive a B.S. in Agricultural Engineering and a B.S. in Agricultural Sciences.

FROM 2010

During the 2010-2011 academic year, the curriculum was again revised to discontinue the concentration in Food and Bioprocess Engineering and establish a new concentration in Agricultural Engineering and a new concentration in Biological Engineering. The Agricultural and Biological Engineering major is maintained at 128 hours (with the exception of students electing the Food and Bioprocess Engineering Concentration, which required 132 hours) but students will be required to choose one of two distinct concentration paths for their degree. Specific changes included:

1. Concentration in Agricultural Engineering: This concentration focuses on the practice of engineering primarily in the agricultural domain of the field of agricultural and biological engineering (ABE) with students required to select a coherent set of courses in

consultation with their advisor that constitutes a specialization in this domain such as off-road equipment engineering, soil and water resources engineering, and renewable energy systems. The concentration consists of 14 hours of required core technical courses and 23 hours of technical electives.

2. Concentration in Biological Engineering: This concentration focuses on the practice of engineering in the realm of living systems in agriculture, food, energy, the environment, and related biological systems. This extends beyond the singular area of study currently available as the Food and Bioprocess Engineering Concentration with students again required to select coherent sets of courses that constitute specializations in this domain such as bioenvironmental engineering (for example greenhouse and livestock building design), ecological engineering, food and bioprocess engineering, and nanoscale biological engineering. The concentration consists of 16 hours of required core technical courses and 21 hours of technical electives.

The details of these changes follows:

Exhibit 3.5. The Degree of Bachelor of Science in Agricultural and Biological Engineering in 2010

For the Degree of Bachelor of Science in Agricultural and Biological Engineering

Agricultural and biological engineering is the application of mathematics, physical and biological science, and engineering to agriculture, food systems, energy, the environment, and related biological systems. This ABET-accredited degree program has special emphasis on environmental protection and the biological interface of plants, animals, soils, and microorganisms with the design and performance of environments, machines, mechanisms, processes, and structures.

Concentrations

The agricultural and biological engineering program provides two concentrations: Agricultural Engineering and Biological Engineering. Each concentration has specific areas of specialization related to career interest.

Agricultural Engineering Concentration

The B.S. Degree in Agricultural and Biological Engineering provides a concentration in Agricultural Engineering. This concentration includes the integration of physical and biological sciences as a foundation for engineering applications in agriculture, food systems, energy, the environment, and related biological systems. Students pursuing this concentration are involved in the design of systems for renewable energy, off-road equipment, water quality, and the utilization and protection of soil and water resources. Important design constraints are economics, conservation of materials and energy, safety, and environmental quality. Within this concentration, students are required to select a set of coherent courses that constitutes a specialization in their area of career interest either from the following list or a customized area chosen in consultation with an advisor:

Renewable Energy Systems
Off-Road Equipment Engineering
Soil and Water Resources Engineering

Biological Engineering Concentration

The B.S. Degree in Agricultural and Biological Engineering also provides a concentration in Biological Engineering. This concentration integrates biology and engineering to provide solutions to problems related to living systems in agriculture, food, energy, the environment, and related biological systems. . Engineered biological systems in these domains vary widely in scale. At the molecular level, nanometer-scale devices consist of a few biomolecules inside individual cells. At the other extreme, regionally-scaled complex ecosystems depend upon multiple species of interacting living organisms. Such systems are becoming increasingly important in areas such as bioenergy, bioprocessing, nanotechnology, biosensing, bio-informatics, and bioenvironment. Within this concentration, students are required to select a set of coherent courses that constitutes a specialization in their area of career interest either from the following list or a customized area chosen in consultation with an advisor:

Bioenvironmental Engineering

Ecological Engineering
Food and Bioprocess Engineering
Nanoscale Biological Engineering

Overview of Curricular Requirements

The curriculum requires 128 hours for graduation. The curriculum is organized as follows.

Orientation and Professional Development

These courses introduce the opportunities and resources that your college, department, and curriculum can offer you as you work to achieve your career goals. They also provide the skills to work effectively and successfully in the engineering profession.

Hours	Requirements
1	ABE 100-Agric & Biological Engrg[1]
0	ENG 100-Engineering Orientation[1]
1	Total

1. External transfer students take ENG 300-Engrg Transfer Orientation instead.

Foundational Mathematics and Science

These courses stress the basic mathematical and scientific principles upon which the engineering discipline is based.

Hours	Requirements
3	CHEM 102-General Chemistry I
1	CHEM 103-General Chemistry Lab I
3	CHEM 104-General Chemistry II
1	CHEM 105-General Chemistry Lab II
4	MATH 221-Calculus I1
2	MATH 225-Introductory Matrix Theory
3	MATH 231-Calculus II
4	MATH 241-Calculus III
3	MATH 285-Intro Differential Equations
4	PHYS 211-University Physics: Mechanics
4	PHYS 212-University Physics: Elec & Mag
2	PHYS 213-Univ Physics: Thermal Physics

34	Total

1. MATH 220-Calculus may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

Agricultural and Biological Engineering Technical Core

These courses stress fundamental concepts and basic laboratory techniques that comprise the common intellectual understanding of agricultural and biological engineering and the background for the technical courses and electives in each student's concentration.

For Both Concentrations

Hours	Requirements
4	ABE 221-Agric & Biological Engrg I
4	ABE 222-Agric & Biological Engrg II
2	ABE 430-Project Management
4	ABE 469-Industry-Linked Design Project
3	CS 101-Intro Computing: Engrg & Sci
3	ECE 205-Elec & Electronic Circuits
3	GE 101-Engineering Graphics & Design
2	TAM 210-Introduction to Statics or TAM 211-Statics1
3	TAM 212-Introductory Dynamics
28	Subtotal for both concentrations. See additional technical core requirements below.

1. The extra hour of credit for this course may be used to help meet free elective requirements.

For the Agricultural Engineering Concentration

Hours	Requirements
3	CEE 202-Engineering Risk & Uncertainty or IE 300-Analysis of Data or ABE 440-Applied Statistical Methods I[1] or STAT 400-Statistics and Probability I[1]
1	ECE 206-Elec & Electronic Circuits Lab
3	ME 300-Thermodynamics

3	TAM 251-Introductory Solid Mechanics
4	TAM 335-Introductory Fluid Mechanics or CHBE 421-Momentum and Heat Transfer or ME 310-Introductory Gas Dynamics
14	Subtotal
42	Total for the Agricultural Engineering Concentration

1. The extra hour of credit for this course may be used to help meet free elective requirements.

For the Biological Engineering Concentration

Hours	Requirements
2	ABE 141-Biological Principles in Engrg
3	ABE 341-Heat/Mass Transfer & Momentum
4	CHBE 321-Thermodynamics
3	CHEM 232-Elementary Organic Chemistry I
4	MCB 150-Molec & Cellular Basis of Life
16	Subtotal
44	Total for the Biological Engineering Concentration

Technical Electives

This elective course work must be completed to fulfill each Concentration. The subjects build upon the agricultural and biological engineering technical core.

For the Agricultural Engineering Concentration

Hours	Requirements
7	Biological and natural sciences electives chosen from a departmentally approved list of Biological and Natural Sciences Electives - Group A
16	Technical electives chosen in consultation with an advisor. At least 8 hours must be Agricultural and Biological Engineering Technical Electives - Group A, and the remainder approved Other Technical Electives - Group A.
23	Total

For the Biological Engineering Concentration

Hours	Requirements
6	Biological and natural sciences electives chosen from a departmentally approved list of Biological and Natural Sciences Electives – Group B
15	Technical electives chosen in consultation with an advisor. At least 8 hours must be Agricultural and Biological Engineering Technical Electives – Group B, and the remainder approved Other Technical Electives – Group B.
21	Total

Social Sciences and Humanities

The social sciences and humanities courses, as approved by the College of Engineering, ensure that students have exposure in breadth and depth to areas of intellectual activity that are essential to the general education of any college graduate.

Hours	Requirements
3	ECON 103–Macroeconomic Principles[1]
15	Electives in social sciences and humanities approved by the College of Engineering and satisfying the campus general education requirements for social sciences and humanities, including cultural studies western and non-western.
18	Total

1. ECON 102 or ACE 100 may be substituted by advisor approval.

Composition

These courses teach fundamentals of expository writing.

Hours	Requirements
4	RHET 105–Principles of Composition
Advanced Composition.	May be satisfied by completing a course with the Advanced Composition designation in either the social sciences and humanities or the free elective categories.
4	Total

Free Electives

These unrestricted electives, subject to certain exceptions as noted at the College of Engineering advising Web site, give the student the opportunity to explore any intellectual area of unique interest. This freedom plays a critical role in helping students to define research specialties or to complete minors.

Hours	Requirements
6	Free electives. Additional unrestricted course work, subject to certain exceptions as noted at the College of Engineering advising Web site, so that there are at least 128 credit hours earned toward the degree.

SENIOR DESIGN COURSE

The Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering & Technology (ABET) requires a capstone design course to be part of any accredited engineering program. The course will utilize the previous engineering education and will demonstrate the student has the design skills appropriate for the professional practice of engineering.

The original capstone design course for the Off-Road Equipment majors (AgE 336) was established 60 years ago by George Pickard who had industry experience with Massey-Harris. He was followed by Dwight Kampe who had worked with Ford Farm Equipment group. Don Hunt who had industry experience with Oliver Farm Equipment led 336 from 1965 until 1985. Richard Coddington was hired from Deere & Co. after extensive design, research and evaluation experiences. He brought his extensive experience and industry contacts to further develop the senior design course. Carroll Goering, who had worked with International Harvester, handled 336 the year that Coddington was on sabbatical leave. In 1995, Coddington was promoted to become the Placement Director for the College of Engineering. He was replaced by Douglas Bosworth, a Past President of the American Society of Agricultural & Biological Engineers and served on the EAC. He came to the University of Illinois after 35 years with Deere & Co. In 2005, Steve Zahos who had 32 years of experience with Union Carbide, Universal Companies, Envirecycle and in consulting attained the leadership of the course and brought new insights to the design experience.

The key elements of this course have been that all of the instructors have worked in industry, the students work in a team environment and the student projects have all involved "real life" problems from industry sponsors. Key sponsors of student projects include: Deere & Co., Caterpillar, Case-New Holland, Hydro-Gear, Alamo Group and Waterborne Engineering. The student teams are assigned design projects that are "needed" by the industry sponsor and they work with a mentor engineer from that organization. A list of the industry-sponsored projects is given in the appendix. The projects are designed so the teams can conduct research, design, build and evaluate the project to assure that it meets the needs of the industry customer. The goal is to have the student teams experience the entire product development process. The course work also involves developing knowledge and skills in the "real world" to enhance their potential for success as engineers. The feedback from the students that have taken this course is that it is the most valuable course they took in college since it prepared them for success in the workplace. Another measure of the success is that besides ABE students, the team members have included Technical Systems Management, Mechanical Engineering and Engineering Mechanics majors.

This course has evolved over the past 60 years to meet the needs of the students and potential customers while utilizing the tools, technology and processes utilized in American industry. The results are that over 1/3 of the projects are ultimately adopted by the industry sponsor and the exposure of the team members have resulted in many career opportunities with the sponsor.

The latest evolution in 2007 was to move from an Off Road Equipment course to a Senior Capstone Design (ABE 469) for all of the options in ABE. This change is a natural move since the product development processes are similar for most industries. The Senior Design course has been a model for other university programs and has provided solid engineering experiences for graduates of the program.

Prior to 2007 Capstone Design was accomplished in other concentrations within senior level courses. In AGE 356, Soil and Water Conservation Structures, and ABE 456, Land and Water Resources Engineering, taught by Kent Mitchell and Prasanta Kalita (both of whom had experience in SW design and construction), students were required to design a major project either individually or, usually, in teams. The project designs included small dams, terrace systems, or other complex systems requiring full use of their knowledge of hydrology, hydraulics, hydraulic structures, soil mechanics, soil science, soil erosion, construction methods, cost and benefit economics, etc. In AGE 357, Land Drainage, and ABE 459, Drainage and Water Management, taught by Richard Cooke (who also had design and construction experience), similar projects were required concerned with the design of drainage or irrigation systems. In some cases the student teams were also involved in construction and emplacement.

For the food and bioprocessing concentration, ABE 385 (renumbered to 485) was taught by Kent Rausch (product development engineering expertise at American Maize and extension experience at Kansas State working with small food processors). ABE 485 worked in teams with food processing companies to develop solutions for chronic processing problems. Companies that collaborated included Quaker Oats (Danville, IL) and General Mills (Minneapolis, MN). Design projects usually involved working with an on site engineer as well as a plant tour. Projects included developing monitoring equipment for measuring food thickness, design and layout of a extruded snack food process, and development of specialty equipment for breakfast cereal production.

AGRICULTURAL AND BIOLOGICAL ENGINEERING GRADUATE PROGRAMS

The MS and PhD programs were essentially unchanged until 2008. Before that, requirements were general statements about total and thesis hours required; a few specific requirements were a responsibility of the Department to transmit to the faculty of the Department.

Beginning in 2008 more specific requirements are stated in the Programs of Study. A description of the ABE graduate programs follows. Graduate courses information was presented in the previous two course listings tables (Tables 1 & 2).

Exhibit 3.6. Department of Agricultural and Biological Engineering Graduate Degree Programs from 2008

The Department of Agricultural and Biological Engineering offers a graduate degree program which is at the forefront of the application of engineering principles to solve problems of agricultural production, utilization, environmental control, and biological systems and to improve the quality of life. Students may concentrate study in one of the faculty research interest areas listed below. Supporting course work includes: mathematics; computer science; statistics; engineering mechanics; chemical, civil, electrical, and mechanical engineering; animal science; crop sciences; food science; and other appropriate fields. Opportunity also exists for specializing in computational science and engineering within the department's graduate program via the Computational Science and Engineering (CSE) Option. The Medical Scholars Program permits highly qualified students to integrate the study of medicine with study for a graduate degree in a second discipline, including Agricultural and Biological Engineering.

Degree Requirements

*For additional details and requirements refer to the department's Graduate Handbook and the Graduate College Handbook.

Master of Science

Required Courses	Thesis Option-Required Hours	Non-thesis Option-Required Hours
1 course in Instrumentation and measurement	3–5	3–5
1 course in statistical design and analysis	3–5	3–5
1 MATH course beyond Differential Equations	3–4	3–4
Formal 500 level course in area of specialization (3 hours min)	3–5	3–5
ABE 594 enrollment (0 hrs) every semester	0	0
ABE 501and 502	2	2
Research and Project Hours (min-max applied toward degree):	4 max	
Thesis Hours Required (min-max applied toward degree):	8	n/a
Total Hours	33	36
Minimum 500-level Hours Required Overall:	12	12
Other Requirements:*		A written report is required The non-thesis option is only allowed with departmental approval at or before initiation of graduate study, and a final report is required.
Minimum GPA:	3.0	3.0

Doctor of Philosophy

Required Courses	Required Hours
1 course in Instrumentation and measurement	3–5
1 course in statistical design and analysis	3–5
1 MATH course beyond Differential Equations	3–4
1 formal 500 level course in area of specialization (3 hours min)	3–5
ABE 594 enrollment every semester	0
ABE 501and 502 (unless taken during MS)	0–2
Thesis Hours Required (min-max applied toward degree):	32 max
Total Hours	64
Other Requirements:*	Teaching experience is required.
Minimum GPA:	3.0
Masters Degree Required for Admission to PhD?	Yes
Qualifying Exam Required	No
Preliminary Exam Required	Yes
Final Exam or Dissertation Defense Required	Yes
Dissertation Deposit Required	Yes

Medical Scholars Program

Students in the Medical Scholars program must meet the specific requirements for both the medical and graduate degrees. On average, students take eight years to complete both degrees. The first year of the combined program is typically spent meeting requirements of the Agricultural and Biological Engineering graduate degree.

Graduate Teaching Experience

Experience in teaching is considered a vital part of the graduate program and is required as part of the academic work of all Ph.D. candidates in this program.

TECHNICAL SYSTEMS MANAGEMENT

BS DEGREE IN TSM

The Technical Systems Management (TSM) curriculum in 1997 was defined in the UI Program of Study as follows:

Exhibit 3.7. Major in Technical Systems Management in 1997

Major in Technical Systems Management

For the degree of Bachelor of Science in Technical Systems Management

This major is designed to prepare students as problem solvers for systems involving the application, management, and/or marketing of agricultural engineering technologies. Students are instructed in engineering and business principles in preparation for professional careers as entrepreneurs, marketing representatives, project managers, or plant managers working with service organizations, manufacturers, corporate farms, retail dealers, power suppliers, contractors and management companies at every stage from production through processing and distribution.

Students pursuing this major can select between three options: production systems; mechanization, marketing and technical systems; and environmental systems.

Prescribed Courses Including Campus General Education

HOURS	COMPOSITION I AND SPEECH
4	Rhet 105 – Principles of Composition or equivalent
3	SPCOM 101 – Principles of Effective Speaking

HOURS	COMPOSITION II
3	Select one from: B&T W 250 – Principles of Business Writing B&T W 253 – Business and Administrative Communication B&T W 272 – Report Writing

HOURS	QUANTITATIVE REASONING
4	Math 134 – Calculus for Social Sciences I, or equivalent
3	STAT 100 – Statistics, or ACE 261 – Statistics for Agricultural and Consumer Economics or ECON 172 – Economic Statistics, I or PSYCH 233 – Descriptive Statistics

HOURS	NATURAL SCIENCES
4	CHEM 101 – General Chemistry
5	PHYCS 101 – General Physics (Mechanics, Heat and Sound)
4–5	One course selected from: BIOL 101 – Biological Sciences or BIOL 104 – Animal Biology MCBIO 100 – Introductory Microbiology and MCBIO 101 – Introductory Experimental Microbiology
3–4	Once course selected from: ATMOS 100 – Introduction to Meteorology GEOG 102 – Weather and Climate or GEOG 103 – Earths Physical Systems GEOL 101 – Introduction to Physical Geology or GEOL 105 – Geology of Energy Resources or GEOL 107 – General Geology, I EEE 105 – Environmental Biology

HOURS	HUMANITIES
6	Select from campus approved list

HOURS	SOCIAL SCIENCES
	From at least two departments to include:
4	ACE 100 – Economics of Resources, Agriculture, and Food
3	ECON 103 – Macroeconomic Principles
2	Social science elective. Select from campus approved list.

CULTURAL STUDIES[1]

Two courses; one western culture and one non-western/US minority culture course

1. Work with advisor to select courses that also satisfy the social sciences and humanities requirements.

HOURS	ACES PRESCRIBED
2	ACES 100 – Contemporary Issues in Agricultural, Consumer and Environmental Sciences

HOURS	OTHER PRESCRIBED
3	ACE 161 – Microcomputer Applications or equivalent
3	ACCY 200 – Fundamentals of Accounting or ACCY 201 – Principles of Accounting I
4	CPSC 121 – Principles of Field Crop Sciences
4	Soils 101 – Introductory Soils
3	TSM 100 – Technical Systems in Agriculture
1	TSM 299 – Technical Systems Management Seminar

HOURS	TSM ELECTIVES
18	TSM elective courses. A total of 18 hours selected from the following courses. A minimum of six hours must be at the 300 level.
	TSM 199 – Undergraduate Seminar
	TSM 200 – Construction Technology
	TSM 202 – Welding Processes, Metallurgy and Materials

	TSM 203 – Electric Wiring, Motors, and Controls
	TSM 221 – Farm Power and Machinery Management
	TSM 250 – Agricultural Mechanization Internship
	TSM 252 – Mechanics of Soil and Water Conservation
	TSM 271 – Engineering Applications in Residential Housing
	TSM 272 – Farm Buildings
	TSM 281 – Grain Drying, Handling, and Storage
	TSM 300 – Special Problems
	TSM 331 – Farm Machinery Technology
	TSM 333 – Agricultural Chemical Applications Systems
	TSM 341 – Engine and Tractor Power
	TSM 372 – Livestock Waste Management
	TSM 381 – Electrical and Microcomputer Controls for Agriculture

HOURS	OPTION ELECTIVES
15	Option elective courses. See specific requirements for each option listed below. A minimum of six hours must be at the 300 level.

HOURS	OPEN ELECTIVES
18–21	Additional free elective courses selected to meet the required 126 hours for graduation
126	Total credit hours required for the B.S. degree

Mechanization, Marketing, and Technology Management Systems Option

Mechanization, marketing and technology management systems is designed for students interested in the management, marketing, and/or application of technical systems in agriculture. The focus of this option is to prepare individuals as technically competent professional for all aspects of the agricultural and food industries.

HOURS	OPTION ELECTIVES
15*	AGCOM 270 – Agricultural Sales Communications
	AGCOM 280 – Leadership Development
	ACE 222 – Marketing Commodity and Food Products

ACE 231 – Food and Agribusiness Management or BA 210 – Management and Organizational Behavior
ACE 233 – Agribusiness Market Planning
ACE 243 – Agricultural Finance
ACE 356 – Agricultural Policies and Programs
B ADM 200 – Legal Environment of Business
B ADM 202 – Principles of Marketing
B ADM 247 – Introduction to Management (no credit if had B ADM 210)
B ADM 261 – Summary of Business Law
B ADM 274 – Operations of Research
B ADM 314 – Production
B ADM 315 – Management in Manufacturing
B ADM 320 – Marketing Research
B ADM 321 – Individual Behavior in Organizations
B&T W 271 – Persuasive Writing
FIN 254 – Introduction to Business Finance Management
FIN 264 – Fundamentals of Real Estate

*Six hours of course work must be at the 300 level.

Production Systems Option

Production Systems is designed for those students interested in learning about and working within the production enterprise. Students in this option learn marketing, management, and application of the technical systems relative to a production agriculture enterprise.

HOURS	OPTION ELECTIVES
15*	Choose from the following:
	ACE 203 – Rural Taxation
	ACE 222 – Marketing of Commodity and Food Products
	ACE 232 – Management of Farm Enterprises
	ACE 243 – Agricultural Finance
	ACE 303 – Agricultural Law
	ACE 320 – Economics of Commodity Marketing
	ACE 332 – Decision-Making in the Agricultural Firm
	ACE 334 – Professional Farm Management

ACE 348 – Rural Real Estate Appraisal
CPSC 318 – Crop Growth and Production
CPSC 321 – Biological Control of Insect Pests
CPSC 322 – Forage Crops and Pastures
CPSC 326 – Weeds and Their Control
SOILS 303 – Soil Fertility and Fertilizers
SOILS 304 – Soil Conservation and Management
ANSCI 221 – Animal Nutrition
ANSCI 283 – Beef Cattle and Swine Production
ANSCI – Any Animal Production Class
HORT 242 – Commercial Vegetable Production

*Six hours of course work must be at the 300 level.

Environmental Systems Option

Environmental Systems is designed for those students interested in environmental systems as they relate to the agricultural and food industries. The focus of this option is the study of technical systems and their management as they relate to the interface between the physical and biological science components of agriculture.

HOURS	OPTION ELECTIVES
15*	Choose from the following:
	ACE 210 – Economics of the Environment
	ACE 306 – Environmental Law
	ACE 310 – Intermediate Natural Resource Economics
	ACE 319 – Regional Environmental Management Simulation
	ANSCI 307 – Environmental Aspects of Animal Management
	B ADM 210 – Management and Organizational Behavior
	C E 241 – Air and Water Quality
	C E 341 – Regional Environmental Management Simulation
	E S 236 – Tomorrow's Environments
	FOR 319 – Environment and Plant Ecosystems
	SOILS 303 – Soil Fertility and Fertilizers
	SOILS 304 – Soils Conservation and Management

*Six hours of course work must be at the 300 level.

In the Fall of 2004 a new system of course numbering was initiated. However, as a follow-up to the previous history that ended in 1997, following is a list of TSM courses from 1997 to 2004. Each entry contains the course name and number, the instructor who developed the course and date (if it is a new course) names of other instructors of the course and date when discontinued.

Table 3.3. Courses in TSM prior to 2004

TSM	100	Technical Systems in Agriculture	P. Buriak
TSM	111	Humanity in the Food Web	P. Buriak, M.C. Hirshi, Westgren
TSM	199	Undergraduate Open Seminar	Faculty
TSM	200	Materials and Construction Systems	P. Buriak, P Benson
TSM	202	Metallurgy, Materials, and Welding Processes	P. Buriak, P Benson
TSM	203	Electric Wiring, Motors, and Controls Systems	P. Buriak, P Benson
TSM	221	Power and Machinery Management	J. F. Reid, T.E. Grift
TSM	240	Fluid Power Technology, 2001	Q. Zhang
TSM	250	Technical Systems Management Internship	Discontinued 2003, P Buriak
TSM	252	Soil and Water Management Systems	M.C. Hirschi, P. Kalita
TSM	271	Residential Housing Design	G.L. Riskowski, T. Funk, M.J. Robert
TSM	272	Structural and Environmental Systems	G.L. Riskowski
TSM	281	Grain Drying, Handling, and Storage Systems	M.R. Paulsen
TSM	293	Off-Campus Internship, 2003	
TSM	295	Independent Study	
TSM	296	Undergraduate Honors Research or Thesis, 2003	
TSM	299	Professional Seminar	Discontinued 2004, L.L. Christianson
TSM	300	Undergraduate Research or Theses	R.A. Aherin, P. Buriak

TSM	324	Agricultural Engineering Project Management, 2003	L.L. Christianson
TSM	331	Farm Machinery Management	Discontinued 2001, J.C. Siemens
TSM	333	Chemical Applications Systems	L.E. Bode, L. Tian
TSM	341	Engine and Tractor Power	C.E.Goering, A.C. Hansen
TSM	372	Livestock Waste Management	Discontinued 2003, T. Funk
TSM	381	Electrical and Microcomputer Control Systems	M.R. Paulsen
TSM	399	Seminar	

An extensive project of renumbering courses to match campus directives resulted in a new list of courses in 2004. Following are the courses available from 2004 to the present in TSM with entries containing:

a) course number
b) previous course number in parenthesis
c) course title
d) date course was started if new
e) faculty member who revised the course for the new system
f) faculty who have taught courses
g) date course discontinued

Table 3.4. Courses in TSM from 2004

TSM	100	(100)	Technical Systems in Agr.	P. Buriak, J.G. Harper, L.F. Rodriguez
TSM	199	(199)	Undergraduate Open Seminar	Faculty
TSM	232	(200)	Materials and Construction Sys	P. Buriak, J.G. Harper
TSM	233	(202)	Metallurgy & Welding Processes	J.G. Harper
TSM	234	(203)	Wiring, Motors and Control Sys	J.G. Harper
TSM	262	(221)	Off-Road Equipment Management	T.E. Grift, A.C. Hansen
TSM	293	(293)	Off-Campus Internship	Faculty
TSM	295	(295)	Undergrad Research or Thesis	Faculty
TSM	311	(111)	Humanity in the Food Web	P. Buriak, Westgren, M.C. Hirschi, L. Schideman, A. Green, M. Danao, R.S. Gates, L.F. Rodriguez, K. Bhalerao
TSM	352	(252)	Land and Water Mgt Systems	M.C. Hirschi, R.A.C. Cooke
TSM	363	(240)	Fluid Power Systems	Q. Zhang, T.E. Grift
TSM	371	(271)	Residential Housing Design	L.L. Christianson, M.J. Robert, R.S. Gates
TSM	372	(272)	Environ Control & HVAN Systems	X. Wang
TSM	381	(281)	Grain Drying :& Storage Systems	M.R. Paulsen, S.R. Eckhoff
TSM	396	(296)	UG Honors Research or Thesis	Faculty
TSM	421		Ag Safety-Injury Prevention, 2007	R.A.Aherin, R.E. Petrea

TSM	422		Ag Health-Illnesses Prevention, 2007	R.E. Petrea, R.A. Aherin
TSM	425		Managing Ag Safety Risk, 2007	R.A. Aherin, R.E. Petrea
TSM	430	(324)	Project Management	L.L. Christianson, S.C. Zahos, L. Schideman
TSM	435	(381)	Elec Computer Ctrl Sys	M.R. Paulsen, K. Bhalerao
TSM	436		Renewable Energy Systems, 2007	X. Wang
TSM	455	(381)	Erosion and Sediment Control, 2007	M.C. Hirschi
TSM	464	(341)	Engine and Tractor Power	A.C. Hansen
TSM	465	(333)	Chemical Application Systems	L. Tian
TSM	486		Grain Bioprocessing Coproducts, 2009	K.D. Rausch, V. Singh
TSM	496	(300)	Independent Study	Faculty
TSM	499	(399)	Seminar	Faculty
TSM	501		Graduate Research I	
TSM	502		Graduate Research II	
TSM	594		Graduate Seminar	
TSM	596		Independent Study	
TSM	598		Special Topics	
TSM	599		Thesis Research	

The final result of these course changes in 2004 was a Program of Study as follows:

Exhibit 3.8. Major in Technical Systems Management from 2006

MAJOR IN TECHNICAL SYSTEMS MANAGEMENT

For the Degree of Bachelor of Science with a Major in Technical Systems Management

This major in Technical Systems Management is designed to prepare students as problem solvers for systems involving the application, management, and/or marketing of agricultural engineering technologies. Students are instructed in engineering and business principles in preparation as technically competent business persons for professional careers as entrepreneurs, marketing representatives, or plant managers working with service organizations, manufacturers, corporate farms, retail dealers, power suppliers, contractors, or management companies from production through processing and distribution.

Students can specialize in Mechanization, Marketing, and Technical Systems; Production Systems; or Environmental Systems by selection of specific electives.

Prescribed Courses Including Campus General Education

Hours	Composition I and Speech
4	RHET 105 - Principles of Composition or equivalent (see college Composition I requirement) AND
3	CMN 101 - Public Speaking
	OR
3	CMN 111 - Oral and Written Communication I AND
3	CMN 112 - Oral and Written Communication II

Hours	Advanced Composition
3-4	Select from campus approved list.

Hours	Cultural Studies: Two courses; one Western culture and one non-Western/US minority culture course.

Hours	Foreign Language: Coursework at or above the third level is required for graduation.

Hours	Quantitative Reasoning I
4	MATH 234 – Calculus for Business I, or equivalent

Hours	Quantitative Reasoning II
3–4	Introductory statistics. See department for approved list.

Hours	Natural Sciences and Technology
4	CHEM 102 – General Chemistry I, and CHEM 103 – General Chemistry Lab I
5	PHYS 101 – College Physics Mech & Heat
4–5	PHYS 102 – College Physics, E & M & Modern, or CHEM 104 – General Chemistry II and CHEM 105 – General Chemistry Lab II
3–5	Biological sciences (see campus approved list)

Hours	Humanities and the Arts
6	Select from campus approved list.

Hours	Social and Behavioral Sciences
4	ACE 100 – Agr Cons and Resource Econ
3	ECON 103 – Macroeconomic Principles
3–4	Social and behavioral sciences elective. Select from campus approved list.

Hours	ACES Prescribed
2	ACES 101 – Contemporary Issues in ACES

Hours	TSM Required
3	ACE 161 – Microcomputer Applications or equivalent
3	ACCY 200 – Fundamentals of Accounting or ACCY 201 – Accounting and Accountancy, I
4	CPSC 112 – Introduction to Crop Science
4	NRES 201 – Introductory Soils
3	TSM 100 – Technical Systems in Agr
2	TSM 430 – Project Management

18	TSM elective courses. A total of 18 hours selected from the following courses. A minimum of six hours must be selected from TSM 295 or 396, or at the 300- or 400-level. TSM 199 - Undergraduate Open Seminar TSM 232 - Materials and Construction Sys TSM 233 - Metallurgy, & Welding Processes TSM 234 - Wiring, Motors, and Controls Sys TSM 262 - Off-Road Equipment Management TSM 295 - Undergrad Research or Thesis TSM 352 - Land & Water Mgt Systems TSM 363 - Fluid Power Systems TSM 371 - Residential Housing Design TSM 372 - Structures and Env Systems TSM 381 - Grain Drying, & Storage Systems TSM 396-UG Honors Research Or Thesis TSM 435 - Elec Microcomputer Ctrl Sys TSM 464 - Engine and Tractor Power TSM 465 - Chemical Applications Systems TSM 496 - Independent Study TSM 499--Seminar

Hours	Specialization Electives
15	Choose from the following: ACE 210 - Environmental Economics ACE 222 - Agricultural Marketing ACE 231 - Food and Agribusiness Mgt ACE 232 - Management of Farm Enterprises ACE 303 - Rural Taxation ACE 310 - Natural Resource Economics ACE 320 - Commodity Marketing ACE 332 - Farm Management ACE 340 - Agricultural Finance ACE 403 - Agricultural Law ACE 406 - Environmental Law ACE 428 - Commodity Futures and Options ACE 448 - Rural Real Estate Appraisal ACE 456 - Agr and Food Policies

AGCM 370 – Ag Sales Communications
AGCM 380 – Leadership Development
ANSC 213 – Beef and Swine Management
ANSC 321 – Animal Nutrition
ANSC 467 – Applied Animal Ecology
BADM 300 – Legal Environment of Business
BADM 301 – Summary of Business Law
BADM 310 – Mgt and Organizational Behavior
BADM 311 – Individual Behavior in Orgs
BADM 320 – Principles of Marketing
BADM 322 – Marketing Research
BADM 374 – Management Decision Models
BADM 375 – Business Process Management
BADM 376 – Enterprise Proc Integr & Dymm
BADM 445 – Small Business Consulting
BADM 446 – Entrepreneurship Sm Bus Form
BTW 271 – Persuasive Writing
CEE 330 – Environmental Engineering
CPSC 226 – Introduction to Weed Science
CPSC 414 – Forage Crops and Pastures Eco
CPSC 418 – Crop Growth and Management
CPSC 477 – Biol Control on Insect Pests
ENVS 336 – Tomorrow's Environment
FIN 221 – Corporate Finance
FIN 341 – Fundamentals of Real Estate
HORT 364 – Vegetable Crop Production
NRES 419 – Env and Plant Ecosystems
NRES 474 – Soil and Water Conservation
NRES 488 – Soil Fertility and Fertilizers

Hours	Open Electives
17–23	Additional free elective courses selected to meet the required 126 hours for graduation.
126	Total credit hours required for the B.S. degree.

Minor in Technical Systems Management

Note: This minor has prerequisites of a minimum of 60 hours with a 2.5 GPA; completion of Math 234 or equivalent; Physics 101 or equivalent; Chemistry 102 and 103 or equivalent; and Physics 102 or Chemistry 104 and 105 or equivalent.

Hours	Minor Required
3	TSM 100--Technical Systems in Agr
15	Fifteen Hours, at least six of which must be at the 400 level
	TSM 232 – Materials and Construction Sys
	TSM 233 – Metallurgy, & Welding Processes
	TSM 234 – Wiring, Motors, and Controls Sys
	TSM 262 – Off-Road Equipment Management
	TSM 352 – Land and Water Mgt Systems
	TSM 363 – Fluid Power Systems
	TSM 371 – Residential Housing Design
	TSM 372 – Structures and Env Systems
	TSM 381 – Grain Drying, & Storage Systems
	TSM 435 – Elec Microcomputer Ctrl Sys
	TSM 464 – Engine and Tractor Power
	TSM 465 – Chemical Applications Systems
	TSM 496 – Independent Study
18	Total Hours Required

A minor in Agricultural Safety and Health was recently approved for inclusion in the TSM program and is described as follows:

Exhibit 3.9. Agricultural Safety and Health Minor Programs

Agricultural Safety and Health Minor Programs and Requirements

The minor in Agricultural Safety and Health is designed to provide students with a strong understanding of the occupational safety and health issues facing production agriculture. The program will familiarize students with the primary injury control methodologies of behavioral persuasion, engineering design, and regulation or enforcement and their related strengths and weaknesses of effecting injury and occupational illness rates among agricultural populations. They will also develop a strong understanding of safety risk management. A minor in agricultural safety and health would benefit most students who intend to pursue any type of agricultural or rural health profession. There are no prerequisites for the minor.

Requirements: A minimum of 18 hours must be completed for this minor.

Hours	Required Courses for Agricultural Safety and Health Minor
3	TSM 421 – Ag Safety-Injury Prevention
3	TSM 422 – Ag Health-Illness Prevention
3	TSM 425 – Managing Ag Safety Risk
	A minimum of 3 credit hours is required from the following courses:
1–4	TSM 293 or ABE 293 – Off-Campus Internship
1–4	TSM 295 or ABE 396 – Undergraduate Research Thesis
1–4	TSM 496 or ABE 295 – Independent Study
	A minimum of 6 credit hours selected from:
3	CHLH 101 – Introduction to Public Health
3	CHLH 244 – Health Statistics
3	CHLH 274 – Introduction to Epidemiology
4	CHLH 304 – Foundations of Health Behavior
3–4	CHLH 469 – Environmental Health
4	CHLH 474 – Principles of Epidemiology
4	CHLH 540 – Health Behavior-Theory
3	EOHS 400 – Principles of Environmental Health Sciences (UIC Web)
2	EOHS 421 – Fundamentals of Industrial Hygiene (UIC Web)
3	FSHN 480 – Basic Toxicology
3	HDFS 105 – Intro to Human Development
4	HRE 415 – Diversity in the Workplace
4	HRE 585 – Program Evaluation
3–4	IE 440 – Occupational Biomechanics
3	IE 442 – Safety Engineering
3–4	KIN 262 – Motor Develop, Growth & Form
3–4	KIN 454 – Growth & Physical Development
4	PSYC 100 – Intro Psych

4	PSYC 103 - Intro Experimental Psych
4	PSYC 358 - Human Factors
3-4	PSYC 456 - Hum Perf and Eng Psych

Prerequisites for the minor: Any student who has completed at least 30 credit hours of course work with a minimum GPA of 2.5 or consent from program director may apply for the minor. There are no other specific prerequisites.

MS DEGREE IN TSM

A Master of Science Degree with a Major in Technical Systems Management and an Optional Graduate Concentration in the Professional Science Master's Program was initiated during the 2010-2011 academic year as follows:

Exhibit 3.10. Master of Science in Technical Systems Management

The Master of Science in Technical Systems Management (TSM) serves students seeking a post-graduate degree as an enhanced preparation for a career in agricultural and biological technical systems management. It will provide exposure to faculty and industry research in agricultural, construction and environmental systems, equipment and food industries, or environmental protection and safety.

Additionally, a non-thesis Master of Science (M.S.) degree program with a major in Technical Systems Management is offered through the University of Illinois' Professional Science Masters (PSM) initiative.

Degree Requirements

<u>For the TSM M.S., required courses for all graduate programs include TSM 501 and TSM 502, one course in statistics, one course in research methods including experimental design and one 500 level course (in the elective list) are required.</u>

Master of Science, Technical Systems Management

The completion of 33 hours (25 h formal course and 8 h research) and the preparation and defense of a thesis involving an analytical or experimental investigation (which satisfies 8 hours of credit) are required of M.S. candidates in both degree programs unless a waiver of thesis is granted. At least 12 hours for the M.S. degree must be in 500-level courses and 8 hours must be in the program rubric. Candidates who are permitted to pursue a non-thesis degree must complete a minimum of 36 hours. Non-thesis TSM graduate students pursuing the Professional Science Masters (PSM) option are required to complete the PSM concentration courses (ten additional credit hours, totaling 42 credit hours). Students may concentrate study in one of the areas of research specialization listed below. Supporting coursework options include: mathematics; computer science; statistics; engineering mechanics; civil and environmental engineering; electrical and computer engineering; mechanical engineering; industrial engineering; general engineering; natural resources and environmental sciences; agricultural communication; agricultural education; food science and human nutrition; animal sciences; agricultural and consumer economics; business management; finance; labor and industrial relations; crop sciences and other appropriate fields.

Curriculum for the M.S. Degree with a Major in Technical Systems Management (TSM).

The M.S. degree with a Major in Technical Systems Management has the following course work that must be completed by all students to fulfill the degree requirements with a minimum of 12 credit hours required at the 500-level:

Core Requirements

TSM 501 Graduate Research I
TSM 502 Graduate Research II
TSM 594 Graduate Seminar
One course in statistics
One course in research methods

Technical Systems Management M.S. Degree Electives: (minimum 3 credit hours are required)

TSM 421 Ag. Safety-Injury Prevention
TSM 422 Ag. Health-Illness Prevention
TSM 425 Applying Safety Interventions
TSM 435 Electronic Microcomputer Control Systems

TSM 436 Renewable Energy Systems
TSM 455 Erosion and Sediment Control
TSM 464 Engine and Tractor Power
TSM 465 Chemical Application Systems
TSM 486 Grain Bioprocessing Coproducts
NRES 510 Adv Natural Resource Economics
TE 461 Technology Entrepreneurship
TE 560 Managing Advanced Technol I
TE 561 Managing Advanced Technol II
UP 546 Land Use Policy and Planning

Curriculum for the M.S. Degree with a Major in Technical Systems Management and Concentration in Professional Science Masters (PSM).

The M.S. degree with a Major in Technical Systems Management and Concentration in PSM curriculum has the following three categories of coursework that must be completed by all students to fulfill the degree requirements:

1. Core Requirements:

TSM 501 Graduate Research I
TSM 502 Graduate Research II
TSM 594 Graduate Seminar
One course in statistics
One course in research methods

2. Technical Systems Management M.S. Degree Electives: (minimum 3 credit hours are required)

TSM 421 Ag. Safety-Injury Prevention
TSM 422 Ag. Health-Illness Prevention
TSM 425 Applying Safety Interventions
TSM 435 Electronic Microcomputer Control Systems
TSM 436 Renewable Energy Systems
TSM 455 Erosion and Sediment Control
TSM 464 Engine and Tractor Power

TSM 465 Chemical Application Systems
TSM 486 Grain Bioprocessing Coproducts
NRES 510 Adv Natural Resource Economics
TE 461 Technology Entrepreneurship
TE 560 Managing Advanced Technol I
TE 561 Managing Advanced Technol II
UP 546 Land Use Policy and Planning

3. PSM Concentration Requirements - 10 hours of coursework required for all students in the program that provides business fundamentals, as part of the proposed campus-wide PSM initiative.

Key Features of the PSM Concentration to be Coupled with the Proposed M.S. Major in Technical Systems Management Required Courses

There are three components of the PSM concentration:
1. Business curriculum (courses listed in table below)
2. Industry seminar series (PSM 501, 502, and 503)
3. Internship (PSM 555)
Business Curriculum (10 hours)
The business curriculum is a sequence of eight courses jointly delivered by the School of Labor and Employment Relations (LER) and the College of Business. These courses, common across all PSM programs, are intended to provide PSM students with core business knowledge and skills. The business curriculum totals 10 semester credit hours in an intensive, focused delivery. The requirements are summarized below.

Term / Semester	Course	Title	Instructional Unit	Credit Hours
1 - Fall	PSM 510	Managerial Accounting	Business	1
1 - Fall	PSM 511	Financial Management	Business	1
1 - Fall	PSM 512	People and Technology at Work	LER	2
2 - Spring	PSM 520	Technology Management	Business	1
2 - Spring	PSM 521	Strategic Decision Making	Business	1
2 - Spring	PSM 522	Human Resource Management for Scientists and Engineers	LER	2
3 - Fall	PSM 530	Entrepreneurship	Business	1
3 - Fall	PSM 531	Marketing	Business	
	1			

Industry Seminar Series (0 hours)

The industry seminars provide opportunities for intellectual and social engagement for students across Illinois PSM programs. The seminars extend the professional preparation provided in the business curriculum. A key element of the seminar is invited guest lecturers in significant science-related leadership roles from business, industry, and governmental organizations. All PSM students will enroll in a common seminar each semester, blending students from multiple disciplines to explore issues in common. PSM students will enroll in the seminar each semester in which they are enrolled in the cohort program (PSM 501, 502 and 503, respectively), excluding summer.

Internship (0 hours)

The internship is judged a necessary component of a professional graduate degree program whose goal is to produce graduates proficient in their science area of study with the knowledge, skills, and abilities to apply their proficiency to managerial and leadership challenges of business, government, and not-for-profits. In consultation with the program coordinator, students find internship companies and positions that match their individual career objectives and meet the learning goals of the program. The student bears the principal responsibility for securing the internship.

4 | STUDENT ACTIVITIES

Students are the lifeblood of the department and the primary reason for the department to exist. In addition to classroom studies, students engage in extra-curricular activities. Most of these activities are carried out through student clubs. The ABE department has three student clubs. The Illinois Student Branch of the ASABE is primarily for engineering students in the ABE department. It first met in 1934. The Illinois Ag Mech club is primarily for ABE students in the TSM curriculum. It was formed in 1960. Alpha Epsilon is the honor society for ABE engineering students. It was formed in 1963.

ASABE Illinois student branch

The ASABE-Illinois Branch student club member numbers varied over the years. During 2003-2005, the club membership dropped a little; however, more students participated in more recent years and with a lot of enthusiasm. The club held its monthly meetings first Wednesday of every month until 2009, when the club shifted its meeting to the second Wednesday of every month. Then the club went back to meeting on the first Wednesday every month. Meetings are held on in 204 AESB with a follow up dinner either in the AESB Courtyard or in room 217 AESB. The format is similar for each meeting – a business meeting is followed by a 20-30 minute presentation by an invited speaker and then dinner. Frequently, speakers for club meetings have been alumni who come back to talk about their career experiences. Speakers from campus and companies provide additional speakers at club meetings. Several times the two student clubs (ASABE and the Illini Ag Mechanization) have organized to have a speaker with a joint meeting. Attendance at each monthly club meeting varies from about 20-50. Faculty and staff are invited to attend and have the evening meal with the students.

The club organizes field trips to businesses and companies of interest for club members and faculty members. In recent years, the club actively participated in a Midwest Regional Rally - a joint meeting of all the ASABE student branches from the Midwest Land Grant Universities. The Illinois ASABE club hosted the Midwest Regional Rally twice during the last six years, most recently one in the 2010 spring semester. About 5 to 10 student members from each of the Midwestern universities participate in these rallies, that last for two days. They tour university/local facilities/ business /industries, share common experiences, provide networking opportunities, play games, and interact with professionals.

To provide for more leadership opportunities, the club elects new officers each semester. Club officers are listed in Tables 4.1A to 4.1D. However, the treasurer is elected for a whole year to provide continuity for the campus Registered Student Organization requirements. The club is actively involved in the Engineering Council and the College of ACES activities. Drs. Qin Zhang and Leslie Christianson served as the club advisors until 2000, and Dr. Prasanta Kalita has been serving as the club advisor since 2000. In 2009, the club also elected Dr. Grace Danao as a co-advisor.

The club's largest fundraising activity is the annual spring "Lawnmower Summarization" held in late April. Townspeople are invited to bring their lawnmowers to the ABE department for servicing and pay a fee for the service. In 2010, the club had more than 75 lawnmowers to service. Club members get together for several days to organize this event. This activity is a fun event and always provides opportunity for freshmen and transfer students to get to know and work with other members of the club, faculty and the club's advisors.

Other club activities include attending and displaying at Engineering Open House, ExplorACES, ACES Phone-A-Thone, polo shirt sales, philanthropy works (roadside clean-ups, gift sponsor, food drive, and special projects like Illini Pullers Quarter Scale Tractor Design and ASABE Fountain Wars. Additional activities include attending ASABE Annual International meetings (about 10 student members attend every year), ASABE sectional meetings, fall picnic, hog roast, annual Christmas party and winter ski trip The club is primarily responsible for organizing the annual ABE spring banquet. The banquet is held at the I-Hotel and is attended by club members, parents, alumni, faculty and staff, and scholarship donors. This is the primary event for awarding scholarships and recognition of students and faculty. The club has continued submitting an entry into the EMI/AEM report competition. For the last few years, the club is always in the top 3 award winners in this competition.

The club's work has been recognized by peers with national awards. In 2003, the club earned national championship award in ASABE Fountain War competition. The Illini Pullers ¼ Scale Tractor team has earned championship awards in 2010; other prestigious awards in recent years. Several club members earned fist, second, and third place awards at the campus-wide EOH and ExplorACES competitions. In 2008, the club members were awarded a US-EPA grant to travel and conduct research in India.

The club membership has been increasing in the past 3 years with increasing female members. Although primarily consisting of ABE students, the recent trend shows increasing numbers coming from diverse academic programs on campus. The club has an excellent reputation on campus and nationally. Almost every year, one club member is elected to serve in the national ASABE student organization. The quality, diversity, and activities of club members are on the rise.

AGMech Club

AgMech Club meetings are held on the first Wednesday of each month in the AESB. Club membership dropped a little, but there is still a lot of enthusiasm. Frequently speakers for club meetings have been alumni who come back to talk about their career experiences. Speakers from campus and companies provide additional speakers at club meetings. Several times the two student clubs have shared a speaker with a joint meeting. After each meeting, the club members adjourn to Rm 119 for a meal and soda from the refrigerator. Sometimes it's a cooked meal and sometimes, depending on the weather, pizza.

The club arranges for field trips to businesses and companies of interest to club members, Farm Progress Shows, and the Gordyville Farm Show. The Illini Ag Mech Club has continued many of activities from years past.

The club is very involved in the College of ACES freshmen welcome. Club members set up a display, wear their club polos and explain club activities to newly arrived freshmen.

The club continued to help Dr. Siemens cook chicken for the ABE picnic until the picnic at the park gave way to the picnic being held in AESB. Both student clubs continue to provide support for the picnic.

The club's big fundraiser is the Lawnmower Winterization project held in early November. Club members get together for several days to winterize lawnmowers for members of the community. This fall activity is always a good chance for new freshmen and transfer students to get to know other members of the club, faculty and the club's advisors.

Every February, the Club still attends the Friday night tractor pulls in Louisville and then visits the National Farm Equipment Show on Saturday.

The club has continued submitting an entry into the EMI/AEM report competition. While not as successful as in the past, the club is always in the top 3.

The club continued to cook and sell chicken and bratwurst sandwiches at ACES Open House as fundraiser and community service project, until ACES Open House was re-formatted into Explore ACES. The club activities during Explore ACES are more aimed at recruiting potential students by answering questions and tours of Room 119.

Much of the work for the Department Awards Banquet is done by the two student clubs. Scholarships and awards are given to students by other students. A very well done slide show has evolved to a PowerPoint show featuring both clubs' activities.

The Reading Day golf outing has continued, but has become more informal and spontaneous. Trash talking and looking for lost golf balls continue to be golf outing mainstays.

The club's community service projects have included making electrical kits for high school students to learning about electricity; rebuilding playground equipment at a church; helping to host the state

FFA welding and electrical competition in Rm 119 and coat drives.

Dr. Benson and Dr. Buriak, Illini Ag Mech Club Advisors and faculty, retired during this time. The club's new advisors are Dr. Joe Harper and Randy Fonner. A list of club officers is given in Tables 4.2A to 4.2D.

ALPHA EPSILON Honor Society

The Alpha Epsilon honor society was formed in 1963 by Agricultural Engineering departments in Missouri, Minnesota, Illinois, Arkansas, Indiana and Virginia. It has since expanded to include most of the universities participating in ASABE. Alpha Epsilon goals are to promote the high ideals of the engineering profession, to give recognition to those biological and agricultural engineers who manifest worthy qualities of character, scholarship and professional attainment, and to encourage and support such improvements in the agricultural and biological engineering profession that make it an instrument of greater service to mankind. The Illinois chapter of Alpha Epsilon is designated as the Delta Chapter.

The Delta chapter typically sponsors two blood drives each year, volunteers to assist with Engineering Open House, the Relay for Life, and other community activities such as toy and clothing drives during the Christmas season.

The Delta chapter won first place in the most outstanding chapter competition in 2001. IN 2004, the Chapter won second place. In 2006, the Delta chapter was again recognized as the most outstanding chapter. In 2007, the Delta chapter was recognized as the most improved chapter.

New chapter officers are elected each year. Tables 4.3A to 4.3D contain a list of chapter officers.

STUDENT Awards and scholarships

All three departmental clubs participate in the annual awards banquet. Table 4.4 is a list of ABE students winning ASABE awards during the time period, 1997 to 2009. Table 4.5 is a list of other important award won by ABE students during the same time period. Tables 4.6A and 4.6B contain lists of scholarships awarded during the annual awards banquets in the period, 1997 to 2009.

Table 4.1A ASABE student branch officers, Fall 1997–Spring 2000

Office	Fall 1997	Spring 1998	Fall 1998	Spring 1999	Fall 1999	Spring 2000
President	T. Growler	B. VanDyne	B. Everitt	A. Najera	E. Edwards	K. Thorp
1st V.P.	B. VanDyne	J. DeVries	J. DeVries	K. Thorp	K. Thorp	A. Zehner
2nd V.P.	E. Edwards	A. Najera	J. Stiff	M. Speller	A. Peters	M. Tan
Secretary	J. Roley	B. Everett	A. Najera	E. Edwards	M. Tan	M. Heyen
Treasurer	B. Everett	N. Barnes	N. Barnes	C. Yagow	C. Yagow	K. Daily
Scribe	C. Yagow	C. Yagow	(none)	(none)	(none)	(none)
Engr. Council Rep.	M. Curl	M. Curl	R. Otto	R. Otto	S. McLaughlin	S. McLaughlin
J. Rogers	L. Beyer					
ACES Council Rep.	N. Barnes	A. Cramsey	D. Schertz	M. Tan	K. Daily	S. McLaughlin
	A. Cramsey	D. Schertz	L. Barrios	M. Peters		
Photographer	T. West	J. Roley	A. Cramsey	A. Cramsey	(none)	(none)
EOH/EMI Chair	D. Wathen	D. Wathen	J. Bower	K. Thorp	A. Viall	A. Viall
	S. Swords	K. Thorp	A. Batcheller	J. Tanner	K. Daily	
Parliamentarian	C. Yagow	R. Otto	J. Kempel	A. Cramsey	(none)	(none)
Membership chair	W. Willmes	M. Hopkins	E. Edwards	J. Stiff	(none)	(none)
Athletic chair	M. Curl	M. Ruble	A. Greenlee	A. Greenlee	(none)	(none)
Sr. Booklet chair	B. VanDyne	B. VanDyne	J. DeVries	K. Thorp	(none)	(none)
Fundraising chair	M. Ruble	J. Stiff	(none)	(none)	(none)	(none)
Comm. Service chair	D. Konneker	D. Spratt	A. Zehner	K. Daily	(none)	(none)
Spr. Banquet chair	(none)	K. Flahive	(none)	L. Barrios	(none)	???

Advisor	J. Reid	J. Reid	Y. Zhang	Y. Zhang	L. Christianson	L Christianson
Asst. Advisor	Y. Zhang	Y. Zhang	S. Walker	S. Walker	Q. Zhang	Q. Zhang
Publication Advisor	Christianson	Christianson	Christianson	Christianson	(none)	(none)

Table 4.1B. ASABE student branch officers, Fall 2000 – Spring 2003

Office	Fall 2000	Spring 2001	Fall 2001	Spring 2002	Fall 2002	Spring 2003
President	C. Yagow	A. Viall	M. Tan	J. Wilson	K. Yagow	B. Tadlock
1st V.P.	A. Zehner	M. Tan	A. Viall	B. Tadlock	B. Cherry	R. Johnson
2nd V.P.	M. Tan	E. Poynter	E. Poynter	T. Anczer	R. Johnson	D. Revin
Secretary	M. Heyen	M. Heyen	I. Williams	R. Johnson	B. Salmon	G. Wellen
Treasurer	K. Daily	K. Daily	K. Daily	K. Yagow	A. Lenkaitis	A. Kenkaitis
Fund raising chair	(none)	(none)	D. Reum	J. Peterson	J. Lane	P. Eckstein
	T. Anczer					
Comm. Service chair	(none)	(none)	R. Johnson	K. Knapp	T.J. Ruyle	T.J. Ruyle
	A. Smith					
Athletic chair	(none)	(none)	R. Johnson	R. Johnson	S. Dixon	M. Tan
Membership chair	(none)	(none)	B. Tadlock	E. Poyner	E. Poynter	S. Dixon
Spr. Banquet chair	(none)		(none)	M. Tan	A. Ostrom	A. Ostrom
	A. Smith	G. Wellen	G. Wellen			
Parlimentarian	(none)	(none)	A. Lenkaitis	P. Eckstein	B. Tomm	B. Salmon
Engr. Council Rep.	S. McLauglin	J. Lowe	J. Lowe	L. Terry	A. Rund	A. Rund
	J. Hubele	J.Hubele	T. Anczer	T. Anczer	L. Terry	

ACES Council Rep.	J. Tanner B. Hogan	J. Wilson B. Hogan	B. Cherry J. Wilson	B. Cherry I. Williams	J. Wolf K. Knapp	J. Wolf K. Knapp
EMI/AEM chair	A. Viall ★★	A. Viall C. Crawford	(none) C. Crawford	A. Lenkaitis	B. Tadlock	B. Tadlock
EOH/AOH chair	(none)	(none)	K. Yagow	K. Yagow	A. Ostrom	A. Ostrom
SAE Rep.	A. Berberich	A. Berberich	(none)	(none)	(none	(none)
¼ Scale Rep.	S. Landers B. Hogan	S. Landers B. Hogan	S. Landers	S. Landers	J. Peterson	J. Peterson
Advisor	Christianson Q. Zhang	Christianson Q. Zhang	Christianson Q. Zhang	Q. Zhang P. Kalita	J. Wolf P. Kalita	J. Wolf P. Kalita

★★ B. Tadlock, and A. Viall were also EMI co-chairs

Table 4.1C. ASABE student branch officers, Fall 2003 – Spring 2006

Office	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006
President	S. Dixon	A. Ostrum	A. Rund	A. Lenkaitis	A. Freeman	J. Bruns
1st V.P.	R. Johnson	R. Johnson	R. Johnson	N. Vandike	A. Ostrom	M. Whyte
2nd V.P.	J. Eisenmann	J. Eisenmann	A. Lenkaitis	K. Knapp	C. Freehill	S. Roth
Secretary	A. Ostrom	A. Freeman	A. Freeman	A. Freeman	C. McKoon	C. McKoon
Treasurer	A. Lenkaitis	A. Lenkaitis	(none)	(none)	L. Zwilling	L. Zwilling
Fund raising chair	G. Wellen J. Bruns	P. Eclsteom	J. Roth	(none)	S. Cole	J. Kesler

Comm. Service chair	C. Freehill	C. Freehill	J. Doelling	J. Doelling	M. Leick	M. Leick
Athletic chair	E. Meister	(none)	(none)	(none)	(none)	(none)
Membership chair	W. Doelling	A. Rund	J. Lane	M. Leick	(none)	C. Unzicker
	J. Wolf	J. Lane				
Spr. Banquet chair	J. Wolf	J. Wolf	M. Clay	M. Clay	P. Davidson	P. Davidson
	R. Kingdon	R. Kingdon	S. Breen	S. Breen		
Parlimentarian	B. Tomm	T.J. Ruyle	A. Maurer	S. Breen	J. Buss	A. Olsen
Engr. Council Rep.	K. Knapp	K. Knapp	J. Kubo	R. Rebenacker	J. Mitchell	S. Breen
	A. Rund	A. Ostrom	R. Richards			
ACES Council Rep.	J. Wolf	E. Meistor	(none)	(none)	(none)	A. Orebaugh
	J. Bruns	J. Bruns	A. Whalen			
AEM chair	K. Tilsy	K. Tilsy	J. Bruns	J. Bruns	J. Bruns	J. Bruns
	A. Lenkaitis	A. Lenkaitis	B. Zigler	B. Ziegler	**`	**
EOH chair	J. Maschhoff	J. Maschhoff	J. Kubo	J. Kubo	J. Mitchell	J. Mitchell
Web Master	(none)	B. Zigler	B. Zigler	R. Muehling	L. Zwilling	L. Zwillling
¼ scale Rep.	J. Peterson	J. Peterson	(none)	(none)	(none)	(none)
Advisor	P. Kalita	P. Kalita	P. Kalita	P. Kalita	P. Kalita	P. Kalita

** J.Scheider and R. Rubenacker were AEM co-chairs

Table 4.1D. ASABE student branch officers, Fall 2006 – Spring 2009

Office	Fall 2006	Spring 2007	Fall 2007	Spring 2008	Fall 2008	Spring 2009
President	M. Whyte	C. McKoon	S. Breen	E. Brooks	C. Zurliene	G. Francis
1st V.P.	J. Roth	A. Olsen	E. Brooks	A. Fulton	G. Francis	C. Campbell
2nd V.P.	M. Tennis	B. Dierker	A. Fulton	M. Hull	C. Campbell	S. Breen
Secretary	C. McKoon	J. Roth	K. Wright	S. Yatsu	A. Byers	R. Dambacher
Treasurer	E. Brooks	E. Brooks	J. Sander	J. Sander	S. Liu	S. Liu
Fund raising chair	J. Bruns	J. Bruns	C. Cordill	S Breen	E. Kahle	J. Lambert
	C. Zurliene	S. Yatsu				
Comm. Service chair	J. Walker	J. Walker	M. Wilhelmi	R. Blackwell	T. Larson	T. Larson
Membership chair	(none)	M. Malone	(none)	D. Schilling	A. Oldani	A. Oldani
Spr. Banquet chair	S. Breen	S. Breen	J. McCrady	J. McCrady	(none)	R. Giertz
	A. Fulton	A. Fulton	J. Lambert	J. Lambert	S. Anderson	
Parlimentarian	K. Heinecke	K. Heinecke	S. Anderson	J. Motsinger	W. Klein	C. Wilhelmi
Engr. Council Rep.	S. Breen	S. Breen	J. Vonk	J. Vonk	M. Hull	M. Hull
	K. Huelskoeter	K. Huelskoeter	C. Zurliene	C. Zurliene	F. Landola	F. Landola
ACES Council Rep.	C. Zurliene	C. Zurliene	J. Tate	A. Byers	J. Motsinger	J. Motsinger
	J. Tate	J. Tate				
AEM chair	S. Anderson	S. Anderson	J. Suratt	J. Suratt	J. Vonk	(none)
	S. Yatsu	S. Yatsu	C. Prater	C. Prater	A. Fulton	
EOH chair	D. Koch	D. Koch	J. Vonk	J. Vonk	(none)	(none)
	T. Zoeller	C. Zurliene	C. Zurliene			

Web Master	J. Tate	J. Tate	C. Zurliene	C. Zurliene	O. Hui	O. Hui
Advisor	P. Kalita	P. Kalita	P. Kalita	P. Kalita	P. Kalita	P. Kalita

Table 4.2A. Ag Mech club officers, Fall 1997–Spring 2000

Office	Fall 1997	Spring 1998	Fall 1998	Spring 1999	Fall 1999	Spring 2000
President	B. Eden	B. Reimer	M. Dry	C. Kallal	G. Behme	S. Studabaker
Vice Pres.	M. Broch	M. Dry	R. McGinn	G. Behme	M. Dry	A. Schweizer
2nd V.P.	M. Dare	V. Reincke	V. Reincke	S. Ludwig	S. Ludwig	E. Bruns
2nd VP elect	C. Kallal					
Secretary	J. Ehrhardt	R. McGinn	T. Cross	E. Bruns	V. Reincke	E. Tautkus
Treasurer	V. Reincke	G. Behme	G. Behme	K. Short	K. Short	G. Stierwalt
Asst. Treasurer	K. Short	A. Schweizer	G. Stierwalt			
Reporter	T. Martens	K.Schumacher	M.Schoenbeck	M. Dry	L. Jacobs	M. Brashear
Ag. Council Rep.	J. Hoult	J. McKinney	J. McKinney	S. Studabaker	E. Bruns	J. Stiers
	G. Behme	J. Grieves	K. Short	J. Earhardt		
Web master	A. Chestnut	L. Grabowski	L. Grabowski	A. Schweizer	(none)	
Advisors	P. Benson	P. Benson	P. Benson	P. Benson	P. Benson	P. Benson
	P. Buriak	P. Buriak	P. Buriak	P. Buriak	P.Buriak	P.Buriak
	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner

Table 4.2B. Ag Mech club officers, Fall 2000–Spring 2003

Office	Fall 2000	Spring 2001	Fall 2001	Spring 2002	Fall 2002	Spring 2003
President	A. Schweizer	M. Brashear	M. Hoffer	J. Kraft	J. Kraft	C. Williams
1st Vice Pres.	J. Stiers	M. Hoffer	J. Kraft	C. Marvel	P. Meharry	L. Meharry
2nd V.P.	E. Bruns	C. Swartz	C. Swartz	J. Finnigan	J. Finnegan	L. Cole
Secretary	M. Brashear	J. Stiers	S. Lawless	P. Meharry	S. Kloth	C. Smilie
Treasurer	G. Stierwalt	K. Holscher	K. Holscher	A. Buhr	A. Buhr	S. Lawless
Asst. Treasurer	S. Nichols	Andy Buhr	A. Buhr	S. Lawless	S. Lawless	
Reporter	E. Tautkus	C. Williams	(none)	S. Kloth	J. Fitzgerald	M. Herpstrieth
EMI chair	L. Cole					
Webmaster	S. Duvall					
Ag. Council Rep.	M. Hoffer	J. Kraft	J. Schaeffer	J. Nobbe	L. Meharry	A. Henninger
	C. Kirschner	C. Marvel	C. Kirschner	C. Williams	L. Cole	S. Clement
Advisors	P. Benson	P. Benson	P. Benson	P. Benson	P. Benson	M. Mohr
	P. Buriak	P. Buriak	P. Buriak	P. Buriak	P.Buriak	P.Buriak
	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner

Table 4.2C. Ag Mech club officers, Fall 2003–Spring 2006

Office	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006
President	C. Williams	J. Nobbe	J. Nobbe	A. Henninger	G. Van Tine	A. Schuster
1st Vice Pres.	J. Nobbe	A. Henninger	A. Henninger	L. Cole	B. Winston	B. Nobbe

2nd V.P.	L. Cole	G. Van Tine	G. Van Tine	J. Wolf	J. Wolf	B. Nobbe
Secretary	C. Smilie	J. Wolf	J. Wolf	M. Clay	A. Schuster	J. Taylor
Treasurer	S. Lawles	C. Hood	C. Hood	B. Nobe	B. Nobbe	J. Maschoff
Asst. Treasurer	A. Charlesworth					
Reporter	M. Herpstrieth	S. Sauder	S. Sauder	E. Dewerff	E. Dewerff	B. Roberts
EMI chair	L. Cole	L. Cole	L. Cole			
Ag. Council Rep.	E. Dewerff	E. Dewerff	D. Cox	A.Charlesworth	A. Young	
	N. Jones	N. Jones	A. Charlesworth	D. Cox	J. Daugherty	
Advisor	P. Buriak	P. Buriak	P. Buriak	P. Buriak	P.Buriak	P.Buriak
Asst. Advisor	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner

Table 4.2D. Ag Mech club officers, Fall 2006–Spring 2009

Office	Fall 2006	Spring 2007	Fall 2007	Spring 2008	Fall 2008	Spring 2009
President	J. Daugherty	C. Unzicker	B. Nobbe	R. Healy	I. Blue	R. Maschhoff
1st Vice Pres.	C. Unzicker	J. Daugherty	R. Richards	D. Whalen	K. Meentemeyer	Meentemeyer
2nd V.P.	B. Nobbe	J. Vonk	J. Vonk	B. Hellman	C. Nelson	R. Richards
Secretary	P. DeHaan	B. Yuskis	R. Healy	J. Dolaz	T. Zoerller	T. Zoeller
Treasurer	J. Maschhoff	D. Toepper	D. Toepper	R. Maschhoff	R. Maschhoff	G. Duewer
Asst. Treasurer	A. Charlesworth	T. Huls	T. Huls	I. Blue	G. Duewer	I. Blue
Reporter	B. Roberts	B. Roberts	A. Young	K. Meentemeyer	B. Beck	J. Carls
Ag. Council Rep.	T. Wallace	D. Taylor	B. Hellman	N. Wiese	N. Wiese	D. Taylor

	C. Bliss	R. Healy				
Spr.Banquet chair		R. Healy				
Advisor	P. Buriak	P. Buriak	J. Harper	J. Harper	J. Harper	J. Harper
Asst. Advisor	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner	R. Fonner

Table 4.3A. Alpha Epsilon officers, 1997–2000

Office	1996–97	1997–98	1998–99	1999–00
President	David Gerstenecker	Bill Northcott	Jeff Zuercher	Eric Benson
Vice President	Vijay Sihgh	Ashok Verma	Keli Christopher	Yoanda Lopez
Secretary	Navpreet Singh	Eric Viall	Eric Viall	Jermiah Nehumelman
Treasurer	Ping Yang	Ping Yang	Chris Harbourt	Chris Harbourt
EC Representative	Bary Bliss	John Roley	Shrinivas Badiger	Jason Kwiatkowski
	Sreekala Gopalapillai	Eric Benson	Mark Wilkins	
Scholarship chair	Brain Steward	Marcia Ruble	none	none
Faculty advisor	Richard Cooke	Richard Cooke	Richard Cooke	Richard Cooke

Table 4.3B Alpha Epsilon officers, 2000–2004

Office	2000–01	2001–02	2002–03	2003–04
President	Mark Wilkins	Mark Wilkins	Josh McClure	Mark Wilkins
Vice President	Jaswinder Singh	Jaswinder Singh	Francisco Rovira	Marguerite Tan
Secretary	Amy Kaleita	Amy Kaleita	Amy Kaleita	Laura Schutte

Treasurer	Jason Kwiatkowski	Jason Kwiatkowski	Jason Kwiatkowski	Dirk Reum
EC Representative	Lynda Barrios Tricia Templin	Lynda Barrios Tricia Templin	Cyril Tai Laura Schutte	Carlos Campabadal Haibo Yao
Faculty advisor	Kent Rausch	Kent Rausch	Kent Rausch	Kent Rausch

Table 4.3C Alpha Epsilon officers, 2004–2008

Office	2004–05	2005–06	2006–07	2007–08
President	Scott Dixon	Abby Rodrigue	Jon McCrady	Paul Davidson
Vice President	Malia Appleford (F) Lynda Cabrales (S)	Malia Appleford	Andy Lenkiatis	Stephen Anderson
Secretary	Monete Hancock	R. Srinvasan	Hong Young Jeon	Gregory Byard
Treasurer	Dirk Reum	Ganti Murthi	Malia Appleford	Malia Appleford
EC Representative	Kyunghyun Kim (F) Anthony Rund (F) Ghanti Murthy (S) Abby Rodrigue (S)	Scottt Dixon Vivek Sharma	Nathanael Gingrich Jonathon McCrady	Ryan Kingdon
Faculty advisor	Kent Rausch	Kent Rausch	Kent Rausch	Kent Rausch

Table 4.3D. Alpha Epsilon officers, 2008–2010.

Office	2008–08	2009–10
President	Stephen Anderson	Mark Hull

Vice President	Greg Goodwin	Stephen Corban
Secretary	Greg Byard	Siddhartha Verma
Treasurer	Dan Koch	Gina Francis
EC Representative	Rabin Bhattarai	Brian Fehrenbacher
	Jon McCrady	Rabin Bhattarai
Faculty advisor	Kent Rausch	Kent Rausch

Table 4.4. ASABE awards won by ABE students

Year	Name	Curriculum	Award
2000	Chad Yagow	ABE	President, Nat't Council Student Branches
2000	ABE student branch	ABE	3rd place, AEM trophy competion
2000	ABE Ag. Mech Club	ABE/TSM	3rd place, AEM trophy competion
2001	ABE stident branch	ABE	1st place, AEM trophy competition
2001	ABE Ag. Mech club	ABE/TSM	2nd place, AEM trophy competition
2002	Steve McLaughlin	ABE	3rd place, ASABE student paper competition
2002	ABE Ag. Mech club	ABE/TSM	2nd place, AEM trophy compeition
2002	Chad Yagow	ABE	ASABE presidential citation
2002	Marguerite Tan	ABE	Parliamentarian, ASABE Preprofessional Council
2003	Anthony Rund	ABE	Chair, Preprofessional Council Advisory Board
2003	Laaura Schutte	ABE	1st place, ASABE undergrad poster competition
2003	ABE Ag. Mech club	ABE/TSM	2nd place, AEM trophy competition

2003	ABE team	ABE	1st place, ASABE Fountain Wars competition
2005	ABE team	ABE	5th place in ASABE Quarter Scale Tractor competition
2007	U of I team	Engr/ABE	One of 6 Winners of USEPA P3 competition
2007	ABE team	ABE	5th place in ASABE Quarter Scale Tractor competition
2008	ABE student branch	ABE	Top 3 in AEM trophy competition
2008	ABE Ag. Mech Club	ABE/TSM	Top 3 in AEM trophy competition
2008	Elizabeth Brooks	ABE	3rd place, ASABE student paper competition
2009	ABE team	ABE	2nd place in ASABE Fountain Wars competition
2009	ABE team	ABE/TSM	1st place in ASABE Quarter Scale Tractor competition
2010	ABE team	ABE/TSM	1st place in ASABE Quarter Scale Tractor competition

Table 4.5. Non-ASABE awards won by ABE students

ABE Knights of St. Patrick		
Marguerite Tan	2005	AgE
Adrianne Ostrom	2006	AgE
Elizabeth Brooks	2009	AgE
Gina Francis	2010	AgE
Bronze Tablet Winners		
Jeff Erhardt	1999	AgM
Michael Gratton	2002	AgE
Brent Huffman	2004	TSM

Douglas Roth	2006	TSM	
Michael Leick	2008	AgE	
Mark Hull	2010	AgE	
Other awards			
U of I team	2007	Engr/ABE	USEPA National competition winners
Zhongli Pan	2007	Grad	Scientist of the year, Pacific Northwest
Elizabeth Brooks	2008	AgE	Lincoln Academy Award winner
Stephen Anderson	2009	Grad	Illinois Grad. Achievement award
Isaac Blue	2009	TSM	State of Illinois Farm Bureau Discussion meet
U of I team	2009	Engr/ABE	2nd place, USDOE Solar Decathalon

Table 4.6A. Student winners of scholarship and awards at ABE spring banquets, 1997–2003

Scholarship	1997	1998	1999	2000	2001	2002	2003
Alpha Epsilon						Landon Terry	Matthew Full
Bateman AgE	Brianna Van Dyne	Gary Sierens	Emily Edwards	Chad Yagow	Annette Zehner	Jared Lowe	Bradley; Tadlock
Bateman TSM	Michael Dare	Christopher Kallal	Matthew Rund	Skye Studabaker-Nicholson	Erik Tautkus	John Fitzgerald	Steven Lawless
Bauling/ Pershing	Joel Schmidt	Lisa Foster	Joseph Rogers	Peter Groves	Gregory Trame	Bryan Cherry	Aaron Stubblefield

Carlson						Emily Poynter Laura Schutte	Andrew Lenkaitis Kevin Knapp Anthony Rund
Deere Constr					Elizabeth Bruns James Harrington		
Deere Foundation	Eric Hodel	Micah Steele	Sheila Sahu	Emily Edwards	Adam Viall	Michael Gratton	Scott Dixon
Deere Mgt			Clint Peter				
Eckblaw	Micah Steele	Sheila SAhu	Peter Groves	Adam Viall	Laura Schutte	Zachary Waite	
Eckhoff/ Pioneer							Brian Huffman
Espy Prize	Kevin Monk	Todd Maertens	Jeff Ehrhardt	Greg Behme	Matthew Brashear	Jeffrey Kraft	Suhra Kloth
General Mills					Michelle Garcia		
Goering, TSM junior Exc.					Phillip Gaebler	John Finnigan	Christopher Williams
Hay					DeAndre Green		Jennifer Wolf
Lanham						Kevin Knapp	
Lehman AgE	Loren Honegger		Katherine Flahive	Trica Templin	Peter Groves John Heyen Seth Turner	Kathryn Yagow	Peter Eckstein
Lehman TSM	Eric Viall (AgE)		Jeffrey Duncan	Jason Meredith	Joshua Zipprich Gregory Stierwalt		

Matthews		Andrew Greenlee	Adam Cramsey	Joseph Bartoli	Jared Lowe	Adam Viall	Seth Wenzel
McGinn				Gregory Stierwalt Elizabeth Bruns	Craig Swartz	Christopher Williams	Grant VanTime
Pierce	Lisa Foster	Katherine Flahive	Chad Yagow	Gregory Trame	Marguerite Tan		
TSM Freshman	Vince Reincke Jason Hoult	Adam Cramsey- AE Vince Reincke	Peter Groves (AE) Tony Cross		Chris Willimas		Adam Henninger
TSM Soph	Jeff Ehrhardt Nathan Marsh	Mellissa Dry Vinceent Reincke		Adam Viall (AgE) Elizabeth Bruns	Andy buhr		Luke Cole Jared Nobbe
TSM Junior	Brian Reimer	Nathan Marsh		Alan Schweizer	Kurt Holscher		
TSM Senior	Ben Poletti	Brian Reimer	Nathan Marsh	Vincent Reincke	Alan Schweizer	Elizabeth Bruns	Nathan Kincaid
Tranfer Student		Michael Curl	Darren Spratt	Kelly Thorpe			
Van Dern Foods	Yolanda Lopez Julie Grabowski						
Weber	Clark Anderson	Michael Mendoza	Kelly Thorpe		Sean Landers		
Women in Engr		Anntte Zehnere Lindsey Schilling					
Advisor Freshman		Kevin Short Kyle Schumacher					

Table 4.6B. Student winners of Scholarships and awards at ABE spring banquets, 2004–2009

Scholarship	2004	2005	2006	2007	2008	2009
ASABE CI Section	Adrianne Ostrom		Michael Leick	Jacob Mitchell		Jason Buss
Alpha Epsilon						Andrew Fulton
Bateman AgE congeniality	Peter Eckstein	Justin Bruns	Justin Bruns	Ccale McKoon	Curt Zurliene	Curtis Zurliene
Bateman TSM congeniality	Christopher Williams	Grant Van Tine	Eric DeWerff	Chad Unzicker	Brad Nobbe	Ryan Richards
Bauling/ Pershing	Douglas Temple	Ryan Kingdon	Gregory Byard	Tyson Dollinger	Curtis Zurliene	Anna Oldani
Bowers						Curtis Zurliene
Carlson	Scott Dixon Andrew Lenkaitis John Kinder	Paul Davidson Kevin Knapp Andrew Lenkaitis	Matt Dasenbrock James Hershberger	Jeff Lambert Andrew Fulton George Bozdech Steve Corban Gina Frances	Jason Buss Elizabaeth Brooks Jacob Kesler Jacob Mitchell Tyson Drollinger	Bradley Stubbs
Caterpillar						Mark Hull Jeff Lambert
Coddington	Anthony Rund	Andrew Rout	Edward Farwell	Tyson Drollinger	William Gray	Jacob Kesler
Deere Foundation	Kevin Knapp	Adrianne Ostrom	Daniel Koch	Michael Leick	Mark Hull	Stephen Corban Gina Francis Brian Fehrenbacher

Eckblaw						Jeff Lambert
Eckhoff/ Pioneer	Steven Sauder	Mark Roth	Elizabeth Brooks	Kevin Wright	David Didier	Amy Balek
Espy Prize	Steven Clement	Evan Dagit	Adam Henniger			
Goering, TSM junior Exc.	Jared Nobbe	Adam Henninger	Steven Sauder	Brad Nobbe	Keith Webster	Jordan Tate
Hay Working Scholar				Elizabeth Brooks		Elizabeth Brooks
Huggins						
Jones Undergraduate scholarships					Scott Van Etten Adam Seabert	Brian Campion David Didier
Jones graduate scholarships					Haibei Jiang Paul Davidson	Dan Koch Jonathon McCrady
Lanham	Jonathan Roth	Tyson Dollinger Michael Leick	Ryan Goss Jacob Mitchell	Gina Frances Andrew Fulton	Drew Michalak Michael Wright	
Lehman AgE	Paul Davidson Randy Johnson	Luke Cole John Eisenmann Adam Freeman	Grant Van Tine Adrianne Ostrom Samuel Cole	Clinton Charles Ryan Goss Daniel Koch		Sean Breen Jacob Mitchell George Bozdech
Matthews	Jonathon McCrady	Jonathon Roth	Ryan Kingdon	Jonathon Roth	Michael Leick	
Ryan Tucker McGinn	Adam Henniger	Jennifer Wolf	Brad Nobbe	Michael Wright	Jordan Tate	Joshua Siefker
Pierce						

Illini Pullers			Mark Scherer Matthew Whyte	Matthew Wilhelmi Stephen Corban	Stephen Corban Matthew Tallman	Keith Webster Alex Suchko
TSM Freshman						
TSM Soph						
TSM Junior	Luke Cole					
TSM Senior	Christopher Williams	Jared Nobbe	Mark Roth	Joshua Daugherty	Brad Nobbe	John Luebbers Keith Webster
Tranfer Student						
Van Dern Foods						
Weber						William Klein

In 2006 only, Jonathon Roth was awarded the Southern Farm Equipment Association scholarship.

In 2008 only, best undergraduate cash awards were given to ACES/EOH exhibit winners as follows: 1st place, Sebastian Witkowski and Ed (William) Roy; 2nd place, Kimberly Heinecke, Shotaro Yatsu, Drew Schilling, Mark Hull, Jeff Taylor and Bradley Stoll; and 3rd place, David Brackmann, Peter DeHaan, and Wes Hammes.

5 | RESEARCH PROGRAMS

In the early years of the ABE department, funds from the federal Hatch Act provided the support for most of the department research. In recent decades, however, the Hatch funding that was provided was less than the rate of inflation and Hatch funds gradually became insufficient to mount strong research programs. However, the need for research continued, not only to solve societal problems but also to support graduate students without whom the future would be bleak. In response to the diminishing Hatch funds, departmental faculty members took on a new responsibility in addition to teaching, advising graduate students and conducting research. That new responsibility was to write research proposals and submit them to funding agencies to garner the financial support needed for research. By 2010, virtually all of the ABE department research was being supported by such grant funds.

For many years, the ABE department has had technical interest areas in which students could specialize. In 2009, the five areas were BioEnvironmental Engineering (BEE), Biological Engineering (BioE), Food and BioProcess Engineering (FBE), Off-Road Equipment Engineering (OREE), and Soil and Water Engineering (S&W). Research results are reported below under the technical interest areas. In most cases, research by a faculty member is reported below under the area in which he or she is appointed. However, cooperation between divisions was encouraged. Thus, for example, although John Reid worked in the OREE area, he also used his machine vision expertise to solve problems in the FBE and the S&W areas and the results are reported under those areas. In addition, the reader will notice that many projects included participation by researchers from other departments on campus and even by researchers from other institutions. Also, there is a separate section below on nanotechnology. In 2009, this was a relatively new research area for the ABE department and a significant amount of nanotechnology research is reported below that was not necessarily a part of the research in the five technical areas.

Research – Soil and Water Resources

Soil and water, two of the basic natural resources that are important to agriculture, have been the focal point of investigations since agricultural research began. Research in the area of agricultural engineering has dealt with the conservation of these resources as well as with drainage and irrigation to improve the environment for plants, the movement of water across or through the soil, and the structures used to protect the soil or impound water. Recently studies have placed less emphasis on those subjects described in the previous history and more emphasis on water quality and amelioration of contaminants in surface and subsurface waters.

Erosion Control

Kent Mitchell, Michael Hirschi and Greg McIsaac continued research started in the 1980s and in 1996-1998 reported on the Control, Prediction, Economics, and Environmental Effects of Soil Erosion. Y. Zhao assisted in these efforts. The project was funded by the University of Illinois and the USDA. Dissolved phosphorus was measured in runoff from simulated rainfall applied to two soils and several tillage treatments used in an annual crop rotation of corn and soybeans. The average concentration and load of soluble P in the runoff were significantly greater from the no-till than from other tillage treatments. Only moldboard plowing after surface broadcasting of P fertilizer reduced the soluble P concentration below 0.05 mg-P/L. For the Catlin soil, a variety of tillage practices (disk, field cultivation, and strip-till) appeared to result in soluble P concentrations of approximately 0.14 mg-P/L. For the Tama soil, disk-harrow followed by field cultivation and harrow after fertilizer application appeared to reduce soluble concentration in the runoff to approximately 0.06 mg-P/L. Simulated rainfall was applied to several tillage systems on two soil types at slopes ranging from 1.6% to 10%. Soil profiles were measured using a pin-type rill meter. On Catlin soils, rills widened as erosion progressed. On Tama soils, rills deepened as erosion progressed. Elliott's (1988) equation was a better predictor of rill widths. For tillage systems with crop residue ranging from 15% to 54% in the Tama soil, both equations underestimated rill. The following year, soil losses from four Illinois soils under simulated rainfall were measured, along with variables affecting soil loss. These included soil moisture, bulk density, soil aggregations stability, raindrop fall velocity, and drop size distribution. Equations relating soil loss as a function of raindrop kinetic energy, and soil clay content and organic matter were developed for Tama, Catlin, Cisne and Plainfield soils.

Using funding from the U.S. Army Construction Engineering Research Laboratory, Prasanta Kalita and Michael Hirschi did an Evaluation of Range Design Relative to Combat Readiness and Environmental Risks from 2004 to 2008, assisted by N. G. Svendsen, B. R. Tadlock, and L. Schutte. Training and testing ranges on U.S. Army installations are essential for combat readiness of military personnel. A wide variety of range types are needed to provide realistic training conditions. Problems such as soil erosion, water quality degradation, air quality degraded by dust, wildfires, smoke, obscurants, and heavy metal accumulations from live fire activities were addressed at U.S. Army installations. The objective was to analyze training and testing range design with respect to mission, environmental degradation, regulatory noncompliance and long-term operations and maintenance requirements.

Drainage

Illinois C-FAR supported research from 1999-2002 by Richard Cooke, Michael Hirschi and Jay Davis, assisted by A. M. Garcia, W. J. Northcott and A. K. Verma, on Aerial Infrared Mapping of Subsurface Drainage Systems. The goal was to provide maps that show the layout of subsurface tile systems in the Lake Decatur watershed. Mapping relies on the soil over working tile lines drying faster than at other locations in the field, resulting in higher reflectance in the infrared region of the radiation spectrum.

Richard Cooke conducted a University of Illinois-funded project on Evaluating Preferential Flow Paths in Sludge-amended Soils in 1996-1997. The goal was to characterize the effects of preferential flow paths in sludge-amended soils. Drain flows from sludge-amended and non-amended plots were monitored to test the equivalence of infiltration rate, permeability and effluent water quality. Temporal variations in permeability of soil cores were evaluated when the cores were subjected to water quality variations covering the range of ionic strength of divalent cations measured in leachate from municipal sludge.

Richard Cooke and Kent Mitchell conducted a project from 1996-1999 on The Effect of Water Table Management on Productivity and Water Quality assisted by A. K. Verma and V. M. Kurian. The project was funded by the University of Illinois and the USDA. The primary objective was to optimize the performance of subsurface drainage systems by mapping existing drainage systems and estimating the regions of influence of tiles.

Richard Cooke, Greg McIsaac, and S. E. Walker, in work supported by the USDA, studied Evaluation of Water Quality From Alternative Cropping Systems Using a Multiple-Paired Design. The objective of this study in 1998-2000 was to quantify tile drain effluent under organic and conventional cropping practices in Illinois. Organic systems were paired with conventional systems with similar soils, crops, drainage system size and climate. Pairing eliminates major sources of external variability and allows broadening of the range of applicability of findings.

The Case Corporation funded research in 1998-2004 by Richard Cooke and Prasanta Kalita on Effect of Drainage System Layout on Yield, Yield Uniformity, and Water Quality. They were assisted by S. E. Walker, A. K. Verma, W. J. Northcott, C. Harbourt and K. Kim. The overall goal of this research was to improve the characterization of subsurface drainage processes in tile drained watersheds and to quantify the effect of several depth and spacing combinations on yield, yield uniformity, and water quality. In the long run, the results can be used to select subsurface drainage management practices that optimize yield, water quality, or both.

In 2005 to 2008 The Natural Resource Conservation Service and the ARS Soil Drainage Unit provided funding for Richard Cooke for an Illinois Conservation Drainage Research and Demonstration Watershed Project. The purpose was to provide a showcase watershed for drainage water management and other environmentally-friendly drainage practices; to conduct research on stream flow, water quality, controlled drainage and bioreactors; to collect data for modeling flow and transport in a tile-drained watershed; and to work with local stakeholders to promote conservation drainage.

Richard Cooke used University of Illinois funding in 2006 to 2008 to study Development of Conservation Drainage in Illinois assisted by A. Rodrigue, J Chun and D. Goswami. The goal was to test the hypothesis that differing drainage systems with equal drainage capacities may differ in their effect on water quality. Other goals were to determine design configurations that optimize crop production while minimizing environmental impacts and to involve producers, drainage contractors, educators and local conservation personnel in drainage research.

Illinois C-FAR supported research by Richard Cooke, Sharyl Walker and Michael Hirschi, assisted by W. J. Northcott, K. I. Christopher, J. K. Mitchell, and J. K. Zuercher, from 1999 to 2000 on Effectiveness of Controlled Drainage on Poorly Drained Soils in Illinois. The hypothesis was that use of controlled drainage systems on poorly drained soils will reduce the concentrations of nitrate in the effluent without reducing crop yield. Paired tile drains, one conventional and one with controlled drainage, were monitored. The tiles in each pair had similar soils, crops, size and climate.

Richard Cooke used funding in 2004 to2006 from the Natural Resources Conservation Service to study the Effect of Drainage Water Management on Tile Water Quality. The goal was to test the hypothesis that drainage water management will reduce the loadings of nitrates and phosphorous from tile drainage systems without reducing crop yield. Over a three-year period, effluent from a pair of fields was continuously monitored. The pair consisted of two 40-acre, side by side fields with similar soils, crops and climate. Pairing reduced external variability, thus reducing the time required to draw conclusions.

The USDA Agricultural Research Service funded research from 2004 to 2008 by Richard Cooke, assisted by T. A. Wildman and A. Rodrigue, on Amount, Timing and Quality of Water Coming from Managed (Controlled) and Unmanaged Drainage Systems in Illinois.

Flow was monitored and flow-weighted water quality samples were obtained from managed and free-drainage systems on a range of soil types in various locations in Illinois. Using the resulting data, management criteria were developed for drainage water management systems.

Hydraulics

In a project funded by the University of Illinois and the USDA, Michael Hirschi, Kent Mitchell and Richard Cooke studied the Impact of Agricultural Systems on Surface and Ground Water Quality in 1996-1997. N. Jiang studied two small-scale sediment-trapping controls, filter fabric (also called a silt fence) and a rock check dam were evaluated for their sediment trapping characteristics. A unified conceptual model, using orifice flow relationships, showed promise for describing both control structures. Hydraulic capacity determinations, based on design runoff events, lead to recommendations for contributing area limits based on structure size. Specifications for such control structures were needed by erosion control practitioners and were requested by soil conservation agency personnel.

Hydrology

Ron Bingner completed a study in 1999, supported by the Sedimentation Laboratory, ASR, USDA, that involved the development of a model to simulate, for long term analysis, runoff, sediment yield, and channel characteristics such as bed material or cross section changes, for complex, ungaged watersheds containing various crops, soil types, slopes, channel sizes, levels of conservation management and instream erosion control structures. Temporal and spatial variations of a rainfall event were also considered so the response of the watershed could be accurately modeled. Channel processes were incorporated into a comprehensive model to evaluate the effects of man-made and natural changes to the channel system. Data from the extensively instrumented Goodwin Creek Watershed in northern Mississippi were used to validate the model. The model was then used to simulate the response of the watershed to various conservation and instream erosion control management practices and the effect of these practices on the entire watershed system. The techniques used in the development of the database and modifications of the model can be used for understanding watershed management practices on other watersheds.

Prasanta Kalita, Richard Cooke, Michael Hirschi and R.J. Hudson, assisted by T. Wildman, J. Nelmelman, K. Kim, K. S. Lander, D. Dupre, A. Kaleita, and D. Goswami, conducted a project on Understanding Hydrologic and Water Quality Response of a Tiled Watershed from 2003 to 2008. The work was supported by the USDA and by the National Research Initiative Competitive Grants Program. Tile-drained watersheds contain much of the productive agricultural land in the north central United States, yet the hydrology of these watersheds is not well understood. This study initiated a new dimension for watershed management to improve water quality in tile-drained watersheds. Once the techniques and relationships were validated, an estimate of total maximum daily load (TMDL) to a surface water source was available through simple and accurate means. Overall, the results of this study will be utilized for better management of agricultural practices in east central Illinois and similar areas with tile drained watersheds.

A project on Modeling Flood Flows in Flat, Tile-Drained Watersheds was funded by the Illinois Groundwater Consortium and was conducted by Richard Cooke in 1997 to 1999, assisted by S. E. Walker, J. K. Mitchell, M. C. Hirschi, G. F. McIsaac and A. K. Verma. Most flood flow models do not have the capability of including subsurface drain flow. Drain flow models, on the other hand, are mainly field-scale models that are virtually impossible to apply at a watershed scale. This project addressed the development of a composite model in which a subsurface drainage model was subsumed into a flood flow model to achieve better prediction of flood peaks and of flood water quality.

Richard Cooke and William Northcott, assisted by A. K. Verma, S. E. Walker, J. K. Mitchell, S. M. Badiger, A. M. Garcia, K. I. Christopher, W. J. Northcott, K. S. Lander, J Nehmelman, J. Singh and R. J. Hudson, in work supported by a USDA National Needs Fellowship studied Incorporation of the Effect of Artificial Subsurface Drainage into Surface Water Quality Models in 1999 to 2004. In Illinois, subsurface drains provide alternate pathways for solute movement to rivers and streams. The goal was to incorporate the effects of such subsurface drains into watershed-scale flow and transport models.

NSF funding supported a project by Prasanta Kalita and Michael Hirschi, assisted by W. J. Northcott, S. E. Walker, J. Singh, K. Kim and K. I. Christopher, in 2001-2006 on DHARMA: Domain Specific Metaware for Hydrologic Applications. Many hydrologic models at the watershed scale are limited in resolution and scope by their computational demands. A goal of this project was to build a middleware layer to provide the resources for revolutionizing hydrologic modeling. The required resources ranged from local data to supercomputing power on the national computational grid. Researchers expanded the applicability of the Water Erosion Prediction Project model to large watersheds, specifically applying the extended model to the Lake Decatur Watershed in Illinois, and enabled the model for predicting erosion within the watershed by allowing significantly easier access to computational power and data acquisition capabilities.

The USDA-Foreign Agriculture Service, The National Association of State Universities and Land-Grant Colleges, the Government of India and the Agricultural Knowledge Initiative (AKI) Program provided funding for R.S. Kanwar, Prasanta Kalita, R. Mohtar, M. Walter and V. Singh in 2007 to 2008 to initiate an International Water Management Program. The purpose was to build expertise and human capacity in both priority areas, capacity building and water management, of the U.S.-India AKI Competitive Grants Program. The goals were to develop a consortium of U.S. and Indian Universities/Research Insitutes/NGOs; to develop MS and PhD sandwich degree programs in International Water Management; and to develop collaborative research programs on bio-drainage for salinity control and water harvesting techniques for groundwater recharge.

LVR: Hydrology, Drainage, Water Quality

The Little Vermilion River (LVR) Water Quality Project was begun in 1991 by Kent Mitchell, Michael Hirshi, and A. S. Felsot, and continued under various supporting programs until 2003; with evaluations and reporting continuing until 2006. The project titles supporting this work were 'Best Management Practices (BMPs) for Controlling Field-to-Stream Delivery of Agrochemicals Field Validation in the Little Vermilion River Watershed', 'Management Practice Effects on Nitrate-N Concentrations in the LVR', 'Modeling Agricultural Practices for Water Quality Improvement Using GIS', and 'Understanding and Modeling the Hydrology of Tile-Drained Watersheds'. All data were organized and stored by Kent Mitchell in 2007 and are available for further analyses. The project was supported by the UIUC/Illinois Agricultural Experiment Station; the USDA Hydrologic Unit Area – CES and NRCS; the Illinois Groundwater Consortium; a USDA – National Research Initiative; a USDA – Special Research Initiative; C-FAR – Projects 95-89-5 and 99I-021-5; the Illinois Council on Food and Agricultural Research; and the Champaign County Soil and Water Conservation District. Faculty members Prasanta Kalita, Richard Cooke, Ken Konyha, Greg McIsaac, Sheryl Walker, and Kazimierz Banasik contributed to the project as well as Graduate Assistants V. M. Kurien, S. Kim, K. Kim, W. J. Northcott, Paul Miller, Y. Yuan, Chris Harbourt, N. Jiang, J. Singh, K. P. Lander, R. H. Mohtar, and A. Algoazamy. The overall objective of the study was to develop strategies that mutually benefit both agriculture and water quality in regions where hydrology is strongly influenced by subsurface drainage. This was done by monitoring flow and water quality from subsurface tile drains in the Little Vermilion River Watershed in Illinois. Results from field observations have been used to develop fundamental relationships describing flow components to incorporate in computer simulation models.

The Little Vermilion River Watershed is 489 km2 located in East Central Illinois and is terminated by Georgetown Reservoir, which was a drinking water supply. The topography is flat and the watershed is characterized by dark prairie soils with poor internal drainage, classified as silt loam and silty clay loam. Approximately 90% of the watershed is used for row crop production, primarily corn rotated with soybeans and those areas have slopes of 1% or less. Seven sampling points were established along the Little Vermilion River, including Georgetown Lake. Flow stage was recorded and water samples were collected at intervals following rainfall events and during baseflow (one river station was continuous stage monitoring and pump sampling). Water was analyzed for nitrate, phosphate and nine pesticides. Eight small subsurface drainage systems were selected within the watershed for which the exact extent of drainage was known. Seven of the sites were in corn-soybean production in various combinations, while an eighth site was permanent meadow. Four surface runoff monitoring stations were also established in conjunction with four of the subsurface drainage monitoring stations, and surface flow monitoring and pump sampling was conducted. Tillage practices represented by the seven sites under production included no-till, reduced tillage and conventional tillage.

Sub-surface drainage (tile) flow was sampled bi-weekly and additional samples were taken during increased flow following major rainfall events. These samples were analyzed for nitrate as well as pesticides. The sub-surface outflow was monitored continuously with a flume and stage recorder. Records of agrichemical application to and tillage on the monitored fields were maintained. Soil sampling was performed to provide background and periodic concentration of agrichemicals in the field soil.

The use and loss of nitrogen data have shown that concentrations of nitrate differed little among specific sampling locations along the river, but they definitely followed a seasonal cycle. Nitrate concentrations from tile drains varied considerably between fields depending upon cropping management systems used, with concentrations varying seasonally as in the river. The effect of the application of broadcast, pre-plant nitrogen fertilizer is clearly shown in the nitrate-N concentrations from tile drains. The pre-plant anhydrous-N application systems with average nitrogen application of 100 kg/ha/yr. had a mean concentration of nitrate-N of 16.8 mg/L while the side-dress and manure application systems with average nitrogen application of 85 kg/ha/yr. had a mean concentration of nitrate-N of 9.8 mg/L. The mean concentration of nitrate-N from a permanent meadow field was 1.1 mg/L. Nitrate-N losses from cropped fields have ranged from 15 to 41 kg/ha/yr. depending upon the management system. Losses from the grassed system were 3.8 kg/ha/yr. and in the most upstream river station was 12 kg/ha/yr. of nitrate-N.

The DRAINMOD model was used with an optimization routine to determine the region of influence of random tile drains. The random tile drains in the agricultural fields on Drummer/Flanagan soils in Central Illinois have an effective region of influence of 328 ft. The GRASS GIS was used to explore relationships between watershed characteristics and watershed outlet response. A linear model, relating field tile flow and watershed soils to outlet flow, was particularly successful in predicting 1993 measurements. The Root Zone Water Quality Model (RZWQM) does an adequate job of simulating non-extreme tile flow events and provides a realistic estimate of crop yield (at least at typical fertilizer application rates). A physically based hydrology model to simulate the runoff response from rainfall was developed from the framework of TOPMODEL. The model can identify the portions of the hydrograph resulting from tile flow, subsurface flow and surface runoff. Perhaps the most common method for predicting storm runoff volume is the SCS curve number method. The potential for using watershed outlet base flow prior to an event as an alternative to five-day antecedent rainfall for evaluating the antecedent moisture condition of the watershed was studied. Watershed lag time (LAG) is an important factor in determining the time to peak and the peak value of the instantaneous unit hydrograph, IUH. In the procedure of predicting a sedimentgraph (suspended sediment load as a function of time) a similar parameter is the lag time for the sedimentgraph (LAGs).

Results of three-year water quality monitoring programs carried out in two small, lowland agricultural watersheds of various fertilization levels; the Upper Little Vermilion River (ULVR) located in Central Illinois and the Zagozdzonka River located in Central Poland, were analyzed. The watershed with intensive agricultural practice (ULVR) generates runoff with higher concentrations of nutrients. Nitrate-nitrogen losses amount to a significant part (about 15%) of applied total nitrogen fertilization in the ULVR. High concentration of P-P04 in runoff from Zagozdzonka watershed was also recorded.

Water Quality

John Reid and John O'Brien, in a study supported by the USDA National Needs Fellowship and the University of Illinois, studied Machine Vision as a Sensor for Microbial Contamination in Water in 1996 to 1999. The goal was to evaluate machine vision and image analysis as a means of identifying and enumerating pathogenic protozoans such as Giardia lambia and Cryptosporidium in water.

In a project supported by Illinois C-FAR, Prasanta Kalita, M.S. Kuhlenschmidt, R.D. Smith and Ted Funk, assisted by J. R. Trask, S. McLaughlin and M. K. Patel, in 2001 through 2005 studied An Integrated Approach to Reduce Pathogens and Nutrients in Runoff from Animal Production Systems. The goal was to limit the delivery of microbial pathogens and nutrients from animal production facilities on small and midsized farms. The fate of C. parvum and E. coli in surface and near-surface was investigated to develop management strategies to limit their transport.

The USDA National Research Initiative provided funding for M.

Kuhlenschmidt and Prasanta Kalita, assisted by P. C. Davidson, in 2007 and 2008 to study Control of Cryptosporidium and Rotavirus Contamination. The goal was to prevent microbial contamination of water resources and provide a safe and sustainable environment for animal production facilities. In order to design and implement field-applicable technology for prevention of microbial contamination, the processes of microbial transport in surface and near surface runoff need to be understood and quantified. The study aimed to indentify and characterize critical factors such as soil slope, composition, vegetation and rainfall that affect microbe transport and viability.

Using funding from the AWWA Research Foundation Project 4101, Lance Schideman, B.J. Marinas and D. H. Metz began an Evaluation of Granular Activated Carbon (GAC) Filter Caps for Control of Disinfection Byproducts and Emerging Trace Organic Contaminants in 2008. The feasibility was evaluated of using GAC for removal of contaminants including endocrine disrupting compounds, pharmaceutically active compounds, potential homeland security threats, pesticides and disinfection byproduct precursors. Industry treatment practices were surveyed and bench-scale testing was done to determine the level of removal for a broad range of potential water contaminants. Novel adsorbents, regeneration techniques, and predictive modeling tools were developed and tested.

Lance Schideman and M.C. White, in 2008, used funding from Camp, Dresser and McKee to study a Mem-brain Intelligent Infrastructure System for Real-Time Optimization of Membrane Treatment Systems. Genetic algorithms and expert systems were used to develop an automated optimization protocol that continually evaluates and updates operational setpoints in response to variable influent conditions and other dynamic factors typical of membrane systems used for water purification. The goal of the intelligent infrastructure was to reduce operating costs, increase reliability and extend equipment life.

The U.S. Army Corps of Engineers Construction Engineering Research Laboratory funded research by Lance Schideman and E. Morgenroth on Evaluation of the Performance of Hydrogen-Enhanced Reactor Treating Perchlorate and RDX was begun in 2008. The project compared a pilot-scale anaerobic membrane bioreactor with two other bioreactor technologies to treat munitions industry wastewater containing perchlorate, RDX and other explosives. The novel membrane bioreactor used hydrogen gas to stimulate autotrophic growth for higher degradation rates, lower residuals production and improved effluent quality. The goal was to facilitate water reuse in the industrial process to save money and reduce environmental impact.

Illinois C-FAR supported research in 2000 to 2003 by Richard Cooke and Michael Hirschi, assisted by T. Wildman and A. Doheny, on Passive Subsurface Bioreactors for Enhanced Edge-of-Field Treatment of Tile Outflow. The goal was to test the hypothesis that installation of passive subsurface bioreactors on tile outlets will reduce the levels of nutrients and pesticides in streams and rivers. A laboratory study determined the substrate (carbon source) that results in the highest removal efficiencies for nitrates and phosphorous. A pilot system was established for field validation and demonstration.

Using funding from the USDA and the Cooperative State Research, Education and Extension Service, Richard Cooke and Prasanta Kalita, assisted by A. Doheny, studied Development of Design Criteria for Watershed-Scale Subsurface Bioreactors in 2004 to 2006. The objectives were to demonstrate the efficacy of passive subsurface bioreactors in removing nitrates from the flow from small watersheds, evaluate the effectiveness of woodchips from softwoods and hardwoods as carbon sources in the bioreactors, and to develop design criteria for subsurface bioreactors.

Richard Cooke, assisted by J. A. Chun, used funding in 2005 to 2008 from the Sand County Foundation and the Agricultural Watershed Institute to study Combined Drainage Water Management/Bioreactor System for Improving the Quality of Tile Outflow. The goal was to evaluate the effectiveness and cost efficiency of bioreactors, either as stand-alone practices or in combination with drainage water management systems, in reducing nitrogen discharge from fields with tile drains. The results were needed in scaling up a regional initiative to reduce nitrogen discharges from agricultural lands while protecting income to landowners and rural communities.

Prasanta Kalita and Richard Cooke used funding from the USEPA to study An Innovative System for Bioremediation of Agricultural Chemicals for Environmental Sustainability in 2007 and 2008. The objective was to design, implement, and evaluate a renewable, naturally-available biofilter to minimize transport of chemicals from agricultural fields into surface water sources. A cost-effective design for minimizing chemical leaching was preferred over reductions in pesticide and chemical application. In addition, this design will allow for sustainable agricultural production and technology, while being environmentally beneficial to surrounding areas.

The USDA and the Iowa Cattlemen/s Association provided funding in 2007 to 2008 for Prasanta Kalita, Ted Funk and Xinlei Wang, assisted by R. Bhattarai and M. K. Patel, to study Vegetative Treatment System Technology. The performance evaluation of a vegetative treatment area (VTA) for beef feedlot runoff management was investigated. This is probably the southernmost site among all the other experimental sites in a multistate effort with significantly different climate, hydrologic, and soil conditions. The overall objective of this investigation was to evaluate through field monitoring the performance of nonbasin (non-containment) technologies for the treatment of open feedlot runoff in several beef operations in different midwestern states. Two nonbasin technologies under consideration were infiltration basin followed by a vegetative treatment area, and vegetative treatment area only.

OREE research

In the 1990's, the name of the Power and Machinery (P&M) area of the department was changed to Off-Road Equipment Engineering (OREE) to more accurately describe the activities of the area. The research sub areas described below are those that were carried out primarily by department faculty assigned to the OREE area, with help from students and, in some cases, help from cooperators from outside the department. In earlier years, USDA personnel housed in the ABE department were an important part of the departmental research staff. Some of the USDA personnel held courtesy appointments on the ABE faculty and participated actively in faculty activities, including advising graduate students. By 1997, the only such USDA employee remaining in the ABE department was John Hummel. Hummel's participation with the ABE faculty ended in 2000, when he was transferred to Columbia, Missouri.

Agricultural safety

In a study funded by USDA Hatch funds, Bob Aherin and Gerald Riskowski designed and tested a system for preventing falls and suffocation of persons who enter grain bins. The system, which can be incorporated into existing or new grain bins, allows workers to accomplish needed tasks while providing protection from falling through crusted-over grain. The grain storage industry was informed of the results.

The primary goal of a study supported by the USDA Agricultural Library was to identify current sensor technology capable of detecting toxic atmospheres within confined spaces on farms. Project participants were Bob Aherin, Les Christianson, Gerald Riskowski and Randy Fonner. The study included a world-wide literature review, contacting federal and private research laboratories and manufacturers of sensors. The final report, released by the USDA, identified sensors with the greatest potential in agricultural confined spaces.

A four-year study supported by the National Institute for Occupational Safety and Health and by the National Farm Medicine Center was aimed at reducing the fatality risk from livestock manure storage pits. The study, led by Bob Aherin and MS student Matt Robert, undertook to understand the interactions that lead to dangerous concentrations of manure pit gases, develop potential strategies to reduce such concentrations, and evaluate sensors capable of detecting the pit gases develop safety procedures for people working in or around manure pits. The researchers found that hydrogen sulfide (H2S) concentrations can exceed published health limits when the manure is agitated, but lowering the % TVS (Total Volatile Solids) in the manure reduced the H2S emissions. They found that high ventilation rates are needed during pit agitation to protect the health of workers and animals.

Bob Aherin was lead scientist in a study on the respiratory health of swine workers. The study was supported by the National Institute for Occupational Safety and Health; the National Farm Medicine Center and by Carle Foundation Hospital Center for Rural Health and Farm Safety. Swine workers were given a lung function test every three months for a year. Results indicated that, in swine facilities that are designed and managed properly, there is only minimal risk to the respiratory health of swine workers.

Bob Aherin, Ted Funk and Yuanhui Zhang participated with other cooperators on a study of Occupational Exposures and Health Outcomes in Swine Confinement Facilities. The study was supported by The National Institute for Occupational Safety and Health and by the University of Illinois School of Public Health. Worker exposures to airborne contaminants in a swine confinement facility were evaluated. Biological markers of inflammation were evaluated before and after work for two consecutive work days in winter. Worker blood samples, exhaled air samples and lung function were evaluated. Each worker wore an air-sampling device that measured contaminants collected during their work shift. Air samples were evaluated for particulates, CO, CO2, H2S, NH3 and O2. Preliminary results showed that workers exposed to the particulates and contaminant gases showed little to no adverse effects.

Agricultural Infotronics Systems

Qin Zhang conducted Research on Agricultural Infotronic Systems in a study supported by USDA Hatch funds. The goal was to create a system capable of providing farmers with actionable information while performing precision farming operations. The framework of the system included data collection, operation planning and automatic implementation modules. The data collection module included algorithms to classify, fuse and track attributes of crop production information. The system was validated in precision farming operations.

Qin Zhang and Shufeng Han worked with agronomists on In-Season, Site-Specific Nitrogen Management for Corn. The study was supported by the Illinois Council for Food and Agricultural Research (C-FAR). The goal was to develop an on-machine corn nitrogen stress sensor and evaluate its potential for real-time site-specific nitrogen management during side-dressing operations. A multispectral imaging sensor was developed to detect nitrogen deficiency during fertilizing applications. The research confirmed that it is technically feasible to reliably detect nitrogen stress.

Biofuels

In a study supported by the Illinois Department of Commerce and Community Affairs, Carroll Goering and MS students Curt Ritter and Ryan Parcell instrumented a Detroit Diesel two cycle bus engine to evaluate 190-proof ethanol as a potential fuel for bus engines. An engine controller was developed to operate the engine on the modified Chicago Transit Authority engine cycle for 454 hours. A 14% power reduction due to injector needle sticking was eliminated by installing new injectors. NOx, CO and HC emissions were less for the 190-proof ethanol than for anhydrous ethanol.

The USDA supported a study by Carroll Goering, Les Savage, and graduate students Anne Meyer, Barry Bliss and Tom Briggs to develop an accelerated evaluation of vegetable oil fuels. A Lister-Petter two cylinder diesel engine was modified to allow one cylinder to run on petroleum diesel while the other ran on a vegetable oil fuel to allow comparative testing under identical conditions. The engine was used to evaluate a variety of biofuels developed by the USDA Peoria laboratory. The effects of the biofuels on engine performance and durability were determined.

In work supported by the Illinois Department of Commerce and Community Affairs, Allen Hansen and Qin Zhang conducted a study to Evaluate E-diesel as an Alternative Fuel for Diesel Engines. E-diesel is a blend containing 10% ethanol and 90% diesel fuel, with a special additive used to keep the two well blended. The researchers conducted a 500-hour test using a procedure developed in cooperation with the International Engine and Truck Corporation. The results were sufficiently promising to merit field testing.

In a study supported by the Illinois Council on Food and Agricultural Research and the Great Lakes Regional Biomass Energy Program, Allen Hansen, Qin Zhang, Rob Hornbaker and MS student Todd Manke did an Evaluation of E-diesel as an Alternative Fuel in Agricultural Machinery. The Illinois Corn Marketing Board, Deere and Company, and Caterpillar, Inc., were industrial partners in the research. Participating farmers on two farms used two tractors and two combines. One tractor and combine on each farm ran on E-diesel while the other tractor and combine ran on petroleum diesel. A standard test procedure was developed for monitoring the performance and condition of the tractors and combines. The tractor and combine engines running on E-diesel showed no abnormal wear but consumed 2.8 to 5.6% more fuel because of the lower energy content of the E-diesel. In addition, ADM ran two Mack trucks on E-diesel for a total of 372,000 miles without any problems. Fifteen Chicago city buses accumulated over 273,000 mile on e-diesel without any problems. The Illinois Corn Growers Association ran a Ford F-250 truck on E-diesel with no problems after 3 months of running.

USDA Hatch funds supported Allen Hansen's research on Evaluation of Biomass-derived Alternative Fuels for Off-road Vehicles. Selected biomass-derived fuels were evaluated as to engine performance, durability and emissions. The laboratory tests were used to optimize engine parameters for minimum emissions and maximum performance. Tests of B2, B5 and B100 in a turbocharged diesel engine showed up to 12% increase in NOx emissions compared to petroleum diesel. However, addition of ethanol to the base fuel suppressed part of the increase in NOx emissions.

In research supported by the Campus Research Board, Allen Hansen studied the Impact of Soybean Oil Methyl Ester Composition on NOx Generation from Combustion. A negative aspect of ester fuels is that they tend to increase NOx emissions. Special emphasis was placed on accurately representing fuel properties. Experiments and 3-dimensional fluid dynamics were used to study the ester composition effects on NOx formation. Results showed that relatively small changes in ester composition can reduce NOx emissions to be equal to or less than those from petroleum diesel fuel.

USDA Hatch funds were used to support Allen Hansen's research on Impact of Biofuels on Emissions Reducing Technologies for Off-road Diesel Engines. The purpose was to evaluate the impact of biofuels on both present and emerging emissions reducing technologies. The strategy of using exhaust gas recirculation to reduce NOx emissions was more effective with biodiesel than with petroleum diesel. Under high loads, EGR rates of 5 to 5.5% were sufficient to reduce NOx emissions to equal those of petroleum diesel. The biodiesel used was the methyl ester of soybean oil.

The US Department of Energy supported work by C.F. Lee, Allen Hansen and D. Kyritis on Graduate Automotive Education (GATE) Center of Excellence: Advanced Automotive Bio-fuel Combustion Engines. The objective of the Center of Excellence is to create an educational and research program to provide automotive engineers with knowledge and skills to develop future engines to run on biofuels such as ethanol and biodiesel.

In work supported by the US Department of Energy, C.F. Lee and Allen Hansen did an Investigation of Biodiesel-Fueled Engines Under Low Temperature Combustion Strategies. Laser diagnostics and multidimensional modeling were used to investigate a novel low-temperature combustion (LTC) strategy with biodiesel. The aim of the LTC strategy is to reduce NOx and particulate emissions while achieving high combustion efficiency. The large differences in properties between petroleum diesel and biodiesel did not affect the outcome of combustion simulations. The simulations predicted that, compared to petroleum diesel, biodiesel generated higher in-cylinder pressures and temperatures and less soot.

A project on Engineering Solutions for Biomass Feedstock Production was supported by the BP funded Energy Biosciences Institute of the University of California-Berkeley, partnering with the Lawrence Berkeley National Laboratory and the University of Illinois. ABE Participants were K.C. Ting, Allen Hansen, Qin Zhang, Tony Grift, Lei Tian, Steve Eckhoff and Lius Rodriguez. Seven postdoctoral students were also hired to assist with the research. BP funded the program to further the development of cellulose-based ethanol fuel. The five interrelated tasks in the program were pre-harvest crop production; harvesting; transportation; storage; and systems informatics and analysis. The research steps were to evaluate existing technologies; characterize task features; identify information needs and researchable questions; develop prototypes and computer models; conduct experiments and computer simulations; analyze experimental data and simulation output; and deliver results in the forms of operational machinery design/prototype and decision support information/tools. To grow micanthus and other feedstocks, 340 acres of UIUC farmland were set aside. The research was initiated in 2007 and was on going at time of writing.

Robotics

In research supported by a C-FAR Sentinel grant, Tony Grift, M. Bohn, Lius Rogriguez and A. Hager studied Development and Evaluation of High Efficiency Flexible Intelligent Farming tools – Phase I, Autonomous Weed Control. They worked on developing a flexible weeding system capable of identifying weeds and treating them based on their response to glyphosate (Roundup). Weeds responsive to glyphosate were treated chemically while resistant weeds were treated mechanically. The operations were carried out by autonomous robots having wireless Internet connectivity for access to a weed image data base and for remote monitoring of robot performance. The work was on going at time of writing.

With support from the Japanese Society for the Promotion of Sciences, Tony Grift and Y. Nagasaka worked on Development of Autonomous Robots for Biosystems Applications. An autonomous robot (Ag Tracker) was developed as a sensor carrier for crop scouting. Several walking robots were developed to demonstrate the potential of robots for crop scouting. A robot was developed as a carrier for a soil-sampling device that was developed at the University of Nebraska.

Mechatronics

At the request of a hydraulic components manufacturer, Carroll Goering and MS student C. Chou investigated the accuracy of the orifice equation in predicting pressure losses. A new model was developed to calculate more accurate values for the orifice flow coefficient as a function of Reynolds number.

Carroll Goering, Qin Zhang and PhD student Ruth Book developed a prototype mechatronics valve. Computer software permitted the generic valve to perform the functions of many specialized valves and also permitted implementation of control strategies previously not achievable. A disclosure was filed with the University's intellectual property office but, by the time they filed a patent application, Caterpillar Inc. had filed an application for a similar valve a few months earlier.

With support provided by Caterpillar, Inc., Qin Zhang and D. He researched a Wavelet-based Fault Diagnosis for Pump Health Assessment. The goal was to identify healthy, worn and damaged pumps based on feature extraction from pressure wavelets. The researchers found that wavelet analysis can improve the capability of diagnosing piston pump health and identify types of pump defects. The results were brought the attention of industry via publication in a national journal.

The National Fluid Power Association supported work by Qin Zhang on Maintenance and Fault Diagnosis Tools for Hydraulic Pumps. The goal of the on going program is to give undergraduate and graduate students a better understanding of fluid power through participation in research on pump maintenance and fault diagnosis, enabling them to evaluate the health and maintenance requirements of a fluid power system.

Qin Zhang's Study of Control Methods on Electrohydraulic System Performance was supported by the National Fluid Power Association.

The influences of variable delays, such as sensor delay and loop-time delay, were studied using a hardware-in-the-loop simulator to evaluate their effect on overall system performance. For example, the simulator was used to develop a successful electrohydraulic steering controller for automatic guidance. The simulator was also useful as a laboratory module in teaching undergraduate and graduate courses on electrohydraulics.

Automatic guidance

John Reid worked on Vision-based Guidance and Control of Field Machinery. The systems he developed based automatic guidance on pathways defined by crops, rows and artificial markers. An algorithm was developed to extract the guidance directrix based on machine vision images of crop rows.

Qin Zhang conducted research on Intelligent Navigation Control for Off-Highway Equipment with Automatic Guidance. Objectives were to develop an interactive electrohydraulic steering simulator with steering load control for reproducing load spectrums on various terrains and to develop advanced algorithms for electrohydraulic steering control. The simulator and algorithms that were developed were later used in research sponsored by Deere and Company on Automatic Tuning and Adaptive Control Technologies for Intelligent Vehicle Path Tracking.

USDA Hatch funds supported a study by Qin Zhang and John Reid on Fuzzy Controls for Mechatonized Off-Road Equipment. The goal was to develop an automated guidance system based on the hypothesis that an intelligent control system can use experience, common sense and intelligence similar to that used by human drivers in maneuvering equipment. The automated guidance system included technologies for redundant guidance sensing, vehicle path planning, sensor fusion and fuzzy controls for electrohydraulic steering control. The guidance system was developed and implemented on an agricultural tractor.

In January, 2001, John Reid left the department to accept a position with Deere and Company. A while later, Deere and Company began offering their Auto-Trac automatic guidance option for their tractors. Also, Deere and Company began supporting related research in the ABE department.

With support provided by Deere and Company, Shufeng Han and Qin Zhang initiated a project on Dynamic Performance Evaluation of GPS Receivers and GPS Guidance Systems. The project was to develop a procedure for performance evaluation of commercial DGPS receivers and to provide an independent evaluation of such receivers. The researchers developed a method to evaluate the GPS dynamic position accuracy of eight commercially available DGPS receivers under linear parallel-tracking applications. The dynamic performance of a receiver was extremely variable from test to test. The cumulative frequency distribution of the pass-to-pass average error provided a good statistical measure of the GPS dynamic accuracy. The results were reported in an article in a national journal.

Qin Zhang, with support provided by Deere and Company, investigated Vision Guidance for Wheel-Type Agricultural Tractors. The aim was to develop a vision-based system capable of detecting crop rows or crop edges in typical farming operations. A search algorithm was developed to use posture sensors to determine the current tractor position and a tractor dynamics model to estimate the future tractor position. The posture sensors included a real-time kinematic global positioning system (RTK-GPS) receiver and a fiber-optic gyroscope (FOG). The outputs from the dynamic path search algorithm were tractor lateral deviation and the desired yaw angle. Based on these outputs, an intelligent navigator created appropriate steering angles to guide the tractor along the desired path. The results verified that this dynamic path search algorithm could navigate an autonomous tractor in accurately tracking the desired path to perform agricultural operations.

Using support provided by Deere and Company, Qin Zhang did an Investigation on Automatic Tuning and Adaptive Control Technologies for Intelligent Vehicle Path Tracking. Representative controllers, such as PID, feed-forward PID, fuzzy, sliding mode and LQR controllers were implemented on a laboratory scale, hardware in the loop control system simulator to provide preliminary validation of the controllers. Strengths and weaknesses of each candidate controller were identified.

Qin Zhang, with support from Deere and Company, studied 3-D Density and Density Maps for Stereo—Based Navigation. Stereovision cameras potentially provide a 3-D format for detecting objects in the path of autonomous vehicles. The research goal was to develop the concept of using 3-D density and a density map to represent the detected objects in profile and location with sufficient accuracy and reliability needed for safe operations. Field tests with a standing person as the obstacle indicated that the system could reliably detect the obstacle and its motion in the path of an agricultural vehicle. The accuracy decreased as the distance between the obstacle and the vehicle increased. The results were reported in an article in a national journal.

Deere and Company provided support for Qin Zhang's project on Sensor Fusion Development for Auto Trac Guidance Systems. The primary focus was on integration of a low-cost IMU sensor with GPS to provide an accurate, robust navigation input for Auto Trac guidance systems. The integrated sensor system was tested in multiple farm fields.

Site-Specific (Precision) Agriculture

In a C-FAR supported study, Carroll Goering, John Hummel, Rob Hornbaker and PhD student Jing Liu developed an artificial neural network (ANN) to set spatially referenced maize yields on the basis of soil, weather and management factors. Setting realistic yield goals in each part of a field is an important first step in site-specific agriculture. Thirty years of data from the Morrill Plots were used to train the neural network. The ANN was able to account for about 80% of the yield variation in the plots.

In a study supported by C-FAR, Lei Tian, John Reid and PhD student Brian Steward worked on a Low-Input and Nonchemical Weed Control System. The goal was to integrate a machine-vision sensing system with a herbicide sprayer to create a mapping system for weed control. A system was developed to characterize plant features necessary for crop and weed identification. The neural network-based, pattern-recognition algorithm was able to separate broad leaf weed images from grass weeds based on texture differences. The results were reported in a national journal article.

Lei Tian and John Hummel worked on Development of a Precision Herbicide Application System. The goal was to develop a robotic system for applying herbicide only to target weeds during soybean and maize production. Specific tasks were to identify the current state of the technology, develop a working prototype and evaluate it in normal farming operations. A "smart sprayer" was developed. It used a sprayer-mounted machine vision system to identify weeds and turned on the appropriate individual nozzles on the spray boom to apply herbicide to the weeds.

With support from C-FAR, Lei Tian and John Reid developed a "Smart Sprayer" Expert System for Site-Specific Weed Management. The goal of the research was to use the smart sprayer as a research platform to establish a data base on weed distributions, i.e., the "patchiness" of weeds and to further optimize the smart sprayer to bring it closer to commercialization. Results showed that weeds are not uniformly distributed in fields, but grow in patches with up to 90% of the field being weed free.

The Sentinel program of C-FAR supported research by Lei Tian, Don Bullock and J. Westervelt on Developing an Agricultural Remote Sensing Program at the University of Illinois. The program aims were to assess the needs of farmers for remote sensing, develop key technologies needed NASA remote sensing applications in precision agriculture, and foster cooperation among scientists working in precision agriculture and remote sensing. The Illinois Laboratory for Agricultural Remote Sensing was created in the ABE department.

The NASA CRSP Ag20/20 Initiative provided funding for a study by Lei Tian, Lloyd Wax, C. Sprague and MS student Kelly Thorp on Variable Rate Herbicide Applications Using Remotely Sensed Imagery. The goal was to evaluate the effectiveness of variable-rate sprayer technology based on remote sensing in terms of cost savings, effectiveness in eliminating weeds and ability to maintain crop yields compared to traditional methods of herbicide application. In a continuation of the study, the North Central Soybean Research Program sponsored research by Lei Tian and Don Bullock on Using Remotely Sensed Data to Diagnose Soybean Yield Limiting Factors. The objective was to develop sensor-based, within-field maps of weeds, disease and nutrient deficiencies and evaluate their contribution to yield variation. Such data help crop consultants, producers and researchers interpret yield maps and allow appropriate site-specific management options for a field. The spatial quality of the raw hyperspectral data were quite variable and variable soil reflectance was a problem that was overcome be data processing. A successful variable-rate sprayer was developed to apply herbicides based on maps generated from remote sensing imagery. The sprayer was able to achieve a 21% reduction in herbicide use with no significant loss in weed control.

With support of the USDA, Lei Tian, John Hummel, Bob Wolf, Loren Bode and Scott Bretthauer worked on Precise Application of Agricultural Chemicals. Equipment and techniques were developed to improve the application efficiency of agricultural chemicals. Drop size spectra from various atomizers were measured and field-evaluated as to coverage and minimization of spray drift. Sensors and automatic control systems were developed to apply pest control substances as a function of soil organic matter, travel speed and other input variables. Findings from the study were delivered to farmers and professional pesticide applicators through extension meetings and an annual Spray School.

CEMAGREF provided funding for a study by Tony Grift, G. Kweon, E. Piron and F. Rioual on Development of a Smart Spreader System. The goal was to develop a Smart Spreader in which both rate and uniformity are controlled. The study included an investigation of the fundamental flow of particles during spreading. A technique was developed for measuring the Coulomb friction coefficient of sliding particles.

Support from the Citrus Research and Education Center, University of Florida, was used by Tony Grift, M.R. Ehsani and K. Nishiwaki to work on Development of a Yield Monitor for Citrus Fruits. A yield monitor became necessary when traditional fruit bins were replaced by continuous mechanical harvesting machines. A yield monitoring system was developed at the University of Illinois to give yields on a per-tree basis. The system was implemented at the Research and Education Center at the University of Florida.

Other OREE projects

Carroll Goering, PhD student Tim Stombaugh and undergraduate student Corey Neumann developed a total engine performance monitor. The project began as Neumann's undergraduate research thesis. The timing pattern of a needle lift transducer provided data used to calculate engine speed and diesel fuel consumption of the engine in real time. Also in real time, a mathematical model calculated engine torque as a function of engine speed and fuel consumption. Then engine power and specific fuel consumption were calculated. The monitor was brought to the attention of the engine industry via a publication in a national journal.

John Siemens conducted a project on Farm Machinery Selection and Management. A computer program was developed to determine the optimum sizes of a set of farm machines for any given farm. The program schedules field operations for different machinery sets and selects the set that minimizes cost, including cost of lost crop due to untimely operations. The program was brought to the attention of farmers via Simen's extension program.

John Siemens, John Hummel, and E.D. Nafziger conducted research on Tillage Systems. A variety of tillage systems ranging from moldboard plowing to no till were evaluated at five University of Illinois Research Demonstration Centers. Factors studied included crop establishment, growth, yield and weed control under various soil conditions. Results were transmitted to producers via Siemen's extension program.

John Siemens studied Soil Compaction Caused by Wheel Traffic. Treatments included no extra traffic, extra traffic on every other row and traffic over the entire plot before planting. Crop yields decreased due to soil compaction in some years, especially in years when compaction caused inadequate drainage.

Deere and Company supported research by Alan Hansen and Robert Hornbaker on Simulation of In-Field Grain Handling Systems. They fitted combines, grain wagons and semi trucks with data loggers to track their movement and transfer of grain between vehicles. The data were used to verify a model of grain movement and transfer during wheat and corn harvesting. The researchers found that optimization of the combine harvesting pattern can increase efficiency substantially.

Research by Alan Hansen, Robert Hornbaker and Qin Zhang on Real-Time Decision Support System for In-Field Agricultural Operations was supported by Deere and Company. The goal was to develop a decision support system for inter-vehicle, real-time data communication to optimize in-field grain handling by combines, grain wagons, road transport and grain elevators. Wireless communication protocols were established and preliminary field tests of a prototype were successfully completed in the United States and Australia.

Pioneer HI-Bred International, Inc., provided funding for a study by Tony Grift, M. Bohn and J. Novais on Corn Root Evaluation System. The researchers developed a system for efficiently imaging a large number of corn roots. The images were stored and characterized using fractal dimension and entropy to distinguish among corn genotypes.

Another use was to identify genetic markers that have distinct effect on room development under varying soil conditions. A database was developed containing root morphology images for a wide spectrum of corn genotypes grown under diverse field conditions.

Alan Hansen, with support from the Campus Research Board, worked on Development of Portable Tools with Optimum Configuration for Cutting Sugarcane. The goal was to design, build and test portable tools for cutting sugarcane based on engineering and ergonomic principles to maximize productivity and quality while minimizing stress on the human cutter. A platform was developed to measure sugarcane cutting forces and blade acceleration to use as inputs to a biomechanics model.

BEE Research

Research scope and activities in the Bioenvironmental Engineering (BEE) Section underwent noticeable change in 1990s and then growth in the first decade of 21st century.

The change was manifested in 1994 by changing the section name from Structures and Environment (SE) Section to BioEnvironmental Engineering (BEE) Section. Donald L. Day, SE Section Leader, a 32 year veteran of the faculty in ABE at UIUC, retired in 1994. Gerald L. Riskowski, succeeded Day as the Section Leader. The name change to BEE Section reflected the evolving research scope among the faculty, which has been gradually shifted from a more structures oriented program to a more bioenvironmental focused program. Two new faculty members, were added. In 1992, Ted L. Funk filled up the Extension position of Arthur Muehling who retired in 1992; and, in 1996, Yuanhui Zhang filled the teaching and research position of Donald L. Day.

Bioenvironmental engineering is defined as the engineering of environmental systems immediately surrounding the living things – animals, human plants and organisms. Research activities in the 1990's include the following highlights:

Laboratory animal environment: Motivated by biomedical research needs, laboratory animal living environment, in rooms or cages, became a key concern due to animal health and medical research validity. Several research projects were funded by NASA and NIH to BEE faculty (Christianson and Riskowski) to study the living environment in the laboratory animal rooms and cages including measurement and control strategies for ammonia, carbon dioxide and particulate matter concentrations, ventilation rates and thermal conditions.

The indoor air quality program includes swine odor measurement and abatement technologies. Animal building air quality research includes lagoon covers, oil sprinkling, catalytic conversion of swine odor and ammonia. Particulate matter research includes the development of an aerodynamic air cleaning technology (aero-deduster) to remove dust particles from air flow. The aero-deduster research was later expanded to the area of off-road machinery cooling-air cleaning and other civil and military applications funded by US Army, Navy, Deere and Caterpillar. Yuanhui Zhang developed a new senior/graduate level textbook entitled "Indoor Air Quality Engineering".

The Bioenvironmental Structural Systems (BESS) Laboratory was established in 1990 focused on agricultural fan and ventilation equipment testing. By the end of 1990s, the BESS Lab became a nationally and internationally known facility, and publishes an annual report on agricultural fan performance. Approximately 95% brands of agricultural fans manufactured in North America were tested in the BESS Lab. It is estimated the testing results helped to improve fan energy efficiencies 20%.

Non-intrusive, full scale, quantitative and instantaneous measurement techniques for airflow in entire airspaces (versus single point measurements) were needed, especially in the area of developing CFD models. The BEE group investigated the measurement technology of 3-dimensional, volumetric particle tracking velocimetry (VPTV) to measure and model large volume fluid flows such as room air. Using this technology, BEE researchers successfully measured the cabin flow field and pollutants distribution in a full scale Boeing 767 aircraft cabin section containing 35 mannequins. This project was funded by CDC and Boeing.

Since 1996, BEE researchers have pioneered research on a Thermo-Chemical Conversion (TCC) of swine manure into crude oil. Zhang's group mimics the crude oil formation process in nature – biomass buried underneath the earth subjected to high temperature and pressure and then formed into crude oil over millions of years – and successfully converted swine manure into crude oil for the first time in 1999. They continued work with feedstocks including human and food processing waste, and biomass including algae and lignocellulose. The specific technology is called the hydrothermal process (HTP) and directly converts the mixture of biomass and water into a bio-oil. The technology was later licensed to industry which has since developed pilot and commercial plants.

The impact of BEE research also resulted in a noticeable impact on the professional communities. Data, testing procedures and research results are included in the Handbooks of ASABE and ASHRAE.

The first decade of the 2000s was a time of growth. In January 2002, Gerald Riskowski left the department to become Head of Agricultural and Biological Engineering Department at Texas A&M. Yuanhui Zhang succeeded Riskowski as the BEE Section Leader. Xinlei Wang joined the BEE faculty in December 2002 to work on air quality and renewable energy systems. Lance Schideman filled the position of Leslie L. Christianson who retired in 2007. Schideman's area was water quality control processes and wastewater bioenergy systems. Angela Green joined the BEE in February 2008 to work on animal wellbeing and production systems. Richard S. Gates was recruited in August 2008 as the first 'Faculty of Excellence' hire in the Agricultural and Biological Engineering Department. His area was building environmental control. The expansion of faculty substantially extended the research portfolio in BEE and cross linked to other sections and disciplines, notably:

Engine emission control – Xinlei Wang extended his indoor air quality research to engine emission control. His research attracted funding from USEPA, and industry including Deere and Company and International Trucks and Engines Corporation. Diesel engine powered agricultural equipment and highway vehicles were a significant source of air pollution, which posed a significant challenge to the engine manufacturers. Wang's research was to develop after-treatment technologies to clean the exhausted air, including system simulation and a model-based control strategy to control the emissions from diesel engines. He also partnered with the USEPA, Cummins Inc. and the local mass transit district to reduce emissions from city buses.

Water purification and bioenergy production by growing algae – A major theme of Schideman's research program was the combination of environmental benefits with bioenergy production. One example was the use of algae for biological treatment of wastewaters and subsequent harvest and conversion of algal biomass to produce various liquid biofuels. This work was synergistically linked with the ongoing TCC work in Zhang's group to produce algal biocrude oil and provide post-treatment and reuse of TCC process wastewaters. This research showed how these bioreactor systems could be used alone or in combination with other membrane and adsorption treatment technologies to yield valuable energy resources and removing excess nutrients, pesticides, residual pharmaceuticals and endocrine disrupting compounds, which reduces overall environmental pollutant loads and facilitates water reuse applications.

Animal well-being and animal production facilities – Angela Green added a new dimension and bridge with animal sciences, combining principles of engineering a controlled environment with a better understanding of the occupant, including physiological and behavioral responses to environmental conditions and housing systems. One key aspect of Green's work involved preference testing, a way to get direct feedback from an animal about its perceptions. Other important research included development and refinement of technologies for measuring animal feedback, and quantification of real-world environmental conditions in commercial animal production. Green approached each animal housing analysis from a systematic perspective, considering not only animal welfare, but additionally aspects of management, environmental impacts, and economical components. Green and Gates were responsible for the Animal Welfare and Environmental Systems Laboratory (AWES Lab).

Controlled building environmental program – the interaction between building systems and their occupants, whether plants, animals or people, had long been a core strength of the BEE program. In 2008, Rich Gates joined the group, bringing ongoing projects on agricultural air quality focused on livestock and poultry emissions from production facilities, mitigation techniques including biofilters and dietary manipulation for egg laying hens. He began initiating new efforts in controlled environment plant production and cooperative efforts with the VPTV group (focusing on CFD model validation) and with Green on animal preference testing. He initiated two international student exchange programs, one with two Brazilian universities and another with four European universities, both focused on the further development and definition of biological engineering within the context of agricultural and biological engineering.

Food and Bio Process Engineering Research

J. Bruce Litchfield joined the Agricultural and Biological Engineering Department in 1986 to teach food engineering courses and conduct research related to food engineering. He used magnetic resonance imaging (MRI) to measure physical properties of food materials with Shelly J. Schmidt (Foods and Nutrition) and Paul C. Lauterbur (Medical Information Sci.) They measured water diffusivity, thermal conductivity, and thermal diffusivity, and physical structure during processing of grains, seeds, and model foods. They were able to map temperature profiles of flowing food particles which for the first time enabled researchers to non-invasively measure temperatures of particulates in aseptically processed foods. Measurement of temperatures at the coldest spot in food particles enabled verification of effective sterilization of thermally processed foods. In 1994, J. Litchfield, J. Reid, and C. Harper (FDA) investigated MRI and other technologies for detection of defective seals in flexible food packages.

In 1992, Litchfield, J. Bentsman, and N. Miller (Mech & Industrial Engr.) developed a knowledge-based adaptive, fuzzy logic, and neural control system for providing optimal drying conditions for dried food products. In 1992, Drs. Litchfield and Eckhoff developed a 3-dimensional model for moisture movement within a corn kernel during steeping. The model was verified using MRI.

In 1997, Litchfield and K.M. Ghiron developed a magnetic thermometry process to measure temperatures in particles of multiphase foods during aseptic processing. The system utilized magnetic sensor beads, pick-up coils, and a magnetic sensor.

Litchfield, Eckhoff and Mike E. Tumbleson developed alternative separation techniques to recover biosolids from a food processing facility using various biological or food materials instead of commercial flocculants. Recovered biosolids that did not use commercial polymer flocculants could then eventually be used as an animal feed supplement. In 2001, K. Rausch, S. Eckhoff, V. Singh, and M. Tumbleson investigated use of microfiltration of liquid streams from corn wet mills to recover protein and other nutrients as an alternative to using centrifugation, evaporation, and vacuum belt filtration to reduce capital and energy costs.

Litchfield and John F. Reid used in situ image processing with a microscope to monitor cell growth during a fermentation process. Their system used an automatic sampler to deliver microliter-sized samples from a fermentor to a microscope stage. Image features enabled decision making related to environmental conditions in the fermentor.

In the fall of 1997-98, Litchfield started work as a half-time rotating Assistant Dean for the College of Engineering and later became an Assistant Dean in the College of Engineering.

Steven R. Eckhoff joined the Agricultural Engineering Department in 1987 to conduct "value added" research related to corn wet milling. He and his graduate student, L. Du, developed an innovative alkali wet milling process using sodium hydroxide to disrupt the endosperm protein matrix. After alkali debranning of the corn kernels, grinding, and steeping in dilute alkali, total process time was reduced to 1.5 hours with product yields comparable to conventional wet milling. Then Eckhoff and his graduate student, J.F. Lopes, developed an Intermittent Milling and Dynamic Steeping (IMDS) process in which the corn kernel is milled in stages followed by steeping, allowing fast hydration and diffusion of sulfite into the endosperm. This process enabled high starch recovery in only 5 hours compared to normal times of 32 to 56 hours. In conventional steeping of corn in a wet milling operation, the corn is soaked in a solution of sulfur dioxide so that the SO2 can break bonds holding a protein matrix tightly to starch granules. An increase in starch appeared to also come from having less starch left in the fiber fraction.

In another study, Eckhoff with J. McKinney, used gaseous SO2 to diffuse the SO2 into corn kernels 100 times faster than when a liquid solution is used. They found gaseous SO2 cut steep times to ¼ to ½ of normal steep times which would save about 8% of the capital costs of a wet mill. In 1992, Eckhoff and E.J. Fox steeped high lysine corn and found that soft corn such as high lysine requires much lower steep times than hard endosperm corn. In 1993, Eckhoff and K. Rausch developed a resistance/ capacitance method for determining ambient-dried corn from adversely dried corn.

In 1994, Eckhoff with S.K. Singh, K. Rausch, and Am Mistry developed a 100-g lab wet milling procedure which later became the standard reference test used for extractable starch through out the corn wet milling industry. That year Eckhoff, K. Yaptenco, and E.J. Fox developed a lab-scale countercurrent steepbank for simulating steeping operations in a corn wet mill.

In 1997, Eckhoff with P. Yang, and R. Denhart designed a lab-scale steep battery as a computer-controlled system. In 2000, Eckhoff with K. Rausch and P. Yang steeped corn at 50°C with SO2 levels of 1000, 2000, and 3000 ppm for 18, 24, 30 and 36 hours in their countercurrent steep battery. Starch yield was significantly increased by increasing S02 level or by longer steep times.

Eckhoff with graduate student, V. Singh, developed a "Quick Germ" process for ethanol production by removing the corn germ prior to fermentation. This was the beginning of a later patented process that became widely accepted in the dry-grind ethanol industry.

Kent Rausch joined the ABE faculty in 1997. Rausch received his Ph.D. in 1993 from ABE at UIUC with Eckhoff. Rausch spent a year in industry with Cerestar wet milling, followed by three years in Biological and Agricultural Engineering at Kansas State University.

In 2000, Eckhoff with Kent Rausch, Vijay Singh, and A. McAloon developed a "Quick Fiber" process that enabled recovery of pericarp fiber from degerminated corn used in a dry grind ethanol process. The fiber was recovered using hydrocyclones following germ recovery done by the "Quick Germ" process. At that time, this process was estimated to provide a $0.04 per gallon savings by providing increased fermentation capacity by removing fiber ahead of the fermentors. Eckhoff, V. Singh, and R. Moreau with USDA, also determined the best fraction of corn fiber to use for recovering ferulate esters, which have been shown to be good for lowering cholesterol in the blood stream.

In 2001, Eckhoff, D. Gupta, L. Dickey, K. Rausch, V. Singh, and M. Tumbleson developed a "Quick Protein" process to obtain a zein protein rich fraction obtained from corn after undergoing the "Quick Germ" and the "Quick Fiber" processes. In 2001, K. Rausch, S. Eckhoff, M. Paulsen, and M. Tumbleson studied compositional changes in coproduct streams, light gluten and light steepwater, from a corn wet milling plant. Since these streams become part of corn gluten meal and corn gluten feed coproducts, the compositional variability greatly impacts finished coproducts.

In 2006 and 2007, Eckhoff worked with water absorption rates (tempering) of corn and adjunct chemicals to more cleanly separate corn fractions as a preprocess for dry grind ethanol processing.

In 2007 and 2008, Eckhoff and L. Berger compared ruminant digestibility of corn stover at 35-40% moisture to stover at lower harvest moistures.

In 2001, Rausch with J. Faller and S. Eckhoff investigated effects of specific hybrids on dry milling, extrusion variability, and starch rapid visco analysis (RVA). This was the beginning of work on hybrid specific processing.

In 2004, Rausch with V. Singh and R. Belyea from University of Missouri characterized coproducts from dry-grind ethanol processing. They found phosphorous concentrates in the thin stillage stream which is then added to DDGS, distillers dried grains with solubles. Due to environmental concerns with phosphorous, DDGS value is enhanced if its phosphorous content can be reduced. Rausch with V. Singh and M. Tumbleson also investigated dewatering technologies and membrane filtration to recover water and remove nutrients from dilute bioprocess streams. In 2006, Rausch continued work to identity bioprocesses that dewater, dry, or convert solids into higher valued products. In 2008, Rausch, V. Singh, and R. Belyea (University of Missouri) determined membrane filtration and heat transfer fouling characteristics of thin stillage to identify the potential for increased water recycling and reduced energy requirements for a dry grind ethanol plant.

In 2006, Rausch with B. Dien (USDA-ARS) and V. Singh developed a small-scale 25-g dry-grind ethanol test procedure to determine expected ethanol yield from raw corn.

In 1985, S. Gunasekaran, M. Paulsen, and G. Shove developed a laser optical method for sorting corn kernels with stress cracks. In 1986, C. Weller, M. Paulsen and M. Steinberg measured stress cracking and breakage susceptibility of four hybrids dried at 49, 71, and 93ºC.

In 1987, M. Paulsen, L.D. Hill, and G.C. Shove reported on the 1986 loading of a 57,000 metric tonne ocean vessel at New Orleans with corn that was shipped to Japan. Two holds were monitored with thermocouples to measure temperatures during the 35-day voyage. Corn within 1 meter of edges and headspace changed in temperature but corn remained uniformly cold within the center grain mass. Corn moisture contents did not change appreciably but breakage increased significantly during and after loading. Dr. Paulsen also started work using machine vision for detection of corn quality factors related to color and kernel breakage.

In 1989, K. Baker, M. Paulsen, and J. Van Zweden determined seed corn drying rates for three F-1 hybrids in thin-layer tests at 32, 40, 48, and 56°C. Warm and cold germination was reduced significantly at the higher drying temperatures.

In 1992, W. Casady, M. Paulsen, J. Reid, and J. Sinclair developed an image pattern classification system using machine vision using chromaticity coordinates to classify fungal damage in soybeans. In 1992, K. Liao, M. Paulsen, J. Reid, B. Ni, and E. Bonifacio developed a neural network classifier using machine vision to identify corn kernels for broken and whole kernels with about 92% accuracy.

In 1996, E. Bonifacio-Maghirang, M. Paulsen, L. Hill, and K. Bender determined single kernel moisture variation of 29% and 10% moisture blended corn. Moistures equilibrated to 18% by the third day.

In 1997, M. Paulsen with W. Xie used machine vision to determine degree of corn kernel respiration and damage based on tetrazolium color staining in pinkish red (healthy), purple (damaged cells), or white (totally dead cells). Kernels heated at 60 °C for 3 hours turned purple, and for 9 hours were dead while unheated check samples remained a healthy red color. In 1997, B. Ni, M. Paulsen and J. Reid developed an electronic corn kernel size grading system using machine vision. Accuracies averaged 74 to 90% based on pre-sized samples run through precision graders.

In 1997, Paulsen, Reid and Irfan Ahmad developed a machine vision to system use color, morphological and textural features to detect soybean seeds with fungal damage from healthy seeds. In 1997, J. Liu and Paulsen determined degree of whiteness of corn kernels using red, green and blue images which were converted to chromaticity coordinates. Machine vision inspections of corn maintained consistency and the same order as human-inspected samples.

In 1998, Paulsen and L. Pordesimo tested soft, medium and hard endosperm corn varieties, harvested at moistures of 30, 25, and 20% which were dried at temperatures of 25, 50, 60 and 70 °C for starch yield and a near-infrared spectroscopy calibration for starch yield was developed. In 1999, Paulsen and S. Mbuvi developed a corn extractable starch calibration for the NIRSystems 6500 spectrophotometer. In 2000, Paulsen and S. Mbuvi conducted high temperature drying at 90 to 110°C and found 0.9 to 16.0 % point reduction in extractable starch using a Foss Infratec 1229 near-infrared transmission calibration. Each % point gain in extractable starch was estimated to be valued at 4 to 6 cents per bu. In 2002, Paulsen, M. Singh, S. Mbuvi, and L. Pordesimo developed and an extractable starch calibration for corn wet milling and licensed it worldwide through Foss North America. In 2004, E. Newgard and M. Paulsen expanded the extractable starch calibration with more corn varieties and samples. In 2005, the extractable starch corn calibration was licensed to a major spectrometer company and became publicly available.

A project involving garlic bulblets in wheat was initiated with Eckhoff, Paulsen, E. Jones from Virginia Tech University and D. Eustace at Kansas State University. Helping on the project were L. Obaldo, B. Ye, and J. Liu. The relationship between garlic bulblet concentration and plugging of break rolls in flour mills causing economic loss was investigated, so that possible changes to USDA grading practices could be recommended. In 1999, kernel density and dimensional measurements of garlic bulblets and wheat kernels were determined to evaluate alternative sieving and cleaning methods. Garlic bulblets were found to have strong affinity for water and were usually found over a riddle sieve and larger sieves.

In 2004, Paulsen and S. Nimaiyar scanned ground soybeans and developed a Fourier transform near-infrared reflectance (FT-NIR) calibration for isoflavones in soybeans. In 2005 they developed FT-NIR calibrations for palmitic, stearic, oleic, linolenic, and linolenic fatty acids in ground soybean samples.

In 2006, Paulsen and S. Rathore used FT-NIR to identify and determine ethanol and total sugars in fermentation broths for a dry-grind ethanol process. In July 2006, Paulsen retired from the Agricultural and Biological Engineering Department after 31 years of service. In 2007, Paulsen with S. Rathore continued a project to develop a FT-NIR calibration to classify corn hybrids based on predicted ethanol yields. In 2008, Paulsen and S. Rathore developed a calibration and used FT-NIR to monitor a lab-scale liquefaction process to determine the effect of reaction time, initial enzyme dose, and corn hybrid on dextrose equivalent (DE) values.

Vijay Singh received his Ph.D. in 1998 from ABE at UIUC with Eckhoff. Singh joined the ABE faculty in 1998 as a Visiting Assistant Professor but was working at the Eastern Regional Research Center/ARS/USDA, at Wyndmoor, PA. While there he conducted research on developing enzymatic milling for the corn wet milling process and optimizing recovery of nutraceuticals from corn and other cereal grains. Later, in June 2002, Singh became an Assistant Professor at the University Illinois to teach and conduct research on process development and value added processing of corn for wet milling and dry grind ethanol processes.

Singh worked to develop novel corn fractionation technologies for corn dry grind ethanol and for corn wet milling processes. In the corn dry grind process approximately 70 percent of the fuel ethanol in the US is produced by the corn dry grind ethanol process. The dry grind process suffered from low coproduct value. Improving process efficiency and increasing the number of coproducts and their value reduces the cost of ethanol production and increases the viability of the ethanol industry. He and others developed several modified dry grind ethanol processes that allow cost-effective removal of germ, pericarp fiber and endosperm fiber as valuable coproducts at the beginning of the dry grind corn process. Additional benefits of these modifications are an increase in quality of coproducts and greater ethanol production per batch. He received two US patents and filed two more patent applications with United States Patent and Trademark Office. Two issued patents are being negotiated for licenses.

The conventional corn wet milling process currently uses sulfur dioxide to steep and process corn for starch. Sulfur dioxide is a health and environmental concern.

Dr. Singh and others developed an enzymatic corn wet milling process that reduces or eliminates sulfur dioxide requirements during steeping, which considerably reduces steep time and produces starch yields comparable to conventional corn wet-milling. Significant amounts of capital and energy savings are realized due to shorter steep times. He received another US Patent for this work and it has been licensed to a major US company. Singh and F. Taylor, ARS/USDA, received a patent in July 2003 entitled "Method for removing the hull from corn kernels."

In 2003, V. Singh and D. Johnston with ARS/USDA developed an enzymatic corn wet milling process that greatly reduces need for SO2 for steeping which would reduce environmental and health risks associated with use of SO2. In 2005, they found enzymatic milling reduced process time by 70% and maintained acceptable product yields and quality. In 2006 they evaluated enzymatic milling with corn wet milling processors. In 2008, they licensed the enzymatic milling technology to a major enzyme company and conducted commercial enzymatic milling trials with wet millers in Malaysia, India, and Turkey.

In 2003, Rausch and Tumbleson with M. Wilkins studied hybrid specific effects on starch modification. The work investigated reaction characteristics of starch samples obtained from single hybrids and found that initial (unmodified) starch characteristics were apparent following modification.

In 2005, V. Singh, L. Hoyer, D.B. Johnston and M. Tumbleson investigated strategies to control microbial growth in corn wet milling using enzymes in place of sulfites.

In 2005 and 2007, Rausch, L.M. Raskin (Civ Env Eng, now at U of Mich) and M.E. Tumbleson characterized processing streams in the corn wet milling process. This identified variability of process operation and identified opportunities for improved coproduct value in the wet milling process.

In 2004, V. Singh and J. Graeber with Syngenta Seeds investigated corn hybrid variability and planting location effects on ethanol yield. Singh and Rausch tested exogenous alpha amylase transgenic corn during liquefaction and fermentation as a means to use fewer enzymes during dry-grind liquefaction processes. In 2005 to 2008, Drs. Singh and Rausch worked with a major seed biotechnology company to determine liquefaction and fermentation properties of endogenous amylase corn for dry grind ethanol processing.

In 2005, Singh, Rausch, Tumbleson and G. Murthy simulated starch hydrolysis using a Monte Carlo simulation technique on a starch structure and combined it with a flux balance analysis (FBA) and cybernetic model for yeast metabolism to develop an optimal control of SSF. Optimal control of the dry grind SSF process resulted in reduced fermenter glucose concentrations, <2.0% w/v. Compared to the standard SSF process, use of the optimal controller resulted in 50% reduction in enzyme (glucoamylase) required for the SSF process under varying operating conditions. The optimal controller was tested in a commercial Midwestern dry grind ethanol plant and a 35% reduction in glucoamylase dose was observed compared to control treatment; final ethanol concentrations were similar for optimal controller and conventional treatments.

In 2006, Rausch, Singh and Tumbleson with M. Wilkins investigated the tendencies of thin stillage to foul evaporator surfaces. Thin stillage is a process stream from corn ethanol production and eventually becomes part of the distillers dried grains with solubles (DDGS) coproduct. They found that thin stillage fouled evaporator surfaces readily, but the rates were variable. Additional work in 2009 and 2010 with A. Arora determined that microfiltration membranes affected fouling rates and may be an effective method to reduce evaporator fouling. In 2003, Rausch, Singh and Tumbleson with R. Agbisit reported a similar effect when microfiltering steepwater from the corn wet milling process.

In 2006, V. Singh, K. Rausch, M. Tumbleson, E. Khullar and E. Sall from Monsanto investigated effect of corn genetics, planting population and post harvest conditions on modified dry grind processes for coproduct yields and fermentation profiles.

In 2007, V. Singh, K. Rausch, M. Tumbleson, B. Vidal and Jim Liu of Novozymes NA investigated use of granular starch and proteases in dry grind corn fractionation processes to improve rate of fermentation and increase ethanol yield.

In 2008, V. Singh, C. Parsons, J. Pettigrew, and K. Rausch developed a sieving and air separation process (called Elusieve) to separate fiber from DDGS. Since the Elusieve process removed fiber, feeding studies on roosters and hogs were conducted to determine total metabolized energy and true digestibility of amino acids in this low-fiber DDGS.

In 2008, Singh, Rausch, Tumbleson and J. Shihadeh developed simultaneous liquefaction, saccharification, fermentation and distillation (SLSFD) process for dry grind production: process that allows high solids (>32% w/w) fermentation. SLSFD process with 40% slurry solids was evaluated and compared it with the conventional process. The SLSFD process fermented slurry with negligible residual glucose content. However, with the conventional process residual sugar in beer started increasing at 20 hr and final residual sugar concentration of 5% (w/v) was observed. Ethanol productivity of the SLSFD process was 20 to 40% higher compared to the conventional process.

In 2007, Singh, Rausch, Tumbleson and V. Sharma, V evaluated the effect of different amylose and amylopectin ratios in starch that was processed through two different enzymatic techniques: commercial alpha and glucoamylases and raw starch hydrolyzing enzymes. In both processing techniques, the study shows that as the amount of amylose is increased in starch, the ethanol yield decreases.

In 2006, V. Singh, C. Batie, G. Aux, K. Rausch and C. Miller from Syngenta Biotechnology evaluated transgenic corn (amylase corn), containing alpha amylase in the corn kernel (endogenous enzyme) in a conventional dry grind ethanol process. With amylase corn no exogenous alpha amylase is required in the process. The study evaluated 3, 5 and 10% of the amylase corn with conventional yellow dent corn. No difference in final ethanol concentration was observed between the amylase corn treatments and the control treatment (in control treatment exogenous liquefaction enzyme was used).

In 2007, V. Singh, P. Wang, H. Xue, D. Johnston, K. Rausch and M. Tumbleson compared granular starch hydrolyzing (GSH) enzyme with conventional enzymes in dry grind ethanol process. Final ethanol yields with GSH enzymes are comparable to yields using conventional enzymes. However, glucose, maltose and maltotriose concentrations are consistently low with GSH enzymes throughout fermentation. Lower sugar concentrations during SSF helps yeast during fermentation and prevents bacterial infections. GSH enzymes work at the same temperature and pH conditions as conventional and can lower energy requirements in ethanol production.

Biological Engineering

Luis Rodriguez, Richard Cooke, Yuanhui Zhang, A. Kent and J. Zilles, assisted by J. M. Andrus, used NSF funding in 2008 to begin a Microbial Community Analysis of Denitrifying Biofilters. Biofilters developed at the University of Illinois have successfully removed 60% of nitrates on average in field trials, but little is known about the microbial community that mediates denitrification. Molecular DNA and RNA methods are available for characterizing microbial community composition and variation of several field biofilters. A time series was planned to link microbial community to biofilter performance.

In 2008 Luis Rodriguez, G. Menezes, A. Kent and M. Appleford used University of Illinois funding to begin the Development of a Framework to Model Microbial Communities in Humic Lakes. The goal was to model microbial communities and their dynamic response to meteorological, physical and chemical conditions using conventional and emerging molecular techniques and data from long-term ecological research stations such as North Temperate Lakes. Predictions from the models could help shape environmental policies and management decisions on ecosystem functions controlled by microbial processes.

Luis Rodriguez, H. Jiang, S. Bell, K. Bhalerao, D. Kortenkamp, A.B.O. Soboyejo and K.C. Ting used NASA funding to do Coupled Analysis of Life Support Systems Reliability Modeling for Robustness and Cost. The research goal was to increase robustness of life support systems by applying the appropriate mix of people and software, develop model-based techniques for diagnosis, prognosis and control, and procedural techniques to support manual operations. Integrated models were developed to analyze a wide array of design architectures for inherent reliability and robustness. Reliability is a major issue in the design of long-term space missions. The research considered several preventive and corrective maintenance plans. Validation was sought through development of new theoretical models for reliability prediction.

Using NASA funding, Luis Rodriguez, H. Jiang, S. Bell and D. Kortenkamp did Validation of Life Support System Optimization. The focus was to demonstrate that application of heuristic tools on life support problems will find optima that are as useful as those identified using traditional analytical approaches. System complexity and the enormous search space create inherent challenges in identifying where the optima exist in the search space.

Luis Rodriguez and G. Menezes used University of Illinois funding to study Bottom-Up Models of the Photosynthesis from the Molecular Scale to Canopy Scale. The intention was to integrate molecular-scale models with existing leaf and canopy-scale models to improve simulation of crop biosystems at molecular, organelle, cellular, tissue, organism and community levels. The immediate challenge was to identify critical information that must be exchanged between different levels. The long term goal was to integrate within a large, complex model such as an agroecosystem model.

Luis Rodriguez, C. Li,, T. Lin, S. Eckhoff, M. Khanna and A. Spaulding used CFAR funding to develop Engineering-Economic System Models for Rural Ethanol Production Facilities. The explosion of small (35-70 million gallons per year) dry grind ethanol facilities suggested the need for extra care in the design and implementation of such facilities. The objective of the research was to develop a model of such facilities for use in decision making by corporate board members and legislatures considering tax incentives for handling of potential pollutants.

In a project funded by the University of Illinois, Grace Danao and her graduate students are working on Development of New Sensing Technologies. In addition to training graduate students, the goal is to develop new sensing technologies for monitoring the health and safety of animals, food systems and the environment. The researchers seek to take advantage of recent developments in the micro-fabrication and integration of biosensors into arrays capable of specific detection of multiple analytes. An example application would be detecting trace volatile compounds resulting from microbial activity in air, soil, water, crops and food samples and determining food quality and safety during storage and transport. A second interest involves using ultrasonic standing wave fields to manipulate and separate micron-sized particles suspended in a fluid medium to enhance the optical detection and quantification of the particles. A third area of study is the use of ionic liquids in gas-phase bio-catalysis. Ionic liquids are salt-like materials that are liquid at room temperature and exhibit unique properties that might be exploited in biosensors, biomass processing, protein stabilization and extraction and purification of natural products.

Multidisciplinary initiatives

In 2005 the Department hired two faculty members (Luis Rodriguez and Kaustubh Bhalerao) followed by the Department's first female faculty (Grace Danao) in 2007, to start the new Biological Engineering section. The goal of this section was to develop multidisciplinary research programs in diverse areas such as Biological Nanotechnology, Synthetic Biology, Biosensors, Ecosystems Engineering and Advanced Life Support Systems. All of these areas are multidisciplinary in nature and have allowed the Department to build bridged with other Departments and Researcher Centers on campus and led to increased visibility of the Department at the campus level. Since these programs are relatively recent and growing quickly, they represent ongoing projects.

Biological Nanotechnology

Kaustubh Bhalerao and his graduate student, Munima Haque, worked on characterizing the mechanism of corn protein aggregation in different solvent conditions. This waxy protein, called zein, constitutes the major fraction of distillers dry grains with solubles (DDGS), the byproduct of ethanol production from corn. DDGS is used to feed swine, but zein is not easily digested and ends up as excess nitrogen in the soil. Zein is resistant against digestive enzymes because of its insolubility in water. However, zein is soluble in a mixture of ethanol and water and is biodegradable in the long run. As a biopolymer, it has potential as a novel renewable resource for developing packaging materials for food or pharmaceutical purposes, and was used as a textile in the 1950s under the brand name Vicara® before synthetic polymers became economically competitive.

Zein's aggregation behavior is similar to behaviors seen in beta-amyloid proteins responsible for Alzheimer's disease as well as other protein aggregation diseases such as bovine serum encephalopathy (mad cow disease) and sickle cell anemia. Thus zein makes an excellent and simple model system from which to learn more about protein aggregation. One Ph.D. student, in collaborations with Civil and Environmental Engineering and the Department of Food Science and Human Nutrition, is studying zein aggregation.

In 2009, Bhalerao and Rashid Bashir (Electrical and Computer Engineering and Director of the Micro and Nanotechnology Laboratory) won an NSF grant to study the effect of aerosolized nanoparticles on cyanobacteria. Cyanobacteria are photosynthetic bacteria that form the lowest strata of our food chain. An imbalance at this level has the potential to transmit up the food chain with an increasing impact through accumulation of the particles in different species. The hypothesis behind this research was that aerosolization can significantly alter the uptake kinetics of the nanoparticles and has implications on the dispersal of particles in the environment. Two MS students, Sun Min Kim and Vaisak Parakett worked on the project. The former has a BS degree in Environmental Engineering, while the latter has a BS in Biotechnology, which highlights the different skill sets necessary to tackle such problems.

Nanotechnology

Introduction

Richard Feynman, in a December, 1959 talk to the American Physical Society at the California Institute of Technology, described molecular machines building with atomic precision, thus introducing what came to be known as nanotechnology. Feynman said that "the biological example of writing information on a small scale has inspired me to think of something that should be possible". The term, nanotechnology, was first used by Norio Taniguchi in a paper he presented in 1974 on an ion-sputtering machining. Nanotechnology can be described as technology in which the structure of matter is controlled at the scale of nanometers, i.e., 1 to 100 nanometers (A nanometer is one-billionth of a meter and a sheet of paper is about 100,000 nanometers thick), where unique phenomena enable novel applications. Nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale. Unusual physical, chemical, and biological properties can emerge in materials at the nanoscale. These properties may differ in important ways from the properties of bulk materials and single atoms or molecules.

Theoretical studies in chemistry and physics led to predictions as to the kinds of systems that would eventually be possible as our ability to control the structure of matter at the nanoscale increased. While, in 2009, much of the promise of nanotechnology was still in the future, nanotechnology had already produced some useful products. Among them were antibacterial kitchen and tableware with nanosilver coating, which could also kill bacteria and microbes, and avoid disease. The global market for goods based on nanotechnology was predicted to grow from $147 billion in 2007 to $3.1 trillion in 2015, according to the research and advisory firm Lux Research.

Engineers previously built materials and devices using a top-down approach. By contrast, nanotechnology starts at the bottom, with the most fundamental structures of matter, and offers the possibility of engineering unimaginably tiny devices and systems. Nanotechnology made possible a total rethinking of how we could create faster, lighter, and stronger materials and devices. These ultra-small devices promised extraordinary energy saving features such as multi-functionality, portability, and inter-operability. As nanotechnology developed, it was important to avoid raising unrealistic expectations and anxieties. Nanotechnology was not going to solve all the major problems of the world, nor was it going to produce self-replicating nanorobots that take over the world. However, several of the U.N. Millennium Development Goals were possible by leveraging nanotechnology.

What follows is a snapshot of some of the agricultural, biological, and food applications that, in 2009, were under active research and development at the Department of Agricultural and Biological Engineering in association with the University of Illinois Center for Nanoscale Science and Technology (CNST) collaboratory, and the Micro and Nanotechnology Laboratory (MNTL).

Mechanobiology: Experimental evidence at the confluence of biology and engineering suggested that extracellular and intracellular mechanical forces have a profound influence on a wide range of cell behavior such as growth, differentiation, apoptosis, gene expression, adhesion and signal transduction. Advances in micro and nanotechnology offered unique opportunities for probing biological phenomena at a cellular and sub-cellular scale, which is likely to have major impact on the study of cell mechanics. Irfan Ahmad, Taher Saif of MechSE, and Hanafy Fouly and Henry Wilkinson of NRES worked on developing a nano-electro-mechanical system (NEMS) for pathogenesis of fungi, by studying Infectious hyphae invading cortical tissue for Gaeumannomyces graminis var. tritici , a fungus causing take-all of wheat. The NEMS could be adapted for studying food pathogens such as E.coli and Salmonella.

Nanoagriculture

Biosensors: Increases in the number and ferocity of the hurricanes hitting the U.S. coasts increased the risk of attack on the soybean crops by rust spores. Knowing whether to apply fungicides was a perplexing question. Two different fungal species, Phakopsora pachyrhizi and Phakopsora meibomiae, caused soybean rust with the potential to decimate soybean crops and cause huge economic losses. Therefore, timely detection of soybean rust spore detection was critical. Irfan Ahmad (ABE, CNST, and Micro and Nanotechnology Laboratory), Brian Cunningham (Electrical and Computer Engineering, MNTL), Glenn Hartman (United States Department of Agriculture), and Linda Kull (Soybean Disease Biotechnology Center) worked collaboratively in developing field-deployable biosensors for early detection of the spores.

Carbon Nanotubes for Enhanced Crop Germination and Growth

Carbon nanotubes (CNTs), are allotropes of carbon with a cylinderical nanostructure with novel properties. CNTs can penetrate plant cell walls and significantly influence biological activities by acting as smart delivery systems in plants. Irfan Ahmad at ABE and CNST, Linda Kull (Soybean Disease Biotechnology Center), Fabián Fernández (Crop Sciences), and John Rogers (Materials Science and Engineering) worked on using CNTs to produce for bigger and better soybean seeds.

Nanomedicine for Cancer Research. In 2009, over 70% of the developing world's population still depended on the complementary and alternative systems of medicine (CAM). Evidence-based CAM therapies showed remarkable success in healing acute as well as chronic diseases. Pakistan was among the eight leading exporters of medicinal plants. Kenneth Watkin, College of Applied Health Sciences, Irfan Ahmad, ABE, Brian Cunningham (ECE), University of Illinois, and Atiya Abbasi (Chemistry, University of Karachi) did CAMs research funded by the USAID and the Higher Education Commission of Pakistan. The overall objective was to develop partnerships and strengthen the nanomedicine infrastructure through synergistic integration of research, education, and training. Plant extracts such as curcumin (Curcuma longa) from the University of Karachi were tested using bionanophotonic crystal sensors from the University of Illinois to study their affect on breast cancer cells.

Societal Implications

Irfan Ahmad delivered lectures on societal implications of nanotechnology in biosensors classes at the College of Engineering. Semester-long courses were offered by Irfan Ahmad on Biomedical Applications of Nanotechnology jointly with Washington University Medical School, and were made available to the University of Missouri, and the University of Karachi, Pakistan. The lectures and courses were aimed at engaging the public on the societal issues and opportunities in nanotechnology research and development for agricultural, biological, food, environmental and energy applications.

6 | EXTENSION PROGRAMS

The University extension service was in a downsizing mode through the 1980s and 90s, as federal funds from the Smith-Lever act continued to decline. Downsizing came in two ways. Often, retiring extension staff members were not replaced. In addition, faculty remaining on the extension staff had official appointments shifted to include more teaching and/or research. By 2009, the ABE department had only three faculty members with partial extension appointments, i.e., Bob Aherin, Ted Funk and Richard Cooke. The reduction in extension faculty members led to changes in how the extension program was conducted. Some subject matter areas were simply dropped. Some academic professionals were employed to assist the remaining faculty members. Also, scheduling of face-to-face meetings with producer groups declined. Instead, extension faculty began concentrating on developing extension teaching materials for delivery by extension educators or via electronic media. The extension program conducted between 1997 and 2009 is described in the paragraphs below, broken out by subject matter area.

Farm Machinery

John Siemens served on a research and extension appointment until his retirement in 1999. His research was closely linked to his extension activities. His three major thrusts were on machinery management, tillage and soil compaction.

Maintaining a set of farm machinery is a major cost in agricultural production. Choosing machines that are too large results in unnecessary expense, while choosing undersized machinery can result in expensive crop losses. Siemens and his graduate students developed computer software that calculated the optimum sizes of farm machines for any given farm. The software considered the probability of good working days in scheduling farm operations that could be completed in a timely manner. The software selected a compatible set of machinery such that, for example, the tractor or tractors were capable of handling the machines to which they were connected. Siemens brought the software to the attention of Illinois farmers through his extension program. Deere and Company also made use of the software to help their customers choose equipment.

In 1981, the Illinois Department of Agriculture set a T-2000 goal, i.e., to achieve a tolerable level of soil erosion loss by the year 2000. The tolerable level was an annual loss of up to five tons per acre, the theoretical rate at which soil can be replaced by natural processes. Siemens experimented with a variety of tillage practices aimed at reducing soil erosion. The results were brought to the attention of Illinois farmers through Siemens' extension program, including exhibits at the annual Agronomy Days on the South Farms. A major part of achieving T-2000 was retiring the moldboard plow. Chisel plowing and other reduced-tillage operations came into practice as a way to leave crop residues at the ground surface to resist erosion. Siemens' activities led to him being selected to receive the ASABE John Deere Gold Medal award in 1999. Since John Deere came into prominence for inventing the self-scouring moldboard plow, it was ironic that Siemens won the John Deere Gold Medal for helping to retire the moldboard plow.

With the growth in the size of farm tractors, concern arose in Illinois as to the effect of wheel traffic on soil compaction. Siemens began research to study the effect of tractors on soil compaction. His studies showed that soil compaction can reduce crop yields, especially in wet years when compaction caused drainage to be inadequate. Siemens brought the research results to the attention of Illinois farmers through his extension program, including exhibits at the annual Agronomy Days on the South Farms.

When Siemens retired in 1999, Shufeng Han was hired to fill the vacant position and to establish a program in precision agriculture. Use of yield monitors and other precision agriculture technology was growing rapidly and Han's objective was to help producers learn how to use the new technology. After only two years on the faculty, Han was lured away by Deere and Company to work on precision agriculture. Due to budget shortfalls, the department was not permitted to fill the position and it was lost. That position loss ended the department's extension activities in the farm machinery area.

Pesticide Application

The Department has maintained a prominent state and regional educational program regarding the technology for applying pesticides and fertilizers since the 1960's. Wendell Bowers, John Siemens, and Loren Bode provided the leadership for this outreach effort throughout the years. The greatest changes in the application of agricultural chemicals since the mid 1990's included the use of electronics such as variable rate control and automatic swath control, and the introduction of new nozzle designs for the reduction of spray drift. The ABE extension staff worked with pesticide applicators in the adoption of the new technology.

The ABE department cooperated with other departments in the College of ACES in providing education to farmers and commercial applicators on best practices for the efficient and safe use of pesticides. Training clinics were provided to enable applicators to meet certification requirements of the state as well as USEPA. Loren Bode provided leadership for the application and equipment segment of the certification and training program from 1973 until his retirement. Several pesticide application specialists also assisted in providing the educational clinics for both commercial and private applicators. These included Steve Pearson, Bob Wolf, and Mark Mohr. At time of writing, Scott Bretthauer was handling the pesticide application program for the department. Steve Pearson became Vice President for International Sales with Spraying Systems Company, Bob Wolf became a Professor in the ABE Department at Kansas State University, and Mark Mohr began leading the spray nozzle group at the Hypro Pump Division. The entire Pesticide Education Safety Program (PSEP) including the salaries of the specialists is self -supporting with income from training clinics, training materials, and state and federal grants. Annual expenditures for the PSEP program now exceed one-half million dollars.

A variety of venues are used to provide the education regarding the safe and effective use of pesticides. Typically, these include presentations at the annual Agronomy Day at the South Farms, a Spray School held on campus each January, and a training circuit at approximately thirty locations throughout Illinois. At each location on the circuit, a team consisting of specialists from ABE, Crop Sciences, and NRES delivers educational modules for specific categories of commercial operators and applicators. Following the training, representatives of the Illinois Department of Agriculture administer exams to the participants that, if passed, would allow those in attendance to become certified applicators.

Bode and/or his assistants also conducted fly-in clinics at various locations in Illinois as well as other states. Aerial applicators brought their spray planes to these clinics for calibration and analysis of the spray distribution pattern. Each plane flew passes over a collection system aligned across the runway. The results were analyzed and produced a summary of the spray pattern and droplet size distribution. Any needed changes in nozzles, spray pressure spray height, etc., could be made based on the pattern and additional passes flown for verification. The fly-in clinics have significantly improved the aerial application of pesticide not only in Illinois but throughout the mid-west.

Farm safety and health

Bob Aherin served on a research and extension appointment. Chip Petrea was supported on grant funds. Together, they did research that fed into their numerous extension activities on farm safety.

The goal of the disabled farmers' project was to develop a model program for providing comprehensive assistance to Illinois farmers with physical disabilities. Research established the need for such assistance among farmers.

A project was conducted to empower communities to identify agricultural safety and health issues of concern and to advance appropriate intervention programs. The project was set up in six demonstration counties in Illinois. Two major medical centers served as a regional project sponsor. Strategies were developed to support the continuation of the project within the community.

Chip Petrea, Bob Aherin and Phil Buriak participated in the Illinois Easter Seal Society's TASK (Teaching Agricultural Safety to Kids) program. The TASK strategy was to train FFA students to make presentations on agricultural safety and health issues to elementary school students. The ABE participants observed and evaluated the training received by the FFA students, then evaluated the immediate and one-year impacts of the TASK presentations to the elementary students.

With support from the Centers for Disease Control and Prevention, Petrea and cooperators from outside the ABE department mounted a program to reduce eye injuries and illnesses in Latino farm workers. The goal was to determine the intentions and prominent beliefs of the workers towards the prevention strategies currently being utilized and then develop an intervention program based on those intentions and beliefs. By building a partnership among university researchers, advocacy groups, Latino farm workers and local health care professionals, a long-term eye injury and illness prevention program was established.

Aherin and Petrea participated in an effort by Illinois agricultural safety proponents to design and produce a retro-reflective marking system to improve the visibility of farm equipment on public roads. The product was called FARM (Fewer Accidents with Reflective Material) kit. Aherin and Petrea conducted a survey that found that 61% of those surveyed were familiar with FARM kit.

The National Farm Children's Center for Agricultural Health and Safety and the Carle Foundation Center for Rural Health and Farm Safety sponsored a project by Aherin and his cooperators to provide farm safety training to rural youth aged 6 to 13, including a number of Amish youth. A Farm Safety Mobile was equipped with training modules, then transported to rural communities for presentation to the youth. The project was evaluated as to impact and behavior change.

Chip Petrea assisted the Board of Directors of the National Institute for Farm Safety by serving as their administrative secretary. His duties included writing minutes of board meetings and assisting with communications between board members, institute members and with outside entities.

Processing

The processing group, led by Steve Eckhoff, conducted wet milling short courses as part of the outreach program of the department. The purpose of the courses was described as "To provide fundamental understanding of the corn wet milling process, equipment, unit operations and industry trends for representatives of the wet milling and allied industries. The course is ideal for corn wet millers, equipment vendors, enzyme companies, trade organizations and companies allied with the corn processing industry." The teaching faculty for the short courses included Steve Eckhoff, Kent Rausch, Marvin Paulsen, Mike Tumbleson and Vijay Singh, plus selected experts from off campus. Typical topics included drying, handling and storage of corn, kernel structure, composition and chemistry and numerous other topics relevant to corn wet milling. At least six such short courses were conducted over the years, including one held in January, 2009.

The processing group also held starch technology conferences, beginning in 1999 and repeated at two year intervals. Typically the conferences were held at off-campus sites in Champaign/Urbana, starting on a Sunday and concluding on a Wednesday. Speakers included departmental faculty members as well as people employed in industry and government. In addition to oral presentation of papers, poster sessions were held. A conference proceedings was published after each conference. While the conferences all related to starch technology, the special focus changed from conference to conference. For example, the June 2007 conference focus was on energy issues.

Livestock

The ABE department has a long history of conducting extension activities for the Illinois livestock industry. Art Muehling did extensive extension work for the Illinois swine industry until his retirement in 1992. After Muehling's retirement, Ted Funk moved from the Effingham area Extension office and joined the ABE faculty to continue the livestock extension work at the state level. He was joined in August 1997 by Randy Fonner, an academic professional. The primary focus of their work was to help Illinois livestock producers cope with state regulations regarding livestock wastes. These regulations were part of the Management Facilities Act passed by the Illinois legislature on My 21, 1996. One of the requirements of the new act was that livestock facilities with over 300 animal units (for example, 750 finishing hogs, 214 dairy cows or 300 beef feeders) were required to have at least one person certified in waste management. At the time of passage of the act, Illinois had an estimated 2,500 livestock operations subject to the act. Fonner was hired specifically to coordinate the new state-mandated training program, called the Certified Livestock Manager Training (CLMT), for livestock producers. The CLMT program developed by ABE was later adapted and adopted by other states and national organizations.

Three Illinois agencies each had different requirements regarding livestock wastes. These are the Illinois Department of Agriculture (IDOA), the Natural Resources Conservation service (NRCS) and the Illinois Environmental Protection Agency (IEPA). Funk and Fonner worked with representatives of the three organizations in developing a manure management plan handbook for Illinois livestock producers. Producers used the handbook to develop plans and document that their livestock waste handling procedures would be in compliance with the regulations of the IDOA and the IEPA, and the plan suggestions of NRCS. Wastes included animal manure, wastewater, and carcasses of animals that died on the farm.

A primary goal of the livestock waste regulations was to keep excessive plant nutrients, especially nitrogen and phosphorus, from entering surface waters of the state. Thus, the workbook prepared by Funk and Fonner helped producers estimate the quantity and composition of the manure based on the age, size and number of each animal species on the farm. The workbook also helped document details of manure storage and the spreading of manure on the land such that the nutrients applied would not exceed the rate at which the crop could use them. The workbook also helped producers document that manure and wastewater would not be able to be carried to streams by rainfall runoff. The workbook also helped producers document how animals that died during production would be handled, for example, by composting.

Funk and Fonner communicated with producers in a variety of ways. The workbook was made available to producers by posting it on the world-wide web and by releasing it on a CD-ROM. Funk and/or Fonner also attended numerous conferences, with regulatory agencies to prepare for the writing of the workbook and also with producers to assist them in complying with the regulations. The first series of 15 statewide training sessions took place in March through July of 1997 and 2,350 farmers, consultants and others were trained. The CLM certification program requires each facility to send a management-level person for training every three years, so the program provided an opportunity for the BEE group to regularly impact the Illinois livestock industry.

Another continuing BEE extension programs included a biannual Livestock Manure Management Conference for farmers, agencies and educators. The BEE group also conducted a statewide human housing program emphasizing indoor air quality issues and human health, including radon mitigation, mold cleanup and home energy conservation.

Soil and Water

Soil and Water extension programs continued to include soil erosion control and drainage topics, but also increasingly emphasized water quality. Michael Hirschi continued to lead the Soil and Water extension effort until he accepted the position of Assistant Dean – Undergraduate Programs, College of Engineering in 2007. His extension activities included Water Quality Program Coordinator, University of Illinois Extension; Leader, Water Quality Strategic Research Initiative, Illinois Council on Food and Agricultural Research; and Technical Advisor, Conservation Technology Information Center, West Lafayette, IN. He was a member and leader of several extension education teams including the Natural Resources Management Program Team, which coordinated statewide education and professional development efforts in natural resource management and the Water Quality Publications Team that developed and produced materials for water quality outreach.

Hirschi's educational program expanded from erosion and sedimentation to the larger area of water quality because fertilizer and pesticide contaminants in both surface and groundwater became a national priority. Hirschi created innovative ways to educate farmers, and homeowners about ways contamination occurs and how they can improve the quality of our nation's water supply. Of major importance was a series of award winning publications entitled "This Land". This series proved to be a particularly effective means of communicating with extension clientele. Interest in the "This Land" series has been high as evidenced by the fact that the initial monograph, "50 Ways Farmers Can Protect Their Groundwater" is in its second printing. The second monograph, "57 Ways You can Protect Your Home Environment", is oriented to the consumer/homeowner and has increased general public awareness of water quality. Both monographs have won technical (ASAE) and communication (AAAC) awards. A third monograph, "60 Ways Farmers Can Protect Surface Water" is also receiving wide acceptance and use among extension educators. A measure of the impact of this series is that they are available in book stores in addition to normal extension outlets. Hirschi has consistently provided tillage/erosion or water quality presentations at county and regional meetings as requested; totaling 209 presentations since 1990.

Hirschi gradually accepted more teaching responsibilities and some extension activities were picked up by other faculty. As noted in "Agricultural Engineering on the Prairie: Illinois Style" the Department has had a close association with the Illinois Land Improvement Contractors Association (ILICA) since its beginnings when Prof. Hay assisted in the initial organization. The aim of the Association is to encourage high standards of workmanship in resource management, land improvement practices and to promote private enterprises in land improvement contracting.

Kent Mitchell served as educational advisor to ILICA from 1996 to 2003. He immediately became involved in coordinating, planning and construction of ponds by ILICA for the University Arboretum, which was a gift-in-kind valued at $600,000 at that time. ILICA offered annual workshops which were organized by Mitchell in cooperation with the Jim Evans, State Engineer, NRCS. Also, semi-annual "Conservation Expos" were offered at various locations in the state with Extension and NRCS personnel assisting. In 2003, ILICA initiated a certification program that is a testing and continuing education program that seeks to recognize proficiency and professionalism in the land improvement field and upgrade the status of land improvement contractors. ILICA offers five classifications of certification: erosion control, earth-moving, drainage, drainage water management, and septic. Mitchell helped begin this certification program and continues as the certification testing administrator; which requires attendance at workshops to remain current on subjects the ILICA members are learning.

Richard Cooke initially joined the department on a research and teaching appointment, but an extension component was added in 2004. Following one of Cooke's presentations in Bloomington, Illinois, in 2004, agronomist Bob Hoeft suggested to Bob Easter, ACES Dean, that "The College needs to get Richard Cooke on an extension appointment, as he does a great job of delivering the message on water management." Cooke used his extension appointment to feed research results to farmers and contractors in Illinois. Cooke became the Education Advisor to ILICA in 2003 and has worked closely with that organization. Paired research/demonstration sites were established at 18 places in Illinois, one site as a control and the other implementing some conservation drainage practice. One practice was to install structures to regulate tile flow as a way to reduce nutrient (especially nitrates and phosphorous) flow into rivers and lakes and also to regulate the water table height to benefit crop growth. Another project was to map the location of drainage tiles in Illinois by using image analysis software to analyze aerial images of fields. In addition to working with ILICA, Cooke delivered his research results through some direct meetings with farmers, through presentations at drainage and crop workshops throughout the state and at Agronomy Days at the South Farms. In 2007 he initiated a series of four one-day Basic Drainage workshops in different sections of the state, and was the main instructor at a two-day Advanced Drainage workshop, patterned after the Overholt Drainage School in Ohio, He updated and improved the Illinois Drainage Guide and developed it for on-line access. This improvement enables all users to easily access the design information to develop appropriate drainage systems and allows farmers to calculate the costs and benefits of tile drainage on their own farms.

ABE Extension Affiliates

In 2000, each extension educator out in the state was given the opportunity to affiliate with the department of his/her choice on a zero-time appointment. Five extension educators chose to affiliate with the ABE department. These were George Czapar of the Springfield office, Robert Frazee and Stanley Solomon of the East Peoria office, Michael Plumer of the Carbondale office and Duane Friend of the Jacksonville office. The Jacksonville office is a satellite of the Springfield office. Frazee, Friend and Plumer worked in the area of natural resource management. Czapar worked on pest management and Solomon worked on engineering technology.

7 | INTERNATIONAL PROGRAMS

The ABE department has an extensive history of international involvement. In the 1960s, for example, ABE faculty members were involved in starting the GB Pant University of Agriculture and Technology in India. The ABE department has a cosmopolitan faculty, more than half of whom grew up in other countries. These include Richard Cooke from the West Indies, Grace Danao from the Phillippines, Tony Grift from the Netherlands, Al Hansen from Zimbabwe, K.C. Ting from Taiwan, Kaustubh Bhalerao, Prasanta Kalita, and Vijay Singh from India, and Lei Tian, Xinlei Wang, Qin Zhang and Yuanhui Zhang from China. In addition, typically at least half of the post doctoral and graduate students in the department have been from other countries. The department served as host to numerous visiting scholars, most of who were from other counties. A list of visiting scholars is given in the appendix. Also, some departmental students have participated in study-abroad programs and the department has hosted study-abroad students from other countries. Specific examples of departmental international activities are described below.

Republic of South Africa

In the summer of 2004, Al Hansen took a group of ABE students on a four-week trip to South Africa to work with students enrolled at the University of KwaZulu-Natal (UKZN). Similar trips were made in the summers of 2006 and 2008 and future trips are also planned. The objectives of the trips were to expose students to a different culture and to the application of technologies appropriate to South African needs by collaborating on short-term engineering design projects with South African students. In the spring semester preceding each trip, each participant was required to present a paper on an assigned aspect of South Africa and its culture. At the end of the semester, the ABE students met their UKZN counterpart students via a videoconference.

In the summer, Al Hansen flew to South Africa with the students to meet the UKZN counterpart students and begin the project activities. The projects were selected by the ABE students from a list of possible projects submitted by UKZN. The students spent approximately 12 days working intensively on the projects in collaboration with the UKZN students. The students also went on guided excursions to a number of game reserves to see wild animals indigenous to South Africa. They also made visits to mountainous and coastal areas to provide the students with a broad exposure to South African society, culture and its rich ecology and wildlife.

Equipment, software and sensors needed in the research projects were purchased using funds from Deere and Company and from the ABE department. These items were left behind for the use of the UKZN students when the ABE students returned to University of Illinois.

After returning from South Africa, each ABE student completed a survey form to provide feedback. Most students indicated the experience had a beneficial effect; about half said the experience substantially improved their teamwork and interpersonal skills. An example of survey responses was: "Going to South Africa was an awesome experience I will keep with me all of my life. I had a wonderful time learning about the country and its people first hand. I also feel that I may have helped to introduce technology that will help improve their agricultural productivity in the future."

Following is a list of projects and ABE student participants for the three trips to South Africa. Except where indicated in parentheses, each student was an ABE undergraduate engineering student.

Projects 2004

1. Precision agriculture systems
   Students: Scott Dixon, Kevin Knapp, Justin Bruns
2. Sugar cane cutter performance
   Students: Anthony McCullough, Nick Jones (TSM)
3. Design of a micro-flood irrigation system
   Students: Laura Schutte (grad), Geri Wellen
4. Sugar cane crane with automatic weighing system
   Students: Seth Wenzel, Zach Waite

Projects 2006

1. Designing and manufacturing a torque meter sensor for closed loop PTO dynamometer testing
   Students: Andrew Lenkaitis, Amanda Olsen, Matthew Whyte
2. Design and construction of a pedal-kayak
   Students: Paul Davidson (grad), Luke Zwilling
3. Design and construction of a production unit for biodiesel
   Students: Jonathon McCrady (grad), Joshua Vonk

Projects 2008

1. Design of a small scale pyrolysis device for cottage industry charcoal production
   Students: Jenita Johnson (TSM), Curtis Zurliene
2. Design, construction and testing of a jab planter
   Students: Jason Buss, Michael Leick
3. Innovative heating and cooling for a broiler chicken house using a heat pump water heater system
   Students: J. Malia Appleford (grad), John Scheider, Jacob Walker
4. Design of a small scale biomass cooking and heating device for low income households
   Students: Patrick Malone (TSM), Ryan Richards (TSM)
5. Micro-algae biodiesel production system
   Students: Elizabeth Brooks, Rachel Trigger (Australian exchange student)
6. Wastewater treatment at the Shallow Drift/Umgeni Crocodile Farm
   Student: Malia Appleford (grad)

Greece

In the summer of 2009, Steve Zahos took seven Illinois students to Greece on a "Cradle of Democracy" tour. He coordinated the tour with Dr. George Papadakis of the Agricultural University of Athens AUA). Papadakis' two research areas were renewable energy and micro-grids for providing power and desalinated sea water. The Illinois students chose projects from among these areas.

Illinois students Eric Stein, Cris Noble and Shikhank Sharma studied mini-grids, micro-grids and smart grids. Sarah Sotiropoulos and Emmy Riley studied biofuels. Amy Balek and Brent Dirks studied photovoltaic power and solar thermal energy storage. Each Illinois student team worked with one or two AUA graduate students.

Zahos and the Illinois students also spent time on educational and cultural excursions. One trip was to the University of Thessaly to observe the making of stove fuel pellets from agricultural materials. They also visited TERRA, Greece's largest manufacturer of agricultural equipment. Another trip was to the island of Kythnos to see a photovoltaic hybrid system developed by the European Union. The system uses solar and wind energy to power houses on the island. Since Dr. Papadakis had a summer house on the island, the students were able to enjoy the local beach.

Other cultural outings included trips to the Olympic Stadium, the Parthenon, the Acropolis and the islands of Crete and Santorini. Satorini has a dormant volcano off the coast. Gasses from the volcano heats the sea water and visitors can see water swirling as the hot water contacts the cold water of the sea.

At the time of writing, Zahos was planning to conduct a similar tour to Greece in 2010.

India

An experience in India began when, in the Spring of 2006, students in Prasanta Kalita's ABE 456 course decided to write a grant proposal instead of a research paper. The proposal, on bio-remedidation of agricultural chemicals to protect groundwater, was submitted to the EPA P3 (People – Prosperity – Planet) project and was funded in the amount of \$10,000. The funds enabled the class graduate and undergraduate students to compete in a Sustainable Design Experience in Washington, DC, in April, 2007. When it concluded, the EPA director announced that the ABE team was one of 6 (out of 50) winners of a $75,000 grant for additional work. The team also had breakfast with Illinois senators Durbin and Obama.

The additional funds enabled the team to add an international element to their project on biofiltration. In December, 2007, Kalita and his students traveled to India to visit the GB Pant University of Agriculture and Technology. This university was started as part of the University of Illinois extension mission in the 1960s. Despite struggling with a language barrier and a scarcity of tools, the ABE team installed a biofiltration system during the visit. They also visited numerous historical sites, including the Taj Mahal and also had an opportunity to learn about the people and culture of India.

The participants in the India experience included the following; all except one (a student from Purdue) were from the University of Illinois:

1. Stephen Anderson -Graduate Student , ABE
2. J. Malia Appleford - Graduate Student, ABE
3. Elizabeth Brooks - Undergraduate Student , ABE
4. Paul Davidson - Graduate Student, ABE
5. Joseph Good - Undergraduate Student, CEE
6. Gregory Goodwin, Graduate Student, ABE
7. Daniel Koch, Graduate Student, ABE
8. Amanda Olsen, Undergraduate Student, ABE
9. Curtis Zurliene, Undergraduate Student, ABE
10. Luke Zwilling, Undergraduate Student, ABE
11. Debapriya Mazumdar, Grad Student, Dept of Chemistry, UIUC
12. Lindsey Birt, Graduate Student, ABE, Purdue
13. Richard Cooke, ABE faculty
14. Laura Hahn, Center for Teaching Excellence
15. Cheelan Bo-Linn, Center for Teaching Excellence
16. Prasanta Kalita, ABE faculty

Egypt

Phil Buriak visited Egypt three times as an agricultural mechanization consultant. He worked with selected Egyptian faculty members in preparing instructional materials to enhance practical and technical training in selected agricultural mechanization courses for the 50 Agricultural Technical Schools (ATSs) in Egypt. The materials were for development of psychomotor skills, skill sheets, job descriptions for functions in Upper Egypt, task title glossaries and evaluation rubics. Counterpart Egyptian faculty members will introduce the new teaching materials to enhance the capacity of ATS teachers to provide practical skill training to their students. Education for employment was the principal goal.

Poland

Kent Mitchell was a Visiting Professor in the Department of Hydraulic Structures, Faculty of Land Reclamation and Environmental Engineering, Warsaw Agricultural University (WAU), Warsaw, Poland from August to early December, 1998. He worked with with Dr. Kazimierz Banasik, who was involved in the hydrology of agricultural watersheds, rivers and reservoirs, and investigations and physical modeling of hydraulic structures. Mitchell also chaired a technical session and presented a paper at the 3rd International Conference on Hydroscience and Engineering in Cottbus, Germany and at the Conference on Environmental and Technical Problems of Water Management for Sustainable Development at WAU. He gave lectures to classes on Erosion Mechanics, Erosion and Water Quality and Erosion Control. He presented the lecture for Inauguration Ceremonies for The Inter Faculty Program of Environmental Studies, WAU, and Radom College. He was also involved in many other research and teaching activities. Mitchell was also an invited guest speaker at Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland.

In 2001, the Honorary Badge, Warsaw Agricultural University, Warsaw, Poland for "recognition of meritorious service to Warsaw Agricultural University" was conferred on Mitchell by the WAU Senate.

In 2002, Mitchell was invited to chair a session at the Fifth International Conference on Hydro-science and Engineering, Warsaw, Poland. In 2004, he was invited to chair a session at the Sixth International Conference on Hydro-science and Engineering, Brisbane, Australia.

From June to December, 191, Elizabeth Bruns was an International 4H exchange student to Poland.

China

For more than two decades, Robert Easter worked with the American Soybean Association and the US Soybean Export Council office in Beijing to bring practical swine production workshops to Chinese livestock producers, feed company technical consultants, the Ministry of Agriculture and provincial extension agents. These workshops continued after Easter became ACES dean. Ted Funk was the swine facilities agricultural engineer on a four-person team for five summer trips of two weeks each in the period, 2004-2008. The other members on the team were experts on genetics and meat quality, nutrition, and veterinary medicine. The teams also included four translators. Each team performed farm visits, workshops and seminars in three different locations for a total of six locations reached each year.

Funk observed many local swine facilities with their construction and management practices, and made recommendations based on his experiences in North American and elsewhere. He taught workshop segments on confinement building ventilation, building management, flooring, manure handling systems, remodeling, biosecurity, and building security.

England

During the period that Silsoe College offered undergraduate degrees in Agricultural Engineering, the ABE department at Illinois had an exchange program with Silsoe College. Students from the ABE department would spend a semester or two studying at Silsoe College and students from Silsoe College would spend a semester or two studying in the ABE department at Illinois. Careful advising was used to allow these study abroad experiences without delaying the earning of the BS degrees. A summary of these study abroad experiences is given below.

Table 7.1 Students from Silsoe to ABE at Illinois

Name	Time	Program*	Institution*
Mark Johnston	July-Sept 1980	IAESTE	NCAE, Silsoe, UK
Stephen Hickman	July-Sept 1981	IAESTE	NCAE, Silsoe, UK
Edmund J Hughes	July-Sept 1989	IAESTE	Silsoe College, CU
Ravia Bhusia	July- Sept 1990	IAESTE	Silsoe College, CU
Jonathan Richard Miller	June-Dec 1992	IAESTE	Silsoe College, CU
Jonathan Mark Treagust	Aug-Dec 1992	IAESTE	Silsoe College, CU
Georgios Barzis	Aug-Dec 1992	IAESTE	Silsoe College, CU
Victoria Emerson	July-Dec 1993	IAESTE	Silsoe College, CU
Almudena Lorenzo	Jan-July 1994	IAESTE	Silsoe College, CU
Lindsey Anne Stewart	June 1995-Sept 1996	Study Abroad	CU at Silsoe
Joanne Francesca Philpot	Aug 1996-July 1997	Study Abroad	CU at Silsoe
Ian Wayman	Aug 1997-Aug 1998	Study Abroad	CU at Silsoe
Stewart Mitchell	Aug 1997-July 1998	Study Abroad	CU at Silsoe
Mark Peter Wheeler	Apr-Oct 1999	ASET/CEA	CU at Silsoe

*Programs: IAESTE – International Association for the Exchange of Students for Technical Experience. Study Abroad – study abroad agreement between UIUC and Silsoe College, ASET/CEA – Association for Sandwich Education and Training/Cooperative Education Association; Institutions: NCAE – National College of Agricultural Engineering, CU – Cranfield University.

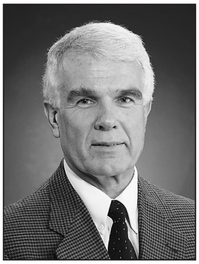
Table 7.2 Students from ABE at Illinois to Silsoe

Name	Time	Program
Claire Ann Eldridge	June–Dec 1984	IAESTE
Joe Frazee	1992–1993	Study Abroad
Mike Boston	uncertain	Study Abroad
Candice Rutter	1994–1995	Study Abroad

In addition to the exchange program with Silsoe College, ABE students participated in the numerous other exchange programs listed in Table 7.3

8 | FACULTY PROFILES

A total of 47 people had faculty appointments in the ABE department between 1997 and 2009. Of these, 15 joined the department during that period, 6 continued their faculty appointments and 18 departed, either to accept new assignments or to retire. Also, 8 people had paid appointments in other departments or institutions but were granted courtesy appointments in the ABE department. The changes in faculty appointments were described in Chapter 2, Changing of the Guard. A complete list of faculty members is given in the appendix. The purpose of Chapter 8 is to provide a personal profile of each of the 18 faculty members who left the department between 1997 and 2009. Those profiles are given below.



Paul Benson
1978–2002

Dr. Paul Benson was raised on a farm near Morris, Illinois. Benson received his bachelor's degree in Agricultural Mechanization from the University of Illinois. He operated a grain and dairy farm until 1975. During that time, he taught science at Morris Junior High School and vocational agriculture in the Morris Community High School.

Benson attended Southern Illinois University and earned his master's in Agricultural Economics. He returned to the U of I to earn a Ph.D. in Vocational Education.

Paul began his career at the U of I as a Research and Teaching Assistant in Agricultural Education in 1978. He joined the Department of Agricultural Engineering as a Visiting Assistant Professor and Extension Specialist. Benson worked with Phil Buriak to build the Technical Systems Management program into one of the best in the nation. He converted the two courses for which he was responsible from basic skills to a concentration of current technology.

Benson served as co-advisor for the Illini Agricultural Mechanization Club during his entire career. His dedication to his students earned him the Department Teaching Excellence Award in 1989, 1993 and 2002. His dedication to teaching youth was demonstrated in other activities as well. He received the FFA Honorary State Farmers Degree for his contributions to youth in FFA. He hosted electrical workshops for 4-H youth throughout Illinois each summer and coordinated 4-H projects for state and county fairs. Benson served on many other state committees, as well as college and department committees.

Benson was appointed Executive Director of the Illinois Electric Council (IEC) in 1988 and served in that capacity until his retirement. Benson received the IEC Merit Award for his contributions in 1991, and in 1999, he received the Professional Staff Award for Sustained Excellence from the College of ACES for his contributions to the use of electric energy through the IEC.

Benson retired from the Department in July of 2002.

STUART J. BIRRELL
1996 – 1998

Dr. Stuart Birrell received his bachelor's degree in Agricultural Engineering from the University of Natal, South Africa in 1984. Birrell came to the University of Illinois in 1985 and earned two degrees in Agricultural Engineering; his master's in 1987 and his Ph.D. in 1995.

During this time, Birrell worked as a Graduate Research Assistant for the Department of Agricultural Engineering, where he taught agricultural engineering and agricultural mechanization courses in power and machinery; conducted research on distillation of soybean oil to produce an alternative diesel fuel; and ran engine performance tests of distillates. At the same time, Birrell was employed by Hitachi, Ltd., in Tokyo, Japan as a Visiting Researcher in the Hitachi Central Research Library. In this position, Birrell conducted research on ion selective membranes for the development of a nitrate ion selective field effect transistor sensor resulting in the development of a system for real-time soil nutrient sensing at the University of Illinois. During this time, Birrell was recognized with the Departmental Teaching Assistant Award for excellence in teaching (1988) and the Campus Recognition for Excellence in Teaching award from the University of Illinois (1991).

Upon graduation, Birrell was employed by the University of Missouri as a Research Assistant Professor in the Agricultural Engineering Department. While at Missouri, Birrell participated in the planning and implementation of site specific crop management research; worked extensively with yield monitors and Global Positioning System technology; developed a combine mounted corn population sensor; and utilized geostatistics and other methods to analyze the spatial variation of crop yield and soil parameters.

Birrell returned to the University of Illinois as a Visiting Assistant Professor in 1996. He worked with Dr. John Hummel on a research project to develop a real-time soil nutrient analysis system for precision fertilizer application, and he taught the agricultural engineering course on instrumentation and measurements.

Birrell is currently a member of the faculty in the Department of Agricultural and Biosystems Engineering at Iowa State University, where he teaches undergraduate courses in Agricultural and Biosystems Engineering and Agricultural Systems Technology. Dr. Birrell's research is concentrated in two areas; the development of sensors and controls that can be applied in advanced machinery control and in precision agriculture; and harvest technologies and biomass harvesting and logistics.

Loren Bode
1973–2008

Dr. Loren E. Bode received his bachelor's degree in Agricultural Engineering from the University of Missouri-Columbia in 1965. He completed his master's in 1967 and his Ph.D. in 1972 from the University of Missouri while working as an ARS Research Engineer. In 1972, Dr. Bode was transferred to Stoneville, Mississippi to initiate an application technology project at the new USDA Federal Research Center. Bode joined the Agricultural Engineering Department at the University of Illinois in September of 1973 with a research/extension appointment to work on the pesticide application portion of power and machinery extension.

Bode's research, teaching and extension activities relating to equipment for applying agricultural chemicals have made him an acknowledged national authority on pesticide application methods and equipment. Highlights of Bode's career include development of techniques for measuring pesticide drift and measuring the effectiveness of equipment used for incorporating pesticides into the soil. He designed a portable spray "patternator" table which is still widely used to teach calibration, selection, and use of spray nozzles and additives. Loren has written more than 200 publications regarding his research findings, which have been recognized with many awards and honors.

Examples of Bode's international reputation include invitations to speak and to present papers in Brazil, Japan, England and Denmark. He has received numerous awards and honors, including the College of ACES Senior Faculty Award for Excellence in 1990; the MACA Educator's Award in 1991; the National ASAE Young Extension Worker Award in 1993; the College of ACES Funk Award in 1993; and the Ben and Georgeann Jones Excellence in Teaching Award in 2008. Bode has served in a variety of positions of leadership in the (now) American Society of Agricultural and Biological Engineering and was elected as a Fellow in 1992.

Bode became the fifth Head of the Department in 1993 and served in that role through December 2004. Many changes occurred during his tenure with many new faculty hires, being rated the number one Department in the nation, and changing the name of the Department of Agricultural and Biological Engineering.

Bode retired from the Department in May of 2008.

DOUGLAS BOSWORTH
1996–2004

Douglas Bosworth was born in Goldfield, Iowa, and received his Bachelor's degree in Agricultural Engineering from Iowa State University in 1962. In 1964 he received a Master's degree in Agricultural Engineering with a minor in Theoretical and Applied Mechanics from the University of Illinois.

Bosworth began his engineering career at Deere and Company in 1959. For the next 35 years, Bosworth served the company in a variety of managerial positions, including Manager, Test Engineering; Reliability Manager; Division Engineer for Tillage; Manager, Manufacturing Engineering; Works Manager; Manufacturing Manager; Manager, Engineering Test and Reliability; and Manager, Business Opportunities.

During those years, Bosworth was an active member of the American Society of Agricultural & Biological Engineers (ASABE), where he served as President Elect from 1991 to 1992 and as President from 1992 to 1993.

Bosworth also served on the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET) from 1985 to 1990 and led ten engineering accreditation teams. He was also a Program Evaluator for fifteen engineering programs beginning in 1976. He used that experience to help the College of ACES conduct self-evaluation and the College of Engineering prepare for ABET reviews.

Bosworth retired from Deere and Company in 1994. He served as President of the Illinois Technology Center at Savoy from 1995 through 1997. He was also the Administrative Principal of WorkSpan, Inc. from 1994 through 2000.

Bosworth joined the faculty of the Department of Agricultural & Biological Engineering at the University of Illinois in 1996. As Adjunct Professor, Bosworth taught the senior capstone engineering design class, which became a model for other departments and colleges of how to utilize the product development team process used in industry to teach design. Under his tutelage, students tackled real-world problems proposed by industry partners, and presented their eventual products and solutions to the industry partner in the same manner as an internal design team. The students' designs and solutions were often adopted by the industry partners.

Bosworth retired from the Department in May of 2004.

Phil Buriak
1988–2004

Dr. Phil Buriak came to the Department in 1988 as an associate professor. Buriak earned a bachelor's in Biology/Secondary Education at Pennsylvania State in 1972 and a master's in Agricultural Education in 1980. He earned a Ph.D. in Agricultural Education from The Ohio State University in 1982. Prior to his time at U of I, he taught at Illinois State and at Mississippi State.

Buriak was recruited by Carroll Goering and Roscoe Pershing to revitalize the Agricultural Mechanization program. When he joined the staff, enrollment in the program had fallen to fewer than 25 majors. Buriak transformed the program to a physics-based curriculum focused on the management of agricultural and technical systems and almost quadrupled enrollment. He also oversaw the name change from Agricultural Mechanization to Technical Systems Management.

During Buriak's tenure at the University, his legacy was his rapport with his students and his ability to communicate to them his passion for excellence. Beginning in 1986, Buriak won many awards for teaching, including the Teaching Award of Merit from the National Association of College Teachers of Agriculture in 1986; the Teaching Excellence Award from the U of I Department of Agricultural Engineering in 1989, 1992, and 1994; the Teaching Award of Excellence from the U of I College of Agricultural, Consumer and Environmental Sciences in 1997; the Senior Teaching Award of Excellence from the U of I College of Agricultural, Consumer and Environmental Sciences in 1999; the Undergraduate Teaching Award of Excellence from U of I in 1999; and the National Award for Excellence in College and University Teaching from the U.S. Department of Agriculture in 1999.

Buriak served as advisor to the Technical Systems Management student organization and under his guidance, the student club was ranked number one 13 times in 15 years. Buriak was very active in the American Society of Agricultural and Biological Engineers and served on a variety of education and technical management committees. He is a life member of the American Association of Agricultural Education and served several years as editor of the Journal of Agricultural Education.

Buriak was a professor in the Department from 1988 until his retirement in 2007.

Les Christianson
1984–2007

Dr. Les Christianson attended South Dakota State University and received a bachelor's degree in Agricultural Engineering in 1974 and a master's in 1976. He then attended the University of Missouri, Columbia, where he received his Ph.D. in the same subject.

While earning his Ph.D., Christianson served as an instructor at the University of Missouri from 1976 until his graduation in 1978. He then took a position as an Assistant Professor in the College of Engineering at South Dakota State University. He remained at South Dakota until October of 1985, moving into the position of Associate Professor and serving as Associate Dean of the College.

In October of 1985, Christianson joined the faculty of the Department of Agricultural Engineering at the University of Illinois as an Associate Professor. He later served as Professor in the Department as well as in the Bioengineering Department of the College of Engineering. In 1982, he became the Director of the Bioenvironmental Engineering Research Laboratory.

Throughout his engineering career, Christianson has worked as an engineering consultant and has been the co-owner of a number of businesses, including the Illinois Technology Center (1994–2003); Plastic Designs, Inc. (2003–2008); Green Valley Manufacturing (2003–present); WorldWide BioEnergy (2007–present); and Skyview Farms (2008–present), where he owns and manages 240 acres of farmland and raises dairy steers and purebred sheep.

Christianson has been a member of the American Society of Agricultural and Biological Engineers since 1971 and a member of the American Society of Heating, Refrigerating and Air-conditioning Engineers since 1972. He has served on the National Pork Board and the National Pork Producers Council.

Christianson was given the Teaching Excellence Award from the Department in 1987 and 1991; the Stanley H. Pierce Award from the College of Engineering in 1989, and the Andersen Consulting Award for Excellence in Advising from the College of Engineering in 1989, 1990 and 1991.

Carroll E. Goering
1977–1999

Carroll E. Goering was raised on a farm near Platte Center, Nebraska. After serving two years in the US Army including service in Korea, he graduated from the University of Nebraska with a BS in Agricultural Engineering in 1959. He worked for two years on advanced implement design for International Harvester Company in Burr Ridge, Illinois before entering graduate school at Iowa State University. There he earned an MSAE and a dual major PhD degree, with majors in Agricultural Engineering and Engineering Mechanics.

Upon graduation in 1965, Goering joined the Agricultural Engineering faculty at the University of Missouri-Columbia, doing teaching and research. His research there was on vehicle automation and on chemical application technology. While at Missouri, Goering was awarded a distinguished faculty award. He spent the academic year, 1972-73, on sabbatical leave in the Agricultural Engineering department at the University of Illinois.

In 1977, Goering joined the Agricultural Engineering faculty at the University of Illinois on a teaching and research appointment, filling a vacancy created by the death of Jay Weber. Goering was leader of the Off-Road Equipment Engineering area from 1985 until his retirement in 1999. He also chaired the department graduate committee during that time, overseeing the graduate student enrollment growth from 25 to 50 students. His research areas at Illinois were in bio-fuels, mechatronics, and precision agriculture. Two of his research publications won ASABE outstanding paper awards and two others won honorable mention.

Goering enjoyed teaching and was on the incomplete list of excellent teachers 24 times. He was awarded the senior teaching excellence award from the College of ACES and the Everitt award for teaching excellence from the College of Engineering. He was a member of the ACES Academy of Teaching Excellence from 1995 to 1999. He was also awarded a Funk Award by the College of ACES. Goering spent all of 1984 on sabbatical leave in South Africa, where he instructed the South Africans on how to measure energy release rates from the fuel in a running engine. Goering was author or coauthor of three textbooks, Engine and Tractor Power, Engineering Principles of Agricultural Machines, and Off-Road Vehicle Engineering Principles. In addition to advising MS and PhD candidates, Goering advised numerous undergraduate students on their research projects. Nine of these undergraduate theses grew into refereed publications in national journals.

Goering was heavily involved in ASABE activities, including twice chairing the Power and Machinery division, serving on the ASAE board of directors and on the board of the ASABE Foundation. While chairing the Power and Machinery division, he led the development of the Agricultural Equipment Technology (AETC) series that still continues annually. Nine times, he was awarded presidential citations for distinguished service to the society. One of these was for helping the society implement an electronic library. Another was for serving on the 3-member committee of the board of directors that rewrote the constitution to decentralize the society. Another was for setting up a system for periodic dues review and for setting appropriate dues rates. The other six citations were for authoring new or revised textbooks. Goering was also awarded the Massey-Ferguson Educational Medal and the McCormick-Case Gold Medal and was elected an ASABE Fellow.

The BioSystems Engineering Department at the University of Nebraska elected Goering to their department hall of fame in 2002. Goering had graduated from that department in 1959. Goering retired in 1999. He and his wife, Carol, have two daughters, a son and four grandchildren.

Shufeng Han
2000 – 2002

Shufeng Han received both his bachelor's (1982) and his master's (1985) degrees in Agricultural Mechanization from Zhejiang University in China. He was an instructor in Agricultural Mechanization at Zhejiang University until 1989, when he came to the University of Illinois to earn his Ph.D. in Agricultural Engineering.

Han first worked in the Department as a Graduate Research Assistant while working toward his degree. Upon graduation in 1993, he took a position as a Research Associate at Washington State University. Han returned to the U of I in 2000 as an Assistant Professor in Agricultural Engineering.

In his time with the Department, Han established a strong research program in the areas of precision agriculture, variable rate application technologies and off-road vehicle automation. Han organized and co-chaired the first Illinois-Missouri Precision Agriculture Conference and gave numerous presentations to Extension educators, grower associations and farmers to promote precision agriculture in Illinois. He also managed the Agricultural Engineering Research Farm and the Applied Machine Vision laboratory.

Han left the U of I in 2002 to take a position as an Engineering Scientist with John Deere Intelligent Vehicle Systems, where he obtained eight patents (out of a total of 15 patents) and received two AgDem Innovation and Collaboration Awards (the highest engineering award within the John Deere Agricultural Division) in the last eight years. Han is currently a Senior Staff Engineer at John Deere Product Engineering Center. Han is also a Collaborator Associate Professor at Iowa State University.

Han has been a member of the American Society of Agricultural and Biological Engineers since 1995, and has served the ASABE in a number of offices, including Vice Chair of the Iowa Section and Vice Chair of the Illinois Section.

Michael Hirschi
1985–2007

Dr. Michael Hirschi earned both his bachelor's and master's in Agricultural Engineering from the University of Minnesota in 1978 and 1980, respectively. He went on to earn a Ph.D. in Agricultural Engineering from the University of Kentucky in 1985. Upon graduation, he joined the faculty of the Department of Agricultural and Biological Engineering at the University of Illinois as an assistant professor, working also as a research associate for the Army Corps of Engineers as part of his summer appointments.

Hirschi's time with the Department spanned 22 years and he served in a variety of positions over that period, including section leader in the Soil and Water Division beginning in 1996 and as Associate Department Head from 2006 to 2008. Hirschi was a valued teacher; his course, Soil and Water Management Systems, was highly rated by students, and he was voted to the "Incomplete List of Teachers Ranked as Excellent by Their Students" each semester the course was taught. He was considered an outstanding advisor, working with and advising students in Agricultural Engineering and Technical Systems Management in both the College of ACES and the College of Engineering.

Hirschi's primary contribution was in Extension, where he served as an Extension Specialist for 22 years. He held a variety of leadership roles, including Acting Assistant Director for Agricultural and Natural Resources for the Cooperative Extension Service, Interim Associate Director for the Cooperative Extension Service, leader of the Water Quality Strategic Research Initiative for the Illinois Council on Food and Agricultural Research, and Water Quality Program Coordinator for UI Extension.

His contributions to Extension have been significant, particularly in the areas of water quality improvement and soil conservation practices. Hirschi emphasized outreach and the need to bring campus research to those who can use it to improve their lives, the lives of those around them, and the environment. Hirschi's work, in particular on the Great Lakes Region Water Quality Leadership Team, has had a major impact on Extension programming in soil and water related areas in Illinois, the Great Lakes Region and the nation.

Hirschi has been a member of the American Society of Agricultural and Biological Engineers since 1977. As such he has served on numerous committees and in various leadership positions. Hirschi has earned numerous awards throughout his career, including the Young Faculty Award for Excellence in 1995, the Karl Gardner Outstanding Undergraduate Advising Award in 2003, and the Senior Faculty Award for Excellence in Extension in 2007.

In 2007, Hirschi took a position in the College of Engineering as Interim Assistant Dean for Academic Programs; he was later appointed Assistant Dean for Undergraduate Programs in 2008.

John W. Hummel
1976 – 2000

John Hummel was raised on a dairy and crop farm near Grantsville, Maryland. He was active in 4-H and FFA programs, and won the Maryland State FFA Public Speaking Contest in 1958. He earned his bachelor's and master's degrees from the University of Maryland, and then entered graduate school at the University of Illinois in 1966. After completing his Ph.D. in 1970, he became an assistant professor at the University of Maryland with teaching and research responsibilities. He was promoted to associate professor in 1973, and became a registered professional engineer in Maryland in 1976. In 1976, he returned to the University of Illinois to work for the Agricultural Research Service (ARS) of the USDA. In 1997, Hummel served a 2-month assignment as National Program Leader (Acting) for Engineering/Energy Programs on the ARS National Program Staff in Beltsville MD. In 2000, the USDA transferred Hummel to the Cropping Systems and Water Quality Research Unit (CSWQRU) at the University of Missouri and he served as Acting Research Leader of the CSWQRU (1/03 – 6/03).

Initially, Hummel's research for the ARS was on soybean production technology, with emphasis on soybean harvesting. He and his coworkers developed innovative methods for reducing soybean harvesting losses. They created a laboratory stand that permitted taking high-speed movies of soybean headers as a means of detecting loss mechanisms. This led to development of an impact cutter that permitted higher harvesting speeds without increased loss. Later, Hummel's research evolved into the new field of precision agriculture. Hummel and his students focused on sensor development, a critical need for precision agriculture. They developed sensors to sense soil organic matter, soil nitrates and corn plant populations. At Columbia, Missouri, he continued his research on precision agriculture,

Hummel's career involved working with numerous students, initially at the University of Maryland, where he served as a part-time instructor while doing graduate work. He was later employed as a full-time faculty member. When he came to the University of Illinois as a USDA employee in 1976, he received a courtesy appointment as an associate professor. He was promoted to professor in 1987. He received an appointment to the graduate faculty that enabled him to advise master's and Ph.D. students. He also advised numerous students for their undergraduate thesis research. In 1996, he was the first winner of the ACES Service Recognition award that recognized outstanding affiliates of the college. Hummel became a member of the Doctoral Faculty of the University of Missouri in 2002, enabling him to advise doctoral candidates there,

Hummel became active in ASAE (now ASABE) early in his career, winning the National Student Paper Contest in 1964. He served on numerous committees, and chaired the chemical application, the cultural practices equipment, the precision agriculture, and the power and machinery program committees. He served for one year as chair of the power and machinery division. In 1989-90, he chaired the society-wide committee that planned annual meetings. In 1982, he was the sole ANSI representative at an ISO meeting held in Europe to negotiate new machinery standards. From 1983 to 1992, he represented the U.S. on the Technical Advisory Group on international standardization. He served on the Board of Trustees of ASAE, and in 2000, he was elected as an ASAE Fellow.

Hummel retired from the USDA in 2004. In 2004, Hummel became Co-Editor-in-Chief of the Computers and Electronics in Agriculture journal, coordinating the editing and publishing of over 250 manuscripts from around the world during a 3-year period.

J. Bruce Elliott-Litchfield
1986–1999

Dr. Bruce Litchfield earned his bachelor's degree in Mechanical Engineering from the University of Illinois in 1978. He continued his education at Purdue University in West Lafayette, Indiana, earning a master's degree in Food Process Engineering in 1984 and a Ph.D. in Food and Biochemical Engineering in 1986.

Litchfield began his engineering career as a Process and Project Engineer at General Foods Corporation from 1978 until 1982. After completion of his degrees at Purdue, Litchfield returned to the U of I as an assistant professor in the Department of Agricultural Engineering in 1986. He advanced to full professor, and during this time, Litchfield played a key role in the development of the Food and Bioprocess Engineering curricula for the Department. Together with engineering executives from several food companies as well as academic personnel, Litchfield developed three courses that were central to the Food and Bioprocess Engineering program; Engineering Properties of Foods (now ABE 493), Food and Bioprocess Engineering Design, and Humanity in the Food Web.

Litchfield earned a number of honors and awards for his work in the Department and the College, including the Outstanding Instructor Award (1989-90); the Young Faculty Award for Excellence in Teaching from the College of Agriculture (1992); and the Faculty Award for Excellence in Research from the College of ACES (1996).

In 1994, Litchfield founded and directed a faculty development program, the Academy for Excellence in Engineering Education that has become a model for excellence. The purpose of the program was to introduce new faculty to new and effective ways to teach at the college level. Litchfield's work with this program was recognized in 1997, when he was named the first recipient of the Collins Award for Innovative Teaching. That same year, Litchfield also received the prestigious Harriet and Charles Luckman Undergraduate Distinguished Teaching Award.

In 1999, Litchfield accepted a position with the College of Engineering as an Assistant Dean for Engineering Academic Programs. Litchfield has been involved in a number of activities in the COE, including the Engineering Emotional Intelligence Course (where he developed and co-taught an interdisciplinary personal development course for engineering students); International Programs in Engineering (serving as director of global study abroad and collaborative programs for more than 5400 undergraduate engineering students); Illinois Foundry for Innovation in Engineering Education (director of first-year experience and a faculty fellow); and the Learning in Community Program (where he developed and directed campus-wide service learning and community engagement programs). Litchfield was also given the Distinguished Teacher/Scholar Award for instructional excellence and leadership and was funded to direct a campus-wide effort in civic engagement (2003-2004).

Recent awards include recognition as an Engineering Council Outstanding Advisor, the YMCA J. Frederick Miller Award and the American Society for Engineering Education Outstanding Campus Representative of the Illinois-Indiana Section.

J. Kent Mitchell
1964 – 2000

Dr. J. Kent Mitchell had a distinguished career in the Department of Agricultural Engineering at the University of Illinois for 36 years. Mitchell was born in Aurora, Illinois, but raised in Oskaloosa, Iowa. He earned his bachelor's degree in 1957 and his master's in 1964, both in Agricultural Engineering from Iowa State University. He earned his Ph.D. in Agricultural Engineering at the University of Illinois in 1970. In the years between his bachelor's and his master's, Kent was an Agricultural Engineer with the USDA Soil Conservation Service in Iowa, and served as a NIKE Unit Commander in the U.S. Army in Irwin, Pennsylvania.

Mitchell's research in soil and water included the collection and compilation of 33 years of continuous hydrologic monitoring data from four small mild slope Allerton Watersheds for use in developing models to describe the hydrology of those terrains; soil erosion studies on various cropping practices using a rainfall simulator resulting in 500 plot events for soil erosion data analyses; and the collection of data from the Little Vermilion River Watershed Water Quality Project resulting in data from 15 stations over 12 years (until 2003) for use in models to properly describe the hydrology of depressional tile-drained areas.

Mitchell used sabbaticals to develop a national and international perspective of soil and water resource engineering. He was Visiting Assistant Professor, Department of Agricultural Engineering, University of Wisconsin, Madison; Visiting Professor, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, South Africa; Visiting Scientist, USDA National Sedimentation Laboratory, Oxford, Mississippi, and Visiting Research Professor, Center for Computational Hydroscience and Engineering, University of Mississippi, Oxford, Mississippi; and Visiting Professor, Department of Hydraulic Structures, Warsaw Agricultural University, Warsaw, Poland. He was, also, an invited speaker at conferences in Belgium, England, Austria, Korea, Thailand, China, Poland, and Australia.

Teaching was a highlight for Mitchell at the University, and he considered it his first priority. Mitchell earned numerous teaching awards during his career at the U of I, including the Teaching Excellence Award from the Department of Agricultural Engineering in 1986 and 2000; the Alpha Zeta Outstanding Instructor from the College of Agriculture in 1986; the Everitt Award for Teaching Excellence from the College of Engineering in 1987; and the Senior Faculty Award for Excellence in Teaching from the College of Agriculture in 1989. He was a member of the Academy of Teaching Excellence in the College of Agriculture in 1989 and 1992.

His teaching included service as Educational Advisor to the Illinois Land Improvement Contractors Association near the end of his career and into retirement.

In other career highlights, Kent received the Paul A. Funk Recognition Award in 1994 from the College of Agriculture and was awarded the grade of Fellow in the American Society of Agricultural Engineers in 2000. Mitchell retired from the Department on March 1, 2000.

Mitchell married Marlene Reynolds in 1956 and they have three sons and one daughter. He has been active in Church committees; and Boy Scout activities, having received the Silver Beaver award.

Marvin R. Paulsen
1975–2006

Dr. Marvin R. Paulsen was born in Minden, Nebraska and earned a bachelor's and a master's degree in Agricultural Engineering from the University of Nebraska in 1969 and 1972, respectively. Paulsen then attended Oklahoma State University, where he received a Ph.D. in Agricultural Engineering in 1975. Upon graduation, Dr. Paulsen joined the Department of Agricultural Engineering at the University of Illinois.

Paulsen's research focused on grain quality – understanding what degrades grain quality and how to protect against that degradation. Paulsen was involved extensively in grain quality measurements. His research on the breakage of corn during export shipment made significant contributions to the state of Illinois and to the U.S. grain trade. His results provided information used by importers, merchandisers and corn geneticists to improve handling methods and corn characteristics.

Paulsen was also involved with the use of machine vision to detect grain kernel defects and later with near-infrared reflectance/transmission (NIR/NIT) spectroscopy to predict starch extractability of corn samples. His research in the use of NIR/NIT to measure corn starch extractability and other quality traits, proved of great benefit to the corn merchandising industry.

Professor Paulsen developed an international expertise in grain quality measurements and effects of drying, handling and transport on quality changes. He has given numerous presentations on U.S. grain quality in Europe, China, Russia, and for the U.S. Grains Council for conferences in Japan, Columbia, Peru, and Mexico. In 2002 he was elected to Fellow in ASABE and in 2005 he received the Paul A. Funk Recognition Award from the College of ACES.

Paulsen became Division Leader of Food and Bioprocess Engineering in May of 1989, serving until July of 2006. He was appointed Graduate Program Director for the Department from 1994 to 1996 and 1997 to 2006. He created the first Graduate Program Handbook in 1999 and revised it each year.

Paulsen served as the Associate Head of the Department from August 2000 until his retirement in July of 2006.

Qin Zhang
1997-2009

Dr. Qin Zhang earned his bachelor's degree in Mechanical Engineering from Zhejiang Agricultural University in China in 1982 and received his master's in Agricultural Engineering from the University of Idaho in 1988. He went on to earn a Ph.D. in Agricultural Engineering from the University of Illinois in 1991. Following a two year Post-Doctoral appointment (1992-94) in the Department, he was employed by Caterpillar Inc. in Peoria, Illinois as a Senior Research Engineer from 1994 to 1997. The Agricultural Engineering Department was able to attract Dr. Zhang back into the academic community in August 1997 as an Assistant Professor in Off-Road Equipment Engineering. He was promoted to Associate Professor in 2002 and Professor in 2009.

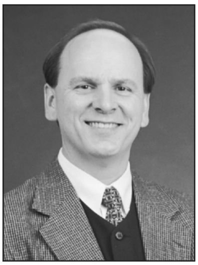
During Zhang's twelve years at the University of Illinois he developed an internationally recognized program in the areas of mobile mechatronics and agricultural infotronics. He was invited to visit over 20 foreign universities and research institutions, and hosted 60 groups of international visitors from more than a dozen countries for academic exchanges. In addition to his many research contributions including a dozen patents, Zhang published a textbook for the study of hydraulic systems. Zhang served as Editor of three major international proceedings on Automation Technology and as Associate Editor of two professional journals. He received several outstanding paper awards, including the Best Paper of the Decade Award in 1995 from the Transactions of Agricultural Engineering (China). Teaching awards include the coveted Collins Award for Innovative Teaching presented by the College of Engineering at the University of Illinois (1999).

Zhang holds Adjunct Professor titles at three top ranked universities in China and is a JSPS Fellow in the Japanese Society for the Promotion of Science. He is active in the American Society of Agricultural and Biological Engineers (ASABE), the Society of Automotive Engineers (SAE), the National Fluid Power Association (NFPA) and served on the Board of the Association of Overseas Chinese Agricultural, Biological, and Food Engineers (AOC).

Zhang's reputation can be summarized from a 2008 cover story in

Farm Industry News in which the editors included Zhang in an A to Z list of people, technology, and trends that will change agriculture in the future. The authors acknowledged his accomplishments with the statement that "Qin Zhang's name is synonymous with mechatronics, the science that integrates 'mechanics' and 'electronics' to create off-road machinery with a 'brain.'"

In 2009, Dr. Zhang accepted a position at Washington State University to develop a Center for Automated Agriculture with an emphasis on high value specialty crops.



John F. Reid
1986–2000

Dr. John F. Reid was born and raised in Staunton, Virginia. He earned his bachelor's and master's degrees in Agricultural Engineering from Virginia Polytechnic Institute and State University (VPI&SU). While at VPI&SU, he was employed as a coop education student by the Shenandoah Valley Electric Cooperative. Reid's graduate education focused on automation and controls applied to agricultural and biological systems. He earned his Ph.D. from Texas A&M University where he and his advisor developed a research program in machine vision for agricultural applications including vehicle guidance. He then joined the Agricultural Engineering department at the University of Illinois in 1986.

While at the U of I, Reid started a research program on development of machine vision sensors for use in agricultural and biological applications. This research was initially supported through Hatch funding to characterize corn plant growth and development to support mechanistic plant growth models.

A major collaboration between Reid, Dr. Bruce Litchfield, their graduate students, and other researchers led to the integration of vision-based sensing for the control and optimization of fermentation processes. Vision-based management and control of tissue culture systems was a topic Reid continued with Dr. Mary Ann Lila in the College of Agriculture.

Reid's research interests took him to the University of Natal in South Africa in the summers of 1990 and 1992 where he worked with

Dr. Alan Hansen and others to establish a machine vision laboratory for this university. Research out of this effort focused on applications of vision sensing to characterize wear on engine parts and fuel injectors and applications to assess the volume and size distribution of logs at weigh bridges for forest logging operations.

Reid, his graduate students, and other research colleagues used machine vision in various applications including grain quality evaluation, selective harvesting of asparagus, inspection of food packages for seal damage, and automatic detection of microbial contaminants in water samples. A U.S. patent was granted based on the research for water contaminant detection.

In 1996, he used a spring-semester sabbatical with Case-IH (and later CNH) to further develop his expertise in automation for the agricultural equipment industry. During this time, Reid's research returned to the use of machine vision in connection with automatic guidance of agricultural vehicles as part of a broader look at robotics and automation in production agriculture. The relationship with CNH continued through an on-going research contract between Case and the University of Illinois that included research in robotics and automation of agricultural vehicles and the development of multi-spectral image sensors for real-time site-specific control of corn nitrogen requirements.

During this same time, Dr. Reid and Dr. Noboru Noguchi of Hokkaido University, along with Dr. Qin Zhang, formed a significant research collaboration that resulted in a global research program in robotics and automation in agriculture including the development of autonomous tractors, and automated guidance for combine harvesters. Dr. Reid went on to win a Japanese Society for the Promotion of Science Fellow award that enabled he and his family to spend 9 weeks in Japan in 1998. During this time Reid further expanded his research interests into robotics and automation as a potential systems solution for agricultural productivity.

While Dr. Reid was deeply involved in research, a strong mentoring relationship with Dr. Loren Bode helped develop Reid into a significant contributor to student activities through teaching and advising. Dr. Reid developed a number of new courses for the department that brought novel technologies into the classroom including machine vision sensing, robotics in agriculture, finite element methods in engineering, and boundary element analysis methods. In 1997, he won the

Karl Gardener award from the College of ACES for innovative advising of students. From 1997 to 2000, Reid was a member of the Teaching Academy of Excellence in the College of ACES.

This blend of innovative teaching, collaborative research, and service to the University and professional societies led to a well-rounded career for Dr. Reid that provided many great and memorable experiences. For the 1995-96 academic year, Reid was one of 21 faculty members on the UIUC campus to win appointment as a University Scholar. Reid was promoted to Associate Professor in 1992 and to full Professor in 1997.

In December, 2000, Reid left the department to accept a position as Manager of Technology Development Support at the John Deere Technical Center. At the time of his departure, he was serving as the leader of the Off-Road Equipment Engineering (OREE) area of the department. Although he moved to the Quad Cities, he was granted a zero-time appointment as an adjunct professor in the ABE department which enabled him to continue to mentor and support his remaining commitments towards the completion of several graduate students. In 2002, Reid became the Manager of Field Robotics at John Deere responsible for the global innovation strategy in robotics and automation. The R-Gator, developed for military applications, was one of the first products commercialized from this effort. In 2006, Reid became the Director, Product Technology and Innovation at John Deere's Moline Technology Innovation Center, where he and colleagues in Advanced Marketing lead and execute the process for new business opportunity identification and execution. Reid is also responsible for the Global Technology Innovation Network at John Deere that identifies and develops the technology strategy that guides the building of capabilities to support John Deere's current and future business needs. This has resulted in the expansion of John Deere's R&D footprint to Europe and Asia.

Reid continues to be active professionally. He is a past Board Member of ASABE and was named ASABE Fellow in 2005. In 2003, Reid became a full member of the Club of Bologna. This club, with 92 members world-wide, has the goal of convening the highest international experts on mechanization to discuss subjects of preeminent importance for the development of agricultural machinery in various countries. Reid has a deep and active record of published work including 18 patents at this time.

Gerald Riskowski
1986–2001

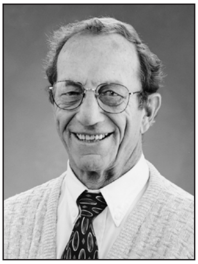
Dr. Gerald Riskowski earned both his bachelor's and master's in Agricultural Engineering from the University of Nebraska in 1974 and 1976, respectively. After four years as a design engineer with Lester's and Wick Building Systems (in Minnesota and Wisconsin) Riskowski took a position as an instructor and Extension engineer at Iowa State University in 1980. He went on to earn his Ph.D. in Agricultural Engineering from Iowa State in 1986.

Riskowski came to the University of Illinois in the fall of 1986, where he was promoted from assistant to associate to full professor in the Department of Agricultural and Biological Engineering. During his time at the U of I, he was the leader of the Bioenvironmental Engineering division in the Department, and a founder and director of the Bioenvironmental and Structural Systems (BESS) Laboratory.

Riskowski is recognized internationally for his research concerning environmental control systems and light-frame structures. He was a principal investigator on several projects sponsored by NIH, NASA, NSF, ASHRAE and industry. His publication record includes over 80 peer-reviewed journal articles and over 100 conference papers. He is an author of nine handbooks, an ASABE standard, ten monographs and book chapters, and has given several invited lectures around the world, including Brazil, China, Europe, and Korea.

Dr. Riskowski is a member of both the American Society of Agricultural and Biological Engineers (ASABE) and the American Society for Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). He has been an associate editor for ASABE journals since 1994. His papers have received four ASABE paper awards and three ASHRAE Technical Paper awards. Other honors have included eight Blue Ribbon awards, an Outstanding Reviewer award from ASABE, and teaching excellence awards. He was also elected into the rural Builders Hall of Fame, received the ASABE Henry Giese Award, and is a Fellow of ASABE.

Dr. Riskowski left the Department at the end of 2001 to take his current position as Professor and Head of the Department of Biological and Agricultural Engineering at Texas A&M University.



John Siemens
1968–1998

Dr. John Siemens grew up in Lancaster, California on an alfalfa/dairy farm. Siemens earned a bachelor's degree in Agricultural Engineering at the University of California at Berkeley and Davis. He earned a master's in Agricultural Engineering at the University of Illinois and a Ph.D. in Civil Engineering, also at the U of I.

Siemens accepted a position as Assistant Professor of Agricultural Engineering at Cornell University in 1963. In 1968, John accepted an offer to return to Illinois as Associate Professor of Agricultural Engineering and Extension Specialist in Field Power and Machinery. Siemens established applied research projects to support his Extension program; several were cooperative efforts with other departments, including the Agronomy Department. Subject matter of major research projects included tillage systems for corn and soybean production, farm machinery management, and soil compaction. In 1970, he accepted a Residency in Engineering Practice and spent a year with Deere & Company at Moline, Illinois, where he worked on the evaluation of tillage systems for corn and soybean production and a computer program to select the optimum machinery set for a farm.

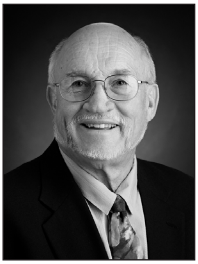
Siemens' relationships with the Agronomy Department and Deere & Company were key to the major research contributions Siemens made to conservation tillage while at U of I. With financial support from Deere & Company, Siemens and Professor Oschwald from the Agronomy Department launched a massive tillage research project in 1971. Results of the project were widely distributed through their Extension Programs and played a major role in the nation-wide acceptance of conservation tillage and the virtual retirement of the moldboard plow.

In 1975–1976, Siemens was granted a sabbatical leave to evaluate and study field machinery selection methods used for corn production in South Africa. This launched John's interest in machinery management and was the first of other overseas assignments in Iraq, Yugoslavia and Jamaica. Siemens worked with several graduate students in the development of machinery selection software for guiding farmers in selecting optimum sets of machinery for their farm operations.

During his career Dr. Siemens was a regular participant in meetings and conferences sponsored by the Illinois Cooperative Extension Service. Siemens provided leadership and presentations in the areas of conservation tillage systems, farm machinery management and soil compaction. Siemens served as Extension Program Leader for the Department from 1983 through 1998.

In 1993, Siemens received the Senior Faculty Award for Excellence in Extension from the (then) College of Agriculture. In 1999, he was presented the John Deere Gold Medal Award, one of the highest honors granted by the (then) American Society of Agricultural Engineering.

Siemens retired from the Department in December of 1998.



M.E. "Mike" Tumbleson
1986–2006

Dr. M.E. "Mike" Tumbleson grew up in the small town of Trimont, Minnesota and hitchhiked to the University of Minnesota at the age of 17. Tumbleson earned a bachelor's degree in Agricultural Education at Minnesota in 1958, a master's in plant physiology in 1961 and a Ph.D. in nutrition and biochemistry in 1964.

After 20 years at the University of Missouri, Tumbleson joined the faculty at the University of Illinois in 1986, where he held a joint appointment in veterinary biosciences and agricultural engineering. In his time at the University, Tumbleson investigated a variety of areas, including the use of swine to evaluate alcoholism, ethanol production and corn utilization.

During the past few years, Tumbleson's research publications have resulted from work on evaluating dry grind corn processing facilities with respect to optimizing ethanol production from corn grain, assessing fumonisin (a mycotoxin produced by fungi existing on corn plants) effects on swine, sheep, cattle and horse health, and commercial plant work with enzyme companies elucidating effects of operating conditions and equipment.

Tumbleson has coauthored more than 200 refereed journal papers and 500 scientific abstracts and presentations, often with colleagues from the Department, including Drs. Phil Buriak, Leslie Christianson, Steven Eckhoff, Kent Rausch and Vijay Singh. Tumbleson coauthored publications with more than 100 other distinguished colleagues, including Robert Eppley (FDA, Washington, DC), David Johnston (ERRC/ARS/USDA, Wyndmoor, PA), D.K. Gupta (G.B. Pant University, Pantnagar, India), and Luk Vriens (Seghers, Wespelaar, Belgium).

In 1985, Tumbleson organized and chaired the international conference, "Swine in Biomedical Research," after which he compiled and edited a three-volume treatise of the same name. In 1995, he organized and co-chaired an international symposium on "Advances in Swine in Biomedical Research," and was a coeditor of a two-volume treatise of the same name.

Tumbleson has been a pilot his entire adult life, working as both an instructor (6500 hours) and an examiner. He often combines work and pleasure, taking farmers and cooperative elevator managers up in the air to evaluate crop conditions.

Tumbleson retired from the University of Illinois in May of 2006.

9 | A GLANCE AHEAD

Although this is a history book, faculty member Tony Grift asked that it include some predictions as to what lies in the future, especially as the future relates to the ABE department. The ABE Futures Committee/Council thought this was a good idea. Accordingly, the decision was made to include a chapter entitled "A Glance Ahead." A number of people were invited to make predictions out to the year, 2025, i.e., 15 years beyond the publication year of the book. Tony Grift worked with Kaustubh Bhalerao, Steve Eckhoff, Al Hansen, Prasanta Kalita and Yuanhui to write a combined prediction. Members of the Futures Committee/Council, Carroll Goering and Roscoe Pershing, wrote predictions. Finally, three undergraduate students contributed predictions. They were Andrew Gentile, Kim Keinecke and Patricia Paulausky. These predictions are presented in the paragraphs below.

A Glance Ahead

Grift, Hansen, Kalita, Zhang, Bhalerao, Eckhoff

The form, shape and size of the department of Agricultural & Biological Engineering in 2025 in terms of teaching, research and extension depends on many factors and is not easy to predict. To limit the scope, assume that in AD 2025, the department will still be an autonomous unit within the University of Illinois having the word Agriculture in its name, committed to addressing global challenges through research, education, and outreach. Following are some global challenges to be addressed, which new technologies will be influential, and the strategy needed to reach Departmental goals.

9.1 Global challenges

The ABE department in 2025 will still be focused on major challenges facing humanity. Food security is crucial since the global population is projected to grow to 9 billion people by the year 2042. We are concerned with securing enough food and also about the safety of the food from deleterious activity. Much of the U.S. food chain is vulnerable to tampering by terrorists. We need to develop monitoring and security systems to assure the food is not tampered with before, during and after production. Most processors have developed security systems for their production facilities, but with over 15.7 million km2 of arable land in the US, it will be difficult to provide security at the level found in processing plants. Agricultural engineers will be taking the lead on providing technology, processes and products for a secure global market.

Secondly, in light of the limited fossil fuel supplies and the influence of their use on climate change, producing energy from renewable sources will become imperative. While it is reasonable to assume that some biomass will need to be processed to achieve the demand for transportation fuels, it is not clear what percentage of the available biomass will be converted. The costs are so high for collecting, storing and transporting biomass that corn to ethanol will remain the predominate pathway to biofuels. The importance of genetic engineering on increasing corn yields cannot be over emphasized. If corn yields can keep up with demand for transportation fuel, biomass may be relegated to non-portable fuel.

Thirdly, the impact of Agriculture on the environment must be addressed and sustainability must be high on the agenda. For instance, there are currently seven weeds that have been designated as 'glyphosate resistant', an alarming trend indeed.

Fourthly, Water resources will become increasingly scarce due to inefficient water usage, climate change and bioenergy production, and new and effective ways will be needed to deal with this issue. Much of the ground water used in bioenergy production is cooling water and given sufficient value to water, there are mechanical cooling methods which may be usable.

In the higher education arena, major challenges also exist for the department in equipping students with high quality and relevant knowledge and skills to be able to practice in their chosen profession. The National Academy of Engineering advocates qualities such as communication and teamwork skills, flexibility, and creativity in their vision for the "Engineer of 2020" . ABET specifies that engineering programs must ensure that their students demonstrate multidisciplinary teamwork, communication skills, ethical and professional responsibility, and an understanding of engineering in a global and societal context. From a broader perspective, the Association of American Colleges and Universities has identified educational outcomes for all students in higher education that are attuned to an increasingly global society, including intercultural competence, local and global civic knowledge and engagement, and the application of knowledge to new settings and complex problems .

9.2 Key technologies and their roles

The department will be developing engineering solutions for the challenges as mentioned. Continuing along the current path, we will develop technologies to make engines run cleaner, more efficient and develop sustainable bio-fuels to power them. We will continue to use systems approaches to optimize multiple agent operations. Corn fractionation processes will become more efficient, providing new and improved end-use co-products. While the processing amount will continue to grow, it is our view that the size of processing facilities may be reduced to be more local and integrated with other processes or agricultural systems.

Previously, new technologies such as GPS, GIS and sensing technologies have spawned the age of Precision Agriculture. The definition of Precision Agriculture now includes Automation Technologies such as wireless communication and robotics. We will continue to develop autonomous robots for scouting the fields for insects, disease damage and crop stresses. We will pursue the concept of multiple robot systems that communicate among themselves, employ internet databases for weed recognition and control, and most importantly apply Mendelian principles to 'evolve' the flock to optimal performance. Robots will also be used in specialty crops such as peach, apple and grape, where operations such as thinning and pruning will be conducted by robots. In the area of machinery, we will design feedback sensor-based equipment to deliver seeds, fertilizers, and pesticides in exact amounts with very high uniformity. We will also develop crop sensors, to be used to monitor insects, diseases, and weeds as well as soil sensors to monitor compaction, nutrient levels, and potential leaching. We will develop high throughput Phenotyping methods, since currently, sequencing of genomes is already affordable and fast, but technologies allowing, for instance, assessment of corn root complexity are severely limiting agronomic research.

Research into new generations of biofuel is rapidly expanding and can be expected to continue strongly over the next two decades. Our department's portfolio of biofuel research is well posed to address key areas of interest, namely production of biomass, including algae, and its conversion into both solid and liquid biofuels. Currently, the department has a BP funded program within the Energy Biosciences Institute created, which began in 2008 that investigates the engineering required for the production of biomass feedstocks that can be converted into biofuel. The program has the potential to continue for another seven years, by which time some crucial answers to the challenges of growing, harvesting and delivering sufficient biomass to bio-refineries will have been provided. Another example in the department's biofuel research portfolio is the Environment-Enhancing Energy (E2-Energy) program initiated in the Bioenvironmental Engineering area, which focuses on a broad vision of converting biowaste and algae into biocrude oil, capturing carbon and cleaning water. Initially the biowaste is separated into liquid and solid streams with the liquid stream being used to provide nutrients for algae growth and the biosolids being converted into biocrude oil via hydrothermal liquefaction (HTL). Simultaneously the algae are separated from the relatively clean water and are added to the bio-solid stream. The resulting biocrude oil can be refined by traditional hydrocarbon-based processes into gasoline, diesel fuel and other products.

The Soil and Water Resources Engineering Division in the Department has been engaged in pioneering research in water quality, nonpoint source pollution, erosion control, drainage, water management, and irrigation. Envisioning the need for more production to meet global food demand, we are emphasizing intense research and educational needs in the area of water production and water management. Water is essential for all socio-economic development and for maintaining healthy ecosystems. As population increases and development calls for increased allocations of groundwater and surface water for the domestic, agriculture, and industrial sectors, the pressure on water resources intensifies. Today, agriculture accounts for 70 percent of all water use globally, up to 95 percent in several developing countries. To keep pace with the growing demand for food, it is estimated that 14 percent more freshwater will need to be withdrawn for agricultural purposes in the next 30 years. Water scarcity threatens the sustainability of the natural resources base. Addressing water scarcity calls for multidisciplinary approach to water resources management without compromising the sustainability of vital ecosystems. Protecting and restoring the productive soils and the ecosystems that naturally capture, filter, store and release water, such as rivers, wetlands, and forests, is crucial to increasing the availability of water of good quality. With trends of climate change patterns, our future work will continue to examine current practices and develop innovative soil and water management practices for significant global impact.

A significant amount of agricultural land in Illinois and other Midwestern states (and many other parts of the world) is artificially drained. For almost all of the approximately 160 years of documented drainage improvements in Illinois, the emphasis has been on improving crop production. However, the last 20 years have seen an increasing focus on the effect of drainage on environmental water quality. This work has been subsumed into a larger national effort to improve water quality from drainage systems. The Agricultural and Biological Engineering at the University of Illinois continues and intensifies research in investigating water quality problems associated with subsurface drainage. Future research emphasizes the need to define solutions to these problems. Our future activities will continue to emphasize long-term watershed research involving stake holders' active participation to understand and overcome barriers for implementing agricultural management practices that reduce nutrient and pesticide transport in surface and subsurface flows, while improving crop production. On-site remediation techniques for nitrate-N contaminated tile drain water with water table management and bioreactors are currently being evaluated. Our future activities will include developing large-scale high-efficiency bioreactors for on-site remediation of contaminated water. Future research and educational activities will need to be continued for reduction of microbial pathogens from receiving water systems for safe drinking water supplies. New educational tools need to be developed and implemented so that our future work force can effectively manage our water resources and sustain food production.

9.3 The evolving role of biological engineering

A 2009 report by the National Academy of Science entitled, "A New Biology for the 21st Century" details the increasing role of life sciences combined with biological engineering in global problems related to agriculture, environment energy and health. To tackle the challenges of improving food security, energy independence, environmental sustainability and individualized healthcare requires commensurate progress in analytical frameworks and design methodologies specific to biological engineering. Inasmuch as every engineering design methodology is based on its corresponding engineering science (e.g. mechanical engineering is based on mechanics, chemical engineering on chemistry and biotechnology on biochemistry), biological engineering design must be based on the science of biology, more specifically, on evolution and ecology. Clearly the current definition of biological engineering falls far short of this vision as few in the biological engineering community recognize this as the future of biological engineering. There are, however, glimmers of an emerging, comprehensive philosophy of biological engineering on the horizon. For instance, our ability to produce biomolecular data (genomic / transcriptomic / metabolomic) for single species as well as collections of species continues to rise at a super-exponential rate. Systems biology is a framework that aims to organize and integrate this incoming data stream into creating a computational picture of the living world around us. Synthetic biology on the other hand provides powerful fabrication tools to design and create genetic molecules with functions and behaviors not seen in nature. Together, these new scientific disciplines provide the foundational tools to reprogram life itself. It is expected that these tools will be fundamental to probe questions about the biosphere, its role in developing structured ecosystems and the evolution of organisms and species with changing environments. As a result, we will expect to see great leaps forward in developing climate change-resistant agriculture, ecosystems designed to maximize their bio-geo-chemical services, tools to quantify environmental impacts of contaminants, natural and anthropogenic as well as fundamental shifts in our understanding and management of health and pathogenesis in humans as well as organisms of agricultural and industrial importance.

Looking to 2025, we expect the world will have come to rely on biological engineering in every facet of living systems, as we have come to rely on information technology and electrical engineering today. At the heart of this (r)evolution will be the technologies and methodologies developed in our Department.

9.4 Strategies

As described in Chapter 1, in 2004 the department went through a process of redefining its mission, vision and its core values. It identified 15 domains pertaining to its scope of activity in agriculture, food, environment and energy as well as four competencies of automation, culture, environment and systems. It is likely that at least the department's mission, vision and core values will change very little between now and AD 2025. We are AD2010 the number one department in undergraduate as well as graduate education. Our department will continue to educate leaders that are capable of leading the development to deal with the challenges mentioned above. In addition the 15 domains overlap substantially with these global challenges, which suggests that the department's research, teaching and extension efforts are already aligned with addressing these challenges.

Collaboration with companies is challenging since companies and academia have very different strategies for success. However, there is a need to create working relationships with companies to provide a workforce for them in the future and in turn employers for our graduates. There is also a great need for collaboration among departments in the college of ACES and Engineering. We need to foster real collaboration between departments in ACES, and Engineering since true innovation takes places where departments overlap. We also need to educate our students to be able to work in multi-disciplinary and multi-cultural environments, and develop a reward system that recognizes the hurdles but also the payoffs of true multi-disciplinary work.

Factors that will influence the education of students as we approach 2025 will include advances in technology with particular reference to ubiquitous inter-communication and computing, practicing engineering in a global context, and applying engineering to the full spectrum of the biological domain from nano scale to ecological systems.

We have to be committed to solving real problems, and not revert to "Picking the low fruit", or following the road most easily traveled. President John F. Kennedy said it best in 1963: "We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard".

The changed US energy mix

Carroll E. Goering, Emeritus Professor, 2010

During the past 15 years since 2010, changes in a number of technologies have led to a substantial change in the US energy mix as shown in the table below.

	Percent of total energy	
Energy source	2010	2025
Petroleum	37	20
Coal	23	27
Natural gas	24	27
Nuclear	8.5	10
Biomass	3.9	10
Hydroelectric	2.5	3.0
Geothermal	0.35	0.4
Wind	0.55	2.0
Direct solar	0.09	0.6

Petroleum was the most critical energy resource in 2010. Petroleum production in the US was declining and over 60% of consumption was being imported, often from countries whose citizens used the petroleum monies in ways that were harmful to the US. While the US population was growing at just under 1% annually, per capita energy consumption was declining enough to hold total annual US energy consumption nearly constant over time.

In 2010, coal was plentiful in the US, but environmental concerns were causing a decline in the use of this fuel resource. The US also had good supplies of natural gas, although this fuel was not at plentiful as coal. Nuclear energy use had reached a plateau and no new nuclear energy plants had been built in several decades. The remaining sources constituted only 7.4% of the total energy sources in the US. The challenge in 2010 was to reduce petroleum imports by reducing the percentage of the total energy supplied by petroleum.

The main focus in reducing petroleum consumption was on transportation as, in 2010, it consumed over two thirds of the total petroleum use. Limited progress in battery development kept battery electric vehicles from extensive use. However, development of plug-in hybrid electric vehicles (PIHEVs) greatly increased the amount of travel possible from each liter of fuel. Moreover, research at the University of Illinois and other places led to production of cellulose-based liquid fuels to power PIHEV engines and led to a more than 250% increase in the portion of total energy supplied via biomass. As a result, the amount of petroleum used for transportation fell by over 40%. While use of electric energy use in vehicles increased, much of that increase was provided by increased use of nuclear power as more nuclear power plants again began coming on line. Also, development of clean coal technology allowed coal use to increase. Use of solar electric increased over 600% and wind energy increased more than 300% since 2010, but both began at such low levels that their contributions to the total were still small.

The US also increased domestic petroleum production through increased exploration and by conversion of coal and shale to petroleum-like fuels. Coupled with increased production, the decreased consumption of petroleum allowed the US to reduce total energy consumption and virtually eliminate petroleum imports. Great increases in petroleum consumption by India and China kept petroleum prices high, but the decreased US petroleum imports led to a large reduction in the US balance of payments deficit and more than offset the cost of the research and development that made the reduced petroleum consumption possible.

A Glance Ahead

Roscoe Pershing, Emeritus Professor (2010)

Technology will continue to develop at an accelerated pace. Many changes will occur that will frighten some and provide opportunities for others. Engineers must seize these opportunities and use them to make the world a better place. Early adopters will benefit most. Electronics and computers will continue to improve and agricultural and biological engineers will utilize these developments to improve all aspects of agricultural and biological processes, equipment and products. Probably, biological breakthroughs will be the most significant in the future since that branch of highly-complex science has been a little slower to develop – thought by some to be the last frontier in science!

Society will change, too. The supply of safe food, clean water, and a sustainable environment will present even greater challenges ahead. The role for ABE will be greater than ever and we must embrace it and respond to it. More remote sensing and automation will be required. Vehicle guidance may lead to remote or fully automated control. Biological sensing and biological design will lead to new fields of endeavor for agricultural and biological engineers. With the growing population, the challenge to feed the world safely with sustainable resources will present a major challenge.

I predict that by 2025, we will be doing more with hand-held electronic devices. Cell phone, computer, and camera, will combine with TV, and sensors and automation control of many processes – all within the same hand-held device. Video conferencing among several persons will be done by cell-phone technology. Cell phones will switch from towers to satellite transmission for better, uninterrupted service and provide reliable service to remote, rural areas. This will interface with or also contain GPS signals and equipment control that can be monitored or set from hand-held devices even when far away from the actual operation being controlled. These individualized hand-held devices will enable us to communicate, control and manage more activities and operations remotely with greater skill and timeliness – giving us the greatest productivity and efficiency we have ever known. At the same time, the nature of social communication, as we know it today, will certainly become a new and major challenge – from face-to-face group discussion to hand-held electronic device video conferencing.

Our charge will be to apply the new and relevant technology to agricultural and engineering-related enterprises to continue to improve the useful technology and lifestyle of the world and its inhabitants!

The good news is that the ABE Department is well-positioned to take a strong leadership role in all of these developments.

Best wishes for continued leadership in 2025!

An article from the San Francisco Chronicle, Sunday August 31st, 2025

Andrew Gentile, undergraduate student in 2010

California just doesn't seem like the Golden State any more. Along with the financial troubles that have plagued Sacramento since the start of the new millennium, Californians have experienced some of the hottest temperatures on record this summer. With less than average rain totals last season, the Central Valley's citrus and nut crops are suffering. Furthermore, farmers and cities alike have been struggling with the federal government to secure more money to protect the state's resources after terrorism struck the Central Valley two years ago. A glimmer of hope arrived yesterday as the government finally approved a plan of action and I certainly believe a brighter future is ahead for the United States as California serves as a model in deploying new security measures and utilizing revolutionary technology to secure its livelihood of agriculture that the rest of the country depends on.

As an undergraduate at the University of Illinois at Urbana-Champaign, I came home to Gilroy for summer break and I used to enjoy the five-hour drive south down Interstate 5 through the Central Valley with my family to visit my brother at the University of Southern California in Los Angeles. En route, I convinced my parents to pull off to the side of the road to gaze at a stretch of the 444-mile-long manmade river that supplied water to some 25 million California residents and countless acres of thirsty crops. People like me could park their cars next to the aqueduct and marvel at this impressive feat of civil engineering. However, these days are gone as of June, 2023. California tightened security along the aqueduct when terrorists, all working for biotechnology companies in San Francisco, dumped a wide variety of biological agents into the aqueduct including Cryptosporidium, a protozoan parasite that caused diarrhea in thousands of Californians and was responsible for countless deaths.

The water filtration facilities already in place destroyed many of the agents present in the terrorists' toxic cocktail. On the other hand, the water from the aqueduct was not decontaminated prior to the irrigation of crops, which led to the pathogens taking residence in the fields surrounding the aqueduct. The leachate from the contaminated soils found a way to enter the drinking water of millions of people. In order to set California on the right track, scientists are faced with two challenges: How to prevent biological agents from entering fresh water supplies again, and how to clean up the mess in the fertile soils of California.

Research from the UIUC on the movement of Cryptosporidium has helped to create computer models that can track how the organisms travel through the soil, allowing for scientists to determine precise locations of contamination so that clean up efforts are concentrated in the proper areas. Information from the United States Geological Survey and the Natural Resources Conservation Service has aided us in our models of soil erosion. These visuals are giving cleanup crews invaluable information. The federal government has also stepped up to the plate by giving grants to private biodefense contractors, thus creating thousands of jobs to design and construct new security measures to detect and track movements of particles and toxins in water supplies throughout the nation.

My hope is that advances in biodefense will wipe the tarnish off the Golden State by stimulating the state's economy, protecting our precious water resources, and increasing the productivity of agriculture not only in California but also throughout the United States.

Andrew Gentile is a bioterrorism specialist at Lawrence Livermore National Laboratory in Livermore, CA. He is a graduate of the University of Illinois at Urbana-Champaign and is a Bay Area resident.

A Glance Forward: Autonomous Vehicles to Poke-less doctor visits

Kimberly Heinecke, undergraduate studet

In 2010, you have to get in your car, drive it to the doctor, and get blood drawn. By 2025, things have changed drastically. You no longer have to drive yourself to the doctor or be stuck by a needle. In 2025, autonomous vehicles and poke-less doctor visits will exist.

Through Agricultural and Biological Engineering, both of these painless and safer ideas will come true. Autonomous electric vehicles, supported through GPS and smart road technology, where vehicles are able to talk to each other as well as monitors in the road, will provide a safer alternative to human driving. Autonomous vehicles will only require the owner's fingerprint to turn on and voice command to give instruction where to go. The vehicles will automatically take care of parking, safe entry and exiting of the passengers, and powering up. There will be known hot spots of wireless charging which the car will recognize; owner's will no longer need to worry about fueling up.

When the patient arrives at the doctor's office in 2025, he or she will no longer need to be poked with a needle in order to get a full patient work up. Through breath and urine analysis as well as a walk through scanner, the patient will be able to see the status of his or her health. Agricultural and Biological Engineers will make this technology possible through identifying certain proteins and enzymes relate to each disease. Needles are only needed when starting an IV, this single use of needles will provide a lessened chance of infection.

Understanding animal behavior

Patricia Paulausky, ABE undergraduate student in 2010

It may be difficult to imagine that a mere 15 years ago Engineers in the field of Animal Housing and Environmental Control were not so fortunate as to have some of the great technological luxuries that we today take for granted. Try to take yourself back to a time when motivational and preference testing were two seemingly simple concepts that could make an engineer cringe – a time when behavioral analysis within these studies was not as effortless as connecting to your computer. In fact, it would have involved a comprehensive review of footage by hand which could take days or weeks – if you were lucky. Today, much time, unnecessary professional collaborations, human error, and not to mention strife, has been eliminated from animal housing and environmental control studies. With the use of computer aided animal behavioral analysis software, engineers have at their disposal a tool which can be used to accurately assess the presence of behaviors indicative of stress or contentment in animal test subjects within a timely fashion. This software is guided by patterns of motions and sounds exhibited by the test subject.

It has been with the assistance of this software that Engineers have been able to expand the knowledge of agricultural animal preferences. Being able to accurately measure these preferences consistently across a variety of studies has been especially crucial in justifying agricultural animal housing, as well as optimal environmental and transportation conditions. It may seem strange now that just 15 years ago the field of animal production was battling the moral dilemma of caged vs. cage-free. This software has made it possible to expedite the data analysis of many of the preference and motivational testing that led to the scientific conclusions of this dilemma – as a result these studies have become more frequent and more accessible. In the case of housing, and similar matters, such as environmental preferences, the software has helped to revolutionize the way the animal agriculture industry makes decisions concerning the well being of their investment. Due to the industry's access to this advancement in knowledge of animal preferences, agricultural animals today are considered to be healthier, and more nutritious animal products are in greater abundance than just a few decades ago. In addition, the software has streamlined the way we observe animal behavior from speculation to scientific conclusion. Streamlining has helped to raise the standards of agricultural animal husbandry because now the field of animal welfare has a more substantial backbone of scientific behavioral data to stand on. Kudos to engineers of the past for paving our way into future discovery..