

2006 SUMMARY OF ENGINEERING RESEARCH

A Report of Activities during 2005

This report is part of the larger *2006 Summary of Engineering Research*, available on the Web at www.engr.uiuc.edu/research and on CD-ROM. The *Summary of Engineering Research* represents the extensive engineering research program conducted in 2005 at the University of Illinois at Urbana-Champaign. Detailed statistics about research in the College of Engineering are included in the *Directory of Engineering and Engineering Technology Programs and Research*, published by the American Society for Engineering Education, Washington, D.C.

How to use the *Summary of Engineering Research*: Research projects are listed by title, followed by the names of the investigators and the sponsoring agencies. Projects are sorted by major topic areas. Project descriptions are brief. Additional information on each project may be obtained from the investigator in charge (denoted by an asterisk). Mailing addresses are provided on the introductory page.

How to obtain publications: Please consult academic and public libraries for the journal articles, papers, and books listed in this report. Information about technical reports is available from the Engineering Documents Center, Grainger Engineering Library Information Center, 1301 West Springfield Avenue, Urbana, IL 61801, USA. To search the center's collection on the Internet, please visit the website at search.grainger.uiuc.edu/top. Copies of theses can be found at the University of Illinois Library, www.library.uiuc.edu, or may be purchased from University Microfilms, 300 Zeeb Road, Ann Arbor, MI 48106, USA, www.umi.com.

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Abbreviation key for College of Engineering departments and major labs:

- Advanced Transportation Research and Engineering Laboratory (ATREL)
- Aerospace Engineering (Aerosp. Engr.)
- Agricultural and Biological Engineering (Ag. & Biol. Engr.)
- Bioengineering (Bioenr.)
- Chemical and Biomolecular Engineering (Chem. & Biomol. Engr.)
- Civil and Environmental Engineering (Civil & Environ. Engr.)
- Computer Science (Comput. Sci.)
- Coordinated Science Laboratory (CSL)
- Electrical and Computer Engineering (Elect. & Comput. Engr.)
- Frederick Seitz Materials Research Laboratory (FS-MRL)
- General Engineering (Gen. Engr.) or Industrial & Enterprise Systems Engineering (Indus. & Enter. Syst. Engr.)*
- Materials Science and Engineering (Mat. Sci. & Engr.)
- Mechanical and Industrial Engineering (Mech. & Indus. Engr.) or Mechanical Science and Engineering (Mech. Sci. & Engr.)*
- Micro and Nanotechnology Laboratory (MNTL)
- Nuclear, Plasma, and Radiological Engineering (Nucl., Plasma, & Radiol. Engr.)
- Physics
- Theoretical and Applied Mechanics (Theoret. & Appl. Mech.)*

*In August 2006, the Industrial Engineering program was merged with the General Engineering Department, which became the Industrial and Enterprise Systems Engineering Department. The Theoretical and Applied Mechanics Department merged with the Mechanical and Industrial Engineering Department, which became the Mechanical Science and Engineering Department. Please check department links at www.engr.uiuc.edu for current faculty lists.



Agricultural and Biological Engineering

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Principles from many scientific and engineering disciplines are applied to address opportunities and problems of agricultural and biological productions, processing, and utilization. Life and engineering sciences are developed, applied, and integrated for analyzing and designing bio-based systems (the concept of “integrating life and engineering,” i.e., using life sciences as resources for engineering work and vice versa). The overarching goal of agricultural and biological engineering work is to “enhance complex living systems” involving human, plants, animals, and microorganisms.

The department is organized into four sections: Bioenvironmental Engineering, Food and Bioprocess Engineering, Off-Road Equipment Engineering, and Soil and Water Resources Engineering. A fifth section of Biological Engineering is being formed. The research program areas of the department include Bio-Based Processing and Production Systems; Biomass and Renewable Energy; Precision and Information Agriculture; Agricultural and Biosystems Management; Agricultural Safety and Health; Food Quality and Safety; Environmental Stewardship; Land and Water Resources; Spatially Distributed Systems; Structure and Facilities for Living Systems; Indoor Environmental Control; Bio-sensors, Bio-instrumentation, Bio-informatics, and Bio-nanotechnology; Intelligent Machinery Systems; Automation of Biological Systems; and Advanced Life Support Systems.

More cooperation with industries that purchase, transport, process, and package agricultural commodities has broadened the scope of agricultural and biological engineering research, especially in the development of intelligent monitoring sensors and process control systems. Research aimed at improving performance and reducing cost at all levels of production with minimal environmental impact is receiving considerable attention in an attempt to keep the U.S. food and agricultural system competitive in the world market. Additionally, new processes, new

products, new uses, and new markets are being sought for using abundant agricultural commodities in achieving sustainable energy utilization and environmental quality.

Geographically located in an area of intense agricultural production, with access to good transportation facilities and surrounded by a large concentration of agricultural and industrial equipment manufacturers and food processors, the department is in an enviable position to serve all areas of the agricultural community. Many agricultural engineering graduates who have been educated and trained in the modern teaching facilities and research laboratories of the University of Illinois Agricultural Engineering Sciences Building are employed throughout the nation. Interaction and cooperation with these graduates and other alumni scattered throughout the world help maintain a viable, useful research program.

Faculty and Their Interests

Robert A. Aherin

Agricultural safety and health, safety behavior analysis, confined space safety, using sensors in safety systems

Kaustubh D. Bhalerao

Biological nanotechnology, probabilistic methods, bioinformatics for nanodevice design

Loren E. Bode

Spray atomization, transport, and deposition; spray nozzle design, spray drift reduction

Philip Buriak

Technical systems management, learning theory, implications to college teaching

Leslie L. Christianson

New product development; engineering design; agricultural buildings; heating, ventilation, and air-conditioning; air quality; swine facilities

Richard A. Cooke

Subsurface drainage, vadose zone water and contaminant transport, modeling of watershed-scale drainage systems

Steven R. Eckhoff

Corn fractionation, wet milling, dry milling, ethanol production, hybrid specific processing

Bruce Elliott-Litchfield

Food engineering

Ted L. Funk

Livestock confinement structures, indoor climate control systems for livestock, manure management systems, residential housing structures, indoor air quality

Tony E. Grift

Sensors and controls in biosystems automation, machine vision systems, agricultural data acquisition systems, mathematical modeling and control, granular mass flow measurement

Alan C. Hansen

Biofuels for diesel engines, simulation modeling of material handling systems, off-road machinery systems, precision agriculture

Joe G. Harper

Technical systems management

Michael C. Hirschi

Water quality, erosion and sediment control

Prasanta K. Kalita

Hydrology, watershed-water quality modeling, pathogen transport, erosion and sediment control

Marvin R. Paulsen

Food and bioprocess applications, grain quality measurements, near-infrared and FT-NIR spectroscopy

Kent D. Rausch

Recovery of nutrients from bioprocesses, corn quality effect on co-product value, variability of co-product quality, co-product quality for human and animal consumption

Luis F. Rodriguez

Modeling and analysis of biological systems, reliability and sustainability, decision support, life support systems, integrated controls

Vijay Singh

Engineering economic analysis and modeling of bioprocesses, design of processes for corn fractionation, recovery and concentration of nutraceuticals and biobased products

Lei Tian

Sensors and information systems for precision agriculture, applied machine vision, remote sensing, variable-rate technology

K. C. Ting

Automation, systems analysis, alternative energy and thermal control; computerized simulation, optimization, and decision support for bioproduction and bioprocessing systems

Xinlei Wang

Air quality, diesel engine emission control, renewable energy, building environment control, system modeling

Qin Zhang

Off-road vehicle mechatronics, machinery systems for bioproduction, electrohydraulic systems control, computer-integrated agricultural systems, sensors and instrumentation

Yuanhui Zhang

Indoor air quality; effect of indoor air quality on occupants; sensor technology for bioenvironmental systems; heating, ventilation, and air-conditioning control; waste treatment

Agricultural Infotronic Systems

Research on Agricultural Infotronic Systems

Q. Zhang*

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U.S. Department of Agriculture Hatch Funds

This research is to establish infotonics technology for production agriculture. This technology is to provide farmers “actionable” information for performing precision farming operations, such as “where and how much nitrogen to apply” while operating a sprayer in the field. Specific objectives include the design of a general framework of an agricultural infotronic system that will consist of data collection, operation planning, and automatic implementation modules; the development of core information processing algorithms, including information classification, fusion, and attributes tracking algorithms for handling production information; and the validation of the developed agricultural infotronic systems in precision farming operations.

* Denotes principal investigator.

Agricultural Safety

Confined Space Entry Training for Agricultural Environments

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University of Iowa Great Plains Center for Agricultural Health; University School of Public Health; Carle Center for Rural Health and Farm Safety

This project will revise a confined space training one-day short course that was developed by the University of Illinois approximately ten years ago. The program will be evaluated for knowledge transfer, format acceptability and safe practice improvement. The course will be offered in the states of Illinois, Iowa, Missouri, and Nebraska. The primary audience will be agricultural businesses that service silos, grain storage structures, and livestock waste handling facilities.

Disabled Farmers Project

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University of Illinois; U.S. Department of Agriculture

The primary objective of this project is to develop a model program that will provide comprehensive assistance to Illinois farmers with physical disabilities. This includes conducting research to identify the level of need for assistance among farmers in the state and the impact of services provided.

Farm Safety Mobile Program for Rural Youth

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The project involves the development and evaluation of interactive agricultural safety and health training modules that are transported to rural communities in a converted mini bus. Community instructors will be trained in the second year of the project. The goal is to reach rural area youth who are not readily exposed to farm safety training. One targeted group is Amish youth. Approximately 12 training modules were developed for pilot testing. Project team members consulted with the Amish safety committee in Douglas and Moultrie counties in the development of the Amish portion of the project. Amish instructors were trained to deliver programs to Amish youth.

Occupational Exposures and Health Outcomes in Swine Confinement Facilities

L. Conroy,* R. A. Aherin, T. Schoonover, P. Scheff, S. Dorevitch, S. Erdal, D. Tessier, J. Franke, L. Forst, R. Cohen, L. Berman, D. Vinson, T. L. Funk, Y. Zhang
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The study evaluated worker's exposure to airborne contaminants, such as dust, bacteria, and ammonia, in a swine confinement facility. Measurements were taken that evaluated exposures by looking at symptoms and biological markers of inflammation before and after work. Each worker and control group participants completed a health history questionnaire. Each participant provided blood samples, exhaled air samples, and performed a lung function test. Tests were conducted before and after work for two consecutive workdays in the winter. Participants wore air-sampling devices that measured for dust, bacteria, and ammonia during their work shift. Data analysis is being completed.

Assistant Director for Agricultural Continuing Education

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Great Lakes Centers for Occupational and Environmental Safety and Health; University of Illinois–Chicago

This project is to assist in the assessment, planning, and implementation of agriculturally related health and safety programs and training that meet the Great Lakes Centers goals of providing graduate and professional education in occupational safety and health and continuing education.

Alternative Fuels

Impact of Biofuels on Emissions Reducing Technologies for Off-Road Diesel Engines

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U.S. Department of Agriculture Hatch Funds

Emissions reducing strategies and technologies are at the forefront of research and development efforts of all major diesel engine manufacturers in order to meet future Environmental Protection Agency regulations. Very little work has been done to investigate the use of these technologies in conjunction with biofuels such as biodiesel and E-diesel (ethanol-diesel blended) fuels. The purpose of this study is to evaluate the impact of biofuels on both present and emerging emissions reducing technologies for

* Denotes principal investigator.

diesel engines. Preliminary results with the exhaust gas recirculation NO_x emissions reducing strategy show that a greater rate of emissions reduction occurs with biodiesel fuel.

Impact of Soybean Oil Methyl Ester Composition on NO_x Generation from Combustion

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Campus Research Board

Biodiesel fuel is seen as a promising alternative to petroleum-derived diesel fuel. One negative aspect of biodiesel combustion is an increase in regulated NO_x emissions. The objective of this project is to investigate the effect of soybean oil methyl ester composition on NO_x formation from combustion with the aid of experiments and a three-dimensional computational fluid dynamics program. Special emphasis is being placed on the accurate representation of fuel properties. Preliminary results suggest that relatively small changes in fatty acid composition can reduce NO_x emissions to be the same or less than those obtained with standard diesel fuel.

Graduate Automotive Technology Education (GATE) Center of Excellence: Advanced Automotive Bio-Fuel Combustion Engines

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U.S. Department of Energy

Increasingly stringent emissions regulations and concerns about U.S. dependence on foreign oil have generated an urgency to seek new technologies and fuels for automotive engines. The objective of this Center of Excellence is to create an education and research program that provides automotive engineers with knowledge and skills to be able to develop advanced engines for the future that can run on renewable biofuels such as ethanol and biodiesel. The curriculum will be based on courses drawn from both the mechanical engineering and agricultural and biological engineering disciplines with research projects relying on interdisciplinary expertise and facilities.

Investigation of Biodiesel Fueled Engines under Low Temperature Combustion Strategies

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U.S. Department of Energy

There is considerable interest in reducing U.S. reliance on imported petroleum. Biodiesel manufactured from vegetable oil is seen as a viable alternative to regular diesel. The objective of this research is to investigate a novel low-

temperature combustion (LTC) strategy with biodiesel that is able to simultaneously reduce regulated NO_x and particulate emissions while achieving high combustion efficiency. LTC combustion with biodiesel will be investigated via laser diagnostic and multidimensional modeling techniques. Experiments will be conducted in both optical and metal engines. Optimum strategies for reducing exhaust emissions and increasing the efficiency of biodiesel LTC engines will also be investigated.

Bioenvironmental Engineering

Bioenvironmental Engineering Research Laboratory

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S. M. Larson, R. I. Mackie, M. T. McCulley,

T. A. Newell, M. J. Rood, W. B. Rose, M. A. Smith,

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National Science Foundation; U.S. Environmental Protection Agency; American Society of Heating, Refrigerating and Air-Conditioning Engineers; Center for Indoor Air Quality Research; U.S. Department of Agriculture; U.S. Department of Energy; University of Illinois

In cooperation with the departments of Animal Sciences, Natural Resources and Environmental Sciences, Civil and Environmental Engineering, Mechanical and Industrial Engineering, Nuclear, Plasma and Radiological Engineering, and Theoretical and Applied Mechanics; College of Veterinary Medicine; and the Small Homes Council/Building Research Council

An interdisciplinary research laboratory was established involving faculty from engineering and biological sciences. The purposes are to characterize and assess the microenvironment and its effects on organisms and biological products. Focus areas include animal and plant interactions with their microenvironments, sensors and instrumentation, indoor air quality, air and air contaminant movement, environmental conditioning equipment, and building materials.

Design and Planning for a Pilot Scale TCC System

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World-Wide Bio-Energy L.L.C.

An industry partner has licensed rights to the laboratory-scale thermo-chemical conversion research being conducted at the university. The industry partner provides financial support, is advising on research directions and

* Denotes principal investigator.

approaches, and is working cooperatively with the university research team to design a farm-scale prototype system. The farm-scale system will be used to optimize the process and to evaluate the economic, energetic, and environmental benefits that can be achieved.

Development of a New Low-Reynolds-Number Turbulence Model for Indoor Air Flows

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Information on air motion in a ventilated room is very important for study of contaminant transport and indoor air quality. During the past several decades, computational fluid dynamics (CFD) based on turbulence modeling has become a very powerful tool in the prediction of indoor airflows. However, their applications are limited due to low Reynolds number effects that are very common in full-scale indoor airflows. In this project, low-Reynolds effects are combined into RANS turbulence models by introducing the intermittency factor that reflects the ratio of turbulence and nonturbulence. The model will predict the transitional flow behaviors.

Engine Emission Control and Aftertreatment On-Board Diagnosis

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In order to meet the EPA emission regulations, some control devices, such as an oxygen catalytic converter, diesel particulate filter, and lean NOx trap (LNT), will be required. However, such “add-on” devices can experience deterioration and malfunction that can go unnoticed by both the driver and repair technician. Those types of malfunctions could result in high emissions without a corresponding adverse drivability or fuel economy impact. This problem could be avoided by incorporating a well-designed OBD-II system to detect emission system malfunctions. In this project, we are investigating various diagnostic methods to develop an aftertreatment OBD-II system for 2010 applications.

Hydrogen Production from Manure

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The application of fuel cell is limited by the availability of hydrogen. At present the main hydrogen production

technologies are either chemical conversion of fossil fuels or electrolysis of water. They are not renewable with fossil fuels or expensive when the process requires massive amounts of electricity. Hydrogen production via biological means is environmentally friendly, and renewable. The preliminary objective of this project is to evaluate raw materials for hydrogen production by anaerobic fermentation, to select bacteria species, and to optimize process conditions. We also investigate the feasibility of hydrogen production from animal manure by using mediator-less microbial fuel cells.

Modeling of Dust Spatial Distribution in Indoor Environment

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One of the challenges in indoor air quality research is to study the dust spatial distribution so that the nature of dust transport can be better understood and appropriate control strategies can be implemented. Numerical modeling will enhance the understanding of the mechanisms of dust transport and provide useful information to control dust sources, improve the design of ventilation systems, and implement the mitigation technologies. A mathematical model was developed based on mass-balance of particulate matter. The numerical simulation indicated that the dust spatial distribution was highly related with the airflow pattern, dust source strength, and gravitational sedimentation of particles.

Quantification of Ventilation Effectiveness for Air Quality Control

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The existing methods or procedures used to determine ventilation effectiveness are primarily for researchers to use, usually require sophisticated instrumentation, and are labor intensive. There is a lack of practical and economical methods for field engineers and researchers to quickly determine the ventilation effectiveness for zones of concern. The focus of this project is to analyze the existing ventilation effectiveness measurement techniques or procedures for production animal facilities and then to develop a practical method of measuring the ventilation effectiveness in animal facilities.

* Denotes principal investigator.

Aerial Pollutant Emissions from Animal Confinement Buildings

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Adverse impacts of target air pollutants including odor, particulate matter, ammonia, hydrogen, carbon dioxide, methane, and nitrous oxide emitted from animal production facilities have created significant public concerns. A mobile laboratory on an 8 x 14 trailer has been developed with the capacity to measure the following real-time variables: PM10, ammonia, hydrogen sulfide, carbon dioxide, methane, ventilation rate, and other environmental variables including temperature, humidity, radiation, and wind speed. Other variables measured include odor and total suspended particles. The mobile lab has been set up on a commercial swine farm in Illinois.

Air Cleaning Technologies for Off-Road Machinery Cooling Systems

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Deere & Company

During a previous project contracted between Deere & Company and the University of Illinois, conceptual design and three prototypes (JD-1, JD-2, JD-3) of an aerodynamic deduster were developed. During the field tests of the JD-3 deduster prototype, several improvement areas were identified such as prescreening of large leaves and aspiration efficiency to remove collected dust. It is critical to have a clearer understanding of the physical properties, mechanical behavior and testing procedures to evaluate the performance of the air cleaning/cooling system. The objective of this project is to characterize the physical properties and plugging mechanisms of different types of debris.

Continuous Thermochemical Conversion (TCC) of Livestock Manure to Produce Oil

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The Grainger Foundation Inc.; Worldwide Water Solutions

A continuous TCC process is more advantageous than a batch process for the following reasons: heat generated from the process can be recycled more efficiently; reactor volume can be reduced for the same capacity; and automated controls can be adapted more readily, thus reducing labor and operating costs. Successful

commercialization will require further cooperative research and development efforts involving industry partners and university researchers. We envision a single unit CTCC system being able to process manure of a 2,000 hog farm or an equivalent amount, and the unit should be no larger than a hot-water boiler in a residential house.

Experimental Characterization of Airflows in Aircraft Cabins

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Centers for Disease Control and Prevention; The Boeing Company

Nonintrusive, full-scale, quantitative and instantaneous measurement techniques for airflow in aircraft cabins (versus single-point measurements) are needed, especially for developing CFD models. For this project, a full-scale Boeing 767 aircraft cabin section, including 35 mannequins, has been developed. A 17.5 kw chiller cools the fuselage internal surface to simulate actual high-altitude flight situations. A 3-D stereoscopic particle imaging velocimetry (SPIV) technology has been developed to measure the cabin airflow under iso- and nonisothermal conditions, and various obstruction conditions.

Hydrothermal Process for Fiber Stream

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The long-term goal of this subproject is to develop and pilot test the continuous thermal hydrolysis process and operating parameters to convert the fiber stream from corn milling, and miscanthus into value-added products, or products that can be easily further processed (such as fermentation or thermochemical conversion). The short-term goal is to define key parameters for the fiber feeding system and the reactor for pilot plant development. A bath reactor and a laboratory scale continuous reactor have been developed for the study.

Microvolumetric Particle Tracking Velocimetry to Study Stenosis Flow in Arteries

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U.S. Department of Agriculture

The long term goal of the investigators is to develop technologies to measure and predict flow velocity profiles in a flow field such as a human artery. In this study, the

* Denotes principal investigator.

objectives are to develop a 3-dimensional microvolumetric particle tracking velocimetry (MVPTV) system for measurement of fluid flow in a simulated artery system. An MVPTV experimental set-up including image acquisition, laser illumination particle seeding, and flow generation systems has been developed.

Size Distribution and Its Effect on Sampling Performance of Particulate Matter in Concentrated Animal Feeding Operations

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U.S. Department of Agriculture National Research Initiative

Fundamental data regarding particulate matter (PM) such as particle size distributions do not exist or are not representative of confined animal feeding operations for estimating emissions. PM generated in agricultural operations typically has a much larger particle size than urban sources of PM. Such large particle sizes and variations have significant impacts on the existing particle measurement and regulatory guidelines. To address this issue, this project aims at answering two fundamental questions: What are the particle size distributions in typical agricultural operations? How does particle size distribution affect the existing particle sampling methods and regulations of agricultural operations?

Thermochemical Conversion (TCC) of Swine Manure to Produce Fuel and Reduce Odor

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Thermochemical conversion (TCC) is a chemical reforming reaction of organic compounds in a heated enclosure. Swine manure with 5% to 20% solid matter was processed in a scale batch TCC reactor, which converted 70% of volatile solids into a crude oil. Based on the batch reactor results, a continuous thermochemical conversion (CTCC) reactor that has a capacity of processing 50 liters of slurry and producing 5 liters of crude oil per day has been developed.

Ventilation Equipment Testing Program in BESS Laboratory

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Ventilation Equipment Industry

More than 95% of agricultural ventilation fan manufacturers and many other ventilation equipment companies test their products at the University of Illinois Bioenvironmental Structure and Systems (BESS) Laboratory. The lab publishes all fan data annually and conducts industry research related to ventilation, airflow characterization, and equipment development. This long-standing program is managed through the Bioenvironmental Engineering Division and conducted within the BESS Laboratory. The program has resulted in a 25% increase in fan efficiency across the United States in the past decade. The program is self-supporting.

Biological Nanotechnology

Fabrication and Characterization of Corn Protein Based Films

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Corn zein, a protein coproduct of the ethanol industry can be fabricated into sturdy films. The structural properties of these films depend upon the orientation of the zein molecule. We are developing methods to analyze and control the nanoscale architecture of the zein films in order to study the feasibility of using zein films in diverse applications, such as flexible electronics, food packaging, and drug delivery.

Decision Support

Concurrent Science and Engineering for Life Support

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A working group is established within NASA to study redundancy, reliability and contingency issues related to advanced life support (ALS) for exploration mission. The objectives are to consider NASA's current approach to reliable design; to consider life support system specific

* Denotes principal investigator.

failure modes; to consider reliability improvement; to make recommendations for how and when to bring the issues of redundancy, reliability, and contingency into systems analysis; to identify specific impacts these issues may have on ALS technology and model development; and to suggest new analysis or testing activities to address these issues.

Food and Bioprocess Engineering

Recovery of Coproducts

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Archer, Daniels, Midland Company; U.S. Department of Agriculture

Tempering in corn dry milling is a mechanical process, relying on the differential rates of water absorption by the various corn components to create a shearing effect at the boundaries of the components. However, the separation is not clean enough for use as a preprocess for dry grind ethanol. This study explores the use of adjunct chemicals in steeping and the use of puffing to recover the germ and pericarp fiber with less attached endosperm material.

Evaluation of Ethanol Production Technologies

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The fuel ethanol industry is rapidly growing and becoming more competitive. As a result, more value needs to be extracted from coproducts made with ethanol. This collaborative project seeks to understand the role of raw material (corn) in optimally producing ethanol and other bioproducts and to identify process methods that generate multiple coproducts with increased value. A small-scale (25g) dry grind procedure is being developed and evaluated to serve as a reference for the fuel ethanol and corn genetics industries. As new sources of genetic material are developed, the procedure will determine ethanol yields accurately.

Process Development to Recover Nutrients from Agricultural Solids

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Bioprocessing of agricultural materials typically uses an intensive amount of water. As a result, bioprocess streams carry nutrients in dilute quantities, causing difficult recovery and low or negative economic value of recovered solids. Conventional drying methods are inherently energy-intensive because of evaporation of water and other solvents. This project investigates emerging technologies or technologies from other industries for use in bioprocesses that dewater, dry, or convert solids into higher valued products. Currently, work has applied membrane filtration technology to corn processes to conserve water and recover nutrients.

Controlling Microorganism Growth in Enzymatic Corn Wet Milling Process

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Corn Refiners Association

Use of sulfites in the conventional corn wet milling process presents health and environmental concerns. An enzymatic corn wet milling process is being developed to reduce use of sulfites in the process. One of the roles of sulfites is to control microbial contamination in the conventional corn wet milling process. Replacement of sulfites by enzymes could result in microbial contaminations. This study evaluates strategies to control microbial growth in the enzymatic corn wet milling process.

Effect of Hybrid Variability and Planting Location on Ethanol Yields

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Syngenta Seeds, Inc.

This study investigates the effect of hybrid variability and planting location on the ethanol yield. Approximately 100 different dent corn hybrids grown at multiple locations in the Midwestern United States will be processed using a laboratory dry grind procedure to determine ethanol yield. Influence of the growing location and hybrid on ethanol yields will be observed. Selected hybrids also will be laboratory wet milled to determine starch yield and the correlation between the starch extractability and ethanol yield.

* Denotes principal investigator.

Effect of Milling Parameters on Fiber and its Removal from the DDGS Dry Grind Ethanol Plant

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This project investigates removal of fiber from distillers dried grains with solubles (DDGS), a coproduct produced in dry grind corn processing. There is a need to reduce the volume of DDGS and diversify its uses. Removal of fiber from DDGS has three potential benefits: another coproduct is added to the process, and it can be used for recovery of high-valued nutraceutical compounds or other industrial products; protein and fat content increases in the resulting DDGS; and fiber content is reduced in the DDGS. The latter two effects may allow use of DDGS in nonruminant animal diets.

Modified Milling Technologies for Dry-Grind Ethanol

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The objective of this research is to develop new or modify existing corn milling technologies that allow value-added processing and lower the capital and operating costs of ethanol production facilities. The project involves recovering multiple coproducts and improving the efficiency of dry-grind corn processing. Economic assessment of process improvements will be done by process simulation and economic modeling.

Use of Enzymes to Reduce Steep Time, Reduce SO₂ Emissions and Improve Product Yield in the Corn Wet Milling Process

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An enzymatic corn wet milling process is being developed to reduce or eliminate sulfur dioxide (SO₂) requirements during steeping, reduce steep time and produce starch yields comparable to conventional processes. Benefits of the process are that it reduces use of sulfur dioxide in the wet milling process. This change would have an effect on reducing environmental and health risks associated with use of SO₂. Enzymatic milling reduces process time by 70% while maintaining product yields and quality. We are working with corn wet milling processors to evaluate this process at commercial scale.

Use of Transgenic Corn for Processing Facilities

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A transgenic corn that produces high levels of endogenous amylase is being evaluated for dry grind corn processing. The enzyme is activated in the presence of water and high temperature. In a conventional process, exogenous alpha amylase enzymes are added during liquefaction to break down starch into dextrans. In this study, liquefaction and fermentation properties of transgenic corn are being tested using a small-scale laboratory dry grind procedure and compared to the fermentation properties of a control sample of isogenic corn.

Grain Qualities and Properties

Near-Infrared Spectroscopy for Ethanol Processes

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The objective of this research was to determine suitable Near-Infrared (NIR) wavelength regions to identify ethanol and total soluble sugars in the fermentation broth for a corn dry grind process. The wavenumber region between 12,000 to 6,400 cm⁻¹ had low correlation coefficients for a 0.5-mm pathlength transmittance accessory. High correlation coefficients for ethanol were found in the region between 4,712 to 4,200 cm⁻¹, and for total sugars between 5,000 to 4,286 cm⁻¹. High RPD (ratio of laboratory standard deviation to the RMSEP) and low RMSEP values for both ethanol and total soluble sugars were found.

Life Support Systems Reliability and Sustainability

Design Architectures for Life Support

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When considering long-term missions to Mars, the design paradigm for life support systems may need to be adjusted from that of existing systems, such as those for the Space Shuttle and the International Space Station. The primary differences would include increasing amounts of resource recycling. This study focuses on the relative merits of

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design architectures with respect to design, contingency, maintenance, and operations. Having a fundamental understanding of the effect of various design, contingency, maintenance, and operations decisions will assist NASA in determining the most advantageous technology development strategies going forward toward Lunar and Martian missions.

Early Life Testing for Costly Life Support Systems

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Conducting life testing and addressing reliability of life support systems are frequently challenging due to extremely high cost of test items, the scarcity of test items, or the risk of endangering test subjects. When considering implementation of life testing, it is critical to control costs and risks. Furthermore, it is possible that the subsequent analysis of test data may not yield worthwhile results unless careful experimental designs and controls are utilized. To address this need, a new statistical model for use with the design of experiments is under development that is suited to the life testing of high-cost, high-risk hardware and systems.

Integrated Modeling of Life Support Systems Modeling for Reliability and Robustness

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Robustness is often reduced to hardware reliability. However, the operation of a system has a great deal of impact on its robustness. Robust operation will be a combination of manual operations supported by software and automated operations supported by people. We will look at increasing the robustness of life support systems by applying the appropriate mix of people and software; model-based techniques for diagnosis, prognosis and control; and procedural techniques for support manual operations. Integrated models will be developed to analyze a wide array of design architectures for the consideration of their inherent reliability and robustness.

Modeling and Analysis of Biological Systems

Bottom-Up Models of the Photosystem at the Molecular Level

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The modeling and understanding of biosystems at all levels has been initiated with the development of pathway models of the photosystem. The intention is to integrate such bottom up models with existing models of leaf and canopy level photosynthesis. The integrated multiscale model should improve the ability to model and simulate crop biosystems. The levels that might be considered include the molecular, organelle, cellular, tissue, system, organism, and community. Remaining challenges include the identification of events and scenarios that require simultaneous consideration at multiple levels and the identification of critical data that must be shared between models at different levels.

Off-Road Equipment Engineering

Corn Root Evaluation System

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A system was developed that allows for efficiently imaging a large number of corn roots. The images were stored and characterized using qualifiers such as fractal dimension and entropy. The qualifiers have shown to allow distinguishing among corn genotypes, and it is anticipated that they can identify genetic markers that have distinct effects on the root development of corn plants under varying soil conditions. A database was developed containing root morphology images featuring a wide spectrum of corn genotypes grown under diverse field conditions (e.g., different plant densities, altered nutritional status, drought, flooding, presence of soil borne diseases, and pests).

Development of a Smart Spreader System

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The application of fertilizers poses a potential threat to the environment and crop if not applied at the correct

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application rate and optimal uniformity. The era of Precision Agriculture has required the development of variable rate spreaders, but traditionally these merely attempt to control the rate and not the uniformity. In cooperation with CEMAGREF at Montoldre, France, the University of Illinois is developing a Smart Spreader System that is both rate and uniformity controlled. In addition, testing arrangements are being developed to study the fundamental flow of particles during spreading as well as material properties such as Coulomb friction coefficients.

Development of a Yield Monitor for Citrus Fruits

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Yield monitors, which measure the material flow during harvesting, have been developed for many agricultural crops, but in citrus growing traditionally bins of fruits were used as the basic unit. With the emergence of continuous mechanical harvesting machines, there is a need for a yield monitor for fruits. This method gives a precise indication of the performance on a per tree basis, which can help growers to better manage their groves. A basic yield monitoring method was developed at the University of Illinois and is currently being implemented at the Citrus Research and Education Center.

Development of Autonomous Robots for Biosystems Applications

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The farm of the future will have a high level of automation technology, including robots for different field operations. As a starting point, an autonomous robot (AgTracker) was developed as a carrier for sensors for crop scouting applications. Several walking robots were built to demonstrate the potential of robotics for crop scouting applications. In addition, a barebones robot was developed specifically as a carrier for a soil-sampling device, developed at the University of Nebraska.

Development of Portable Tools with Optimum Configuration for Cutting Sugarcane

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A survey of sugar cane cutting tools used in different countries shows considerable variation in design, suggesting that the design of the cutting tool has evolved through trial and error rather than clearly defined engineering ergonomic principles. The objective is to design, build, and test portable tools for cutting sugarcane, based on engineering and ergonomic principles, in order to maximize productivity and quality with the least stress on the body. A platform will be developed on which to measure sugar cane cutting forces and cutting blade acceleration to be used as inputs into a biomechanics model.

Real-Time Decision Support System for In-Field Agricultural Operations

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Major advances in agricultural vehicle technologies in recent years have resulted in much higher work rates and efficiencies on a per vehicle basis. However, very little attention has been paid to systems of vehicles cooperating, for example, during crop planting and during harvesting. The overall goal of the project is to develop a decision support system with intervehicle, real-time data communication for optimizing in-field grain handling by combines, grain wagons, road transport, and grain elevator. Wireless communication protocols have been established and preliminary field tests on a prototype have been successfully completed in the United States and Australia.

3-D Density and Density Maps for Stereo Vision-Based Navigation

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Vicinity information of autonomous machinery provides the level of accuracy and reliability needed for safe operations. Stereovision cameras offer rich visual perception in a 3-D format for surrounding detection and safeguarding. This research intends to develop an innovative concept of using 3-D density and a density map to represent the detected objects, both the profile and location, in the operating field to support real-time path-planning. The focus of this project is to investigate the feasibility of implementing the conceptual technology of

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the AutoTrac system for tractor navigation. Field tests will be conducted to validate the developed field information management method.

Investigation on Automatic Tuning and Adaptive Control Technologies for Intelligent Vehicle Path Tracking

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To obtain a high maneuvering performance on ground vehicles, researchers have developed many high-level controllers, including but not limited to PID, feedforward-PID, fuzzy, sliding mode, and LQR. This study intends to identify relevant approaches and research results of a few selective controllers; identify the strengths and weaknesses of each candidate; and recommend approaches and construct guidelines for vehicle controllers. Some representative controllers will be implemented on a laboratory-scale, hardware-in-the-loop control system simulator to provide preliminary validation on the results.

Maintenance and Fault Diagnosis Tools for Hydraulic Pumps

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The primary goal of this project is focused on developing a better understanding of fluid power among graduate and undergraduate students through participating research activities on developing a prognostic tool for hydraulic pump health assessment. It consists of the following specific objectives: developing an educational tool for hydraulic pump maintenance and fault diagnosis; providing engineering students with significant experiences in evaluating the health condition of a fluid power system and determining maintenance requirements; and stimulating future research in fault diagnostics and prognostics of hydraulic systems, which has potential to have a major impact on the fluid power industry.

Sensor Fusion Development for AutoTrac Guidance Systems

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The goal of this project is to develop sensor fusion methodologies to integrate multiple sensors (e.g., GPS, IMU, vision) to provide accurate and robust navigation inputs for Deere AutoTrac guidance systems. Integrations of a low-cost IMU sensor with GPS and a vision sensor

with GPS will be the primary focus of this project. The integrated sensor systems will be tested in multiple fields with AutoTrac guidance vehicles. In addition to identify the current sensor limitations, this project will focus on developing, integrating, implementing, and validating a low-cost IMU and GPS sensor fusion system.

Vehicle-in-the-Loop Virtual Reality Simulation of Tractor Rollover

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The final goal of this research is to develop a vehicle-in-the-loop (VIL) virtual reality simulator consisting of a robot model tractor, a model field, and a tractor dynamic model. This VIL simulator will be capable of assessing the possibility of a tractor rollover under various operating conditions. Upon completion of the research, this simulator can be implemented remotely via the Internet, used as a training tool for drivers, and as a tool for researchers. The current phase is a pilot project focusing on collecting field data and design system architecture for the VIL virtual reality simulator.

Site-Specific Agriculture

Precise Application of Agricultural Chemicals

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Improvements in the application of agricultural chemicals are needed to improve the safe and efficient application of agricultural chemicals. New nozzle designs, sensors and control systems for agricultural sprayers have the potential to improve deposition efficiency with a corresponding decrease in spray drift. The objective of this project is to develop new technology, techniques, and practices that improve the efficiency of applying substances used for control of pests. Specific goals are to characterize new nozzle designs for increasing chemical deposition on plant and pest targets while reducing off-target spray drift.

Data Collection and Analysis for Future Farms

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High-quality data are essential for future crop management. Site-specific information will have higher value when the sensing system is optimized and error is minimized. This project is a pilot study to see what the

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future data set might be and how researchers could best plan to analyze it. The team will use state-of-the-art technologies in the development of sensing systems for future farms. High-performance computing systems will be used in the data management study. A prescriptive study will be conducted concerning the value of information from site-specific technologies.

Developing an Agricultural Remote Sensing Program at the University of Illinois

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Cooperating with NASA researchers, University of Illinois scientists are expanding the agricultural remote sensing program at the University of Illinois. Program objectives are to develop the key technologies needed for NASA remote sensing data applications in precision agriculture settings; design and develop new courses in the area of agricultural remote sensing, spatial data management, and precision agriculture; foster cooperation among scientists from universities, government agencies, and industry working in precision agriculture and remote sensing; and bring new technologies to farmers, assess their needs, target research to address those needs, and maximize the relevancy of the program.

Improved Application of Pest Control Substances

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Equipment and techniques are being developed to improve the application efficiency of agricultural chemicals. Droplet size spectra from various atomizers are measured to determine target coverage versus spray drift potential. Field studies of spray drift deposits are used to verify the droplet size evaluations. Sensors and automatic control systems are being developed to apply pest control substances as a function of soil organic matter, travel speed, and other input variables. Techniques for incorporation of herbicides in the soil profile of conservation tillage systems are being developed and evaluated.

Soil and Water Resources

DHARMA: Domain Specific Metaware for Hydrologic Applications

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Many hydrologic models at the watershed scale are limited in resolution and scope by their computational demands. A goal of this project is to build a middleware layer to provide the resources for revolutionizing hydrologic modeling. The required resources range from local data to the supercomputing power on the national computational grid. Researchers intend to expand 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 enable the model for predicting erosion within the watershed by allowing significantly easier access to the computational power and data acquisition capabilities.

Evaluation of Range Design Relative to Combat Readiness and Environmental Risks

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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 and water quality degradation, poor air quality from dust, wildfires, smokes, and obscurants, and heavy metal accumulation that result from live fire activities are environmental risks that can affect training and testing activities on U.S. Army installations. The objectives of this project are to analyze training and testing range design elements with respect to mission, environmental degradation and regulatory noncompliance, and long-term operations and maintenance requirements.

Understanding and Modeling the Hydrology of Tile-Drained Watersheds

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The overall objective of the study is to develop strategies that mutually benefit both agriculture and water quality in regions where hydrology is strongly influenced by

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subsurface drainage. Researchers have been monitoring flow and water quality from the 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. These data have been used to calibrate and validate these models. Work is in progress to develop watershed-scale model(s) to evaluate the effects of Best Management Practices on watershed water quality.

Water Quality

Amount, Timing, and Quality of Water Coming from Managed (Controlled) and Unmanaged Drainage Systems in Illinois

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This research project is designed to quantify and compare the amount, timing, and quality of water discharging from managed and unmanaged drainage systems in Illinois. It involves monitoring flow and obtaining flow-weighted water quality samples from managed and free drainage systems on a range of soil types in various locations in the state. The resulting data will be used for developing management criteria for drainage water management systems in Illinois.

Combined Drainage Water Management/Bioreactor System for Improving the Quality of Tile Outflow

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The goal of this project is 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 agricultural fields with subsurface tile drainage. This information will be helpful in scaling up a regional initiative to reduce nitrogen and other discharges from agricultural lands and to reduce environmental impacts and protect and possibly enhance income to rural communities and landowners.

Development of Conservation Drainage in Illinois

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The objectives of this project are to test the hypothesis that while different drainage practices may result in the same intensity of drainage, thereby producing the same production benefits, they differ in their effect on water quality; to determine the design configurations that optimize production benefits while having the least deleterious impact on the environment; and to involve producers, drainage contractors, educators, and local conservation personnel in drainage research.

Development of Design Criteria for Watershed-Scale Subsurface Bioreactors

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The objectives of this project are to demonstrate the efficacy of passive subsurface bioreactors in removing nitrates from the outflow from small watersheds, evaluate the effectiveness of wood chips from softwoods and hardwoods as carbon sources in subsurface bioreactors, and to develop design criteria for watershed-scale subsurface bioreactors.

Effect of Drainage Water Management on Tile Water Quality

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This research project is designed to test the hypothesis that drainage water management will reduce the loadings of nitrates and phosphorus from tile drainage systems without adversely affecting crop yield. It involves the continuous monitoring, over a three-year period, of tile effluent from a pair of fields. The pair consists of two 40-acre fields that are side by side with similar soils, crops, and climate. This pairing greatly reduces climatologic and soil differences, and major sources of external variability, thereby reducing the length of time required to draw conclusions.

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Illinois Conservation Drainage Research and Demonstration Watershed Project

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The project was established 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 that can be used to model flow and transport in a tile-drained watershed; and to work in conjunction with local stakeholders to promote conservation drainage.

Understanding Hydrologic and Water Quality Response of a Tiled Watershed

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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 will initiate a new dimension for watershed management to improve water quality in tile-drained watersheds. Once the techniques and relationships are validated, an estimate of total maximum daily load (TMDL) to a surface water source will be 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.

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Hancock, K. M. and Zhang, Q. **Maintenance and fault diagnosis tools for hydraulic pumps.** 50th National Conference of Fluid Power (Las Vegas, NV, Mar. 2005). Proceedings of the 50th National Conference of Fluid Power (2005).

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Ocfemia, K. C. S., Zhang, Y., Christianson, L. L., Funk, T. L., Appleford, J. M., and Dong, R. **Continuous hydrothermal processing of swine manure into oil using a small-scale reactor system.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

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Wang, X. and Zhang, Y. **Experimental study of effect of ventilation on animal environment in a swine building.** 7th International Livestock Environment Symposium (Beijing, China, May 2005). Proceedings of the 7th International Livestock Environment Symposium (2005).

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Biotechnology

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Engineering Education

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Food and Bioprocess Engineering

Belyea, R. L., Singh, V., Johnston, D. B., Srinivasan, R., Clevenger, T. E., Tumbleson, M. E., and Rausch, K. D. **Nutrients in dry grind corn processing.** 4th International Starch Technology Conference (Urbana, IL, Jun. 2005). Proceedings of the 4th International Starch Technology Conference (2005).

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Singh, V., Wang, P., Johnston, D. B., Rausch, K. D., and Tumbleson, M. E. **Converting corn into ethanol and valuable coproducts using the enzymatic dry grind process.** 2005 American Institute of Chemical Engineers Conference (Cincinnati, OH, Nov. 2005). Proceedings of the 2005 American Institute of Chemical Engineers Conference (2005).

Srinivasan, R., Moreau, R. A., Rausch, K. D., Belyea, R. L., Tumbleson, M. E., and Singh, V. **A new process for removing fiber from distillers dried grains with solubles (DDGS).** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

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Tumbleson, M. E., Meerdink, G. L., Singh, V., Constable, P. D., and Haschek, W. M. **Preharvest control of yeast and molds in commodities.** 2005 International Association of Food Protection Annual Meeting (Des Moines, IA, Aug. 2005). International Association of Food Protection 2005 Program and Abstract Book (2005).

Wang, P., Xu, L., Johnston, D. B., Rausch, K. D., Tumbleson, M. E., and Singh, V. **Enzymatic dry grind corn processes using a new enzyme.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

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Life Support Systems Reliability and Sustainability

Bell, S., Rodriguez, L. F., and Kortenkamp, D. **Using dynamic simulations and automated decision tools to design lunar habitats.** 35th Society of Automotive Engineers International Conference on Environmental Systems (Rome, Italy, Jul. 2005). Proceedings of the 35th Society of Automotive Engineers International Conference on Environmental Systems (2005).

Kortenkamp, D., Bell, S., and Rodriguez, L. F. **Simulating lunar habitats and activities to derive system requirements.** 1st American Institute of Aeronautics and Astronautics Space Exploration Conference (Orlando, FL, Jan. 2005). Proceedings of the 1st American Institute of Aeronautics and Astronautics Space Exploration Conference (2005).

Mechatronics

Kise, M. and Zhang, Q. **Dual stereovision application for 3D field mapping and vehicle guidance.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Yao, J., Kong, X. D., Shan, D. S., Gao, Y. J., Han, D., and Zhang, Q. **Study on using multifunctional integrated valve in controlling an asymmetric hydraulic system.** 50th National Conference on Fluid Power (Las Vegas, NV, Mar. 2005). Proceedings of the 50th National Conference of Fluid Power (2005).

Off-Road Equipment Engineering

Hansen, A. C., Gratton, M. R., and Yuan, W. **Steady state diesel engine performance and NO_x emissions with selected biofuels.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Hansen, A. C., Yuan, W., and Zhang, Q. **Computation and analysis of biodiesel physical properties for combustion modeling.** Pacifichem 2005 Conference (Honolulu, HI, Dec. 2005). Proceedings of the 2005 Pacifichem Conference (2005).

Hansen, A. C., Yuan, W., and Zhang, Q. **Computational investigation of the effect of biodiesel fuel properties on NOx emissions.** Pacifichem 2005 Conference (Honolulu, HI, Dec. 2005). Proceedings of the 2005 Pacifichem Conference (2005).

Hansen, A. C., Zhang, Q., Hornbaker, R. H., and Wilcox, T. A. **Modeling and analysis of row crop harvesting patterns by combines.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Wang, X., Wu, H., Zhang, Q., Hansen, A. C., and Malinga, B. **Modeling of LNT for aftertreatment control and diagnosis in diesel engine.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Yuan, W., Gratton, M. R., and Hansen, A. C. **Parametric investigation of NOx emissions from biofuels for compression-ignition engines.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Yuan, W., Hansen, A. C., and Zhang, Q. **Modeling of NOx emissions of biodiesel fuels.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Robotics

Grift, T. E., Kasten, M., and Nagaska, Y. **Robotics in agriculture: Asimov meets corn.** 2005 Illinois Crop Protection Technology Conference (Urbana, IL, Jan. 2005). Proceedings of the 2005 Illinois Crop Protection Technology Conference (2005).

Jeon, H. Y., Tian, L. F., and Grift, T. E. **Development of an individual weed treatment system using a robotic arm.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Site-Specific Agriculture

Brethauer, S. and Bode, L. E. **The importance of spray droplet size for ground and aerial application.** Illinois Crop Protection Technology Conference (Urbana, IL, Jan. 2005). Proceedings, Illinois Crop Protection Technology Conference (2005).

Water Quality

Algoazany, A., Kalita, P. K., Mitchell, J. K., Cooke, R. A. C., and Hirschi, M. C. **A long-term monitoring of agricultural chemical transport from a flat tile-drained watershed.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Goswami, D., Kalita, P. K., and Cooke, R. A. C. **Estimation of base flow in drainage channels in two tile-drained watersheds in Illinois.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Kim, K., Kalita, P. K., and Bowes, M. J. **Modeling phosphorus transport in a river under unsteady flow conditions.** 2005 Modeling Tools for Environment and Resources Management International Conference (Bangkok, Thailand, Jun. 2005). Proceedings of the 2005 Modeling Tools for Environment and Resources Management International Conference (2005).

Kim, K., Kalita, P. K., and Bowes, M. J. **A new modeling approach for phosphorus transport in streams under unsteady flow conditions.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (2005).

Svendsen, N. G., Kalita, P. K., and Gebhart, D. L. **Environmental risk reduction and combat readiness enhancement of military training lands through range design and maintenance.** 2005 American Society of Agricultural and Biological Engineers Annual International Meeting (Tampa, FL, Jul. 2005). Proceedings of the 2005 American Society of Agricultural and Biological Engineers Annual International Meeting 2005.

Theses

Alternative Fuels

Wenqiao, Y. **Computational modeling of NO_x emissions from biodiesel combustion based on accurate fuel properties.** Ph.D. thesis, A. C. Hansen, advisor (2005).

Bioenvironmental Engineering

Appleford, J. M. **Analyses of the products from the continuous hydrothermal conversion process to produce oil from swine manure.** M.S. thesis, Y. Zhang, advisor (2005).

Ocfemia, K. C. S. **Hydrothermal process of swine manure to oil using a continuous reactor system.** Ph.D. thesis, Y. Zhang, advisor (2005).

Food and Bioprocess Engineering

Campabadal, C. A. **Recovery of water-soluble proteins from dry-milled corn germ.** M.S. thesis, S. R. Eckhoff, advisor (2005).

Grain Qualities and Properties

Newgard, E. C. **Evaluation of sample source errors on prediction accuracy for a maize extractable starch calibration for near-infrared transmittance spectroscopy.** M.S. thesis, M. Paulsen, advisor (2005).

Off-Road Equipment Engineering

Hancock, K. M. **Fault detection in hydraulic vane pumps using wavelet packet analysis and adaptive neuron-fuzzy inference.** M.S. thesis, Q. Zhang, advisor (2005).

Reum, D. D. **Wavelet analysis of multi-spectral images of corn plants.** M.S. thesis, Q. Zhang, advisor (2005).

Ryerson, A. E. F. **Vehicle path planning for complete field coverage using genetic algorithms.** M.S. thesis, Q. Zhang, advisor (2005).

Soil and Water Resources

Kim, K. **Modeling phosphorus transport in a river under unsteady flow conditions.** Ph.D. thesis, P. K. Kalita, advisor (2005).

Patel, M. K. **A study of nutrient retention and transport through a field-scale vegetative filter strip.** M.S. thesis, P. K. Kalita, advisor (2005).

Svendsen, N. G. **Erosion and water quality assessments of military training lands at Camp Atterbury Joint Maneuver Training Center.** M.S. thesis, P. K. Kalita, advisor (2005).

Tadlock, B. R. **Testing and evaluation of nozzles for a new generation of rainfall simulators.** M.S. thesis, P. K. Kalita, advisor (2005).

Water Quality

Christopher, K. I. **A DRAINMOD-based decision support system (DSS) for drainage and water quality in Illinois.** Ph.D. thesis, R. A. Cooke, advisor (2005).

Awards and Honors

Robert A. Aherin

Educational Aids Competition Blue Ribbons, American Society of Agricultural Engineers, 1980 (3), 1981 (4), 1982 (3), 1984 (3), 1986 (2), 1988, 1989, 1990
Maynard Coe National Agriculture Safety Award, National Institute for Farm Safety, 1980
Outstanding Young Men of America Award, National Jaycees, 1981

Honorary State Farmer Degree, Minnesota FFA Association, 1983
Outstanding Service Award, American Lung Association, 1983
Agriculture Safety Professional-of-the-Year Award, Minnesota Safety Council, 1983
Packer Engineering Safety Award, American Society of Agricultural Engineering, 1987
Teaching Award, Program, American Society of Agricultural Engineers, 1989
Young Faculty Award for Excellence in Extension, University of Illinois College of Agriculture, 1993
Outstanding Alumni Award, College of Applied Sciences and Technology, Illinois State University, 2002

Loren E. Bode

Educational Aids Competition Blue Ribbons, American Society of Agricultural Engineers, 1976, 1981, 1982, 1985, 1986, 1988, 1993
Paper Award, Honorable Mention, American Society of Agricultural Engineers, 1982
Young Extension Worker Award, American Society of Agricultural Engineers, 1983
Senior Faculty Award for Excellence in Extension, University of Illinois College of Agriculture, 1990
Midwest Agricultural Chemical Association Educator's Award, 1991
Fellow, American Society of Agricultural Engineers, 1992
Paul A. Funk Achievement Award, University of Illinois College of Agriculture, 1993
President's Citation, American Society of Agricultural Engineers, 2000, 2002
Hall of Fame Award, Illinois Extension Agricultural Association, 2004
Honorary Knight of St. Patrick, College of Engineering, 2005

Philip Buriak

Teaching Award of Merit, National Association of College Teachers of Agriculture, 1986
Honorary American Farmer Degree, National FFA Organization, 1987
Paper Award, Outstanding Research Presentation, National Agricultural Education Research Meeting, 1988
Teaching Excellence Award, University of Illinois Department of Agricultural Engineering, 1989, 1992, 1994
Karl E. Gardener Outstanding Undergraduate Advising Award, University of Illinois College of Agriculture, 1993

Author of the Year, 1st Runner Up, *Journal of Agriculture Education*, 1994
Author of the Year, 2nd Runner Up, *Journal of Agricultural Education*, 1997
Honorary Illinois Farmer Degree, Illinois Association FFA, 1997
Teaching Academy of Excellence, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 1997-2002
Teaching Award of Excellence, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 1997
Senior Teaching Award of Excellence, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 1999
Campus Award for Excellence in Undergraduate Teaching, University of Illinois, 1999
National Award for Excellence in College and University Teaching, U.S. Department of Agriculture, 1999
Distinguished Teacher/Scholar, University of Illinois, 2000
Paul A. Funk Recognition Award, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2001
J. Kent Mitchell Teaching Excellence Award, University of Illinois, Department of Agricultural and Biological Engineering, 2001
Team Award for Excellence, The College of Agricultural, Consumer, and Environmental Sciences Teaching Course Team, University of Illinois, College of Agricultural, Consumer and Environmental Sciences, 2001
E. B. Knight Journal Award, North American Colleges and Teachers of Agriculture, 2003
Teaching Fellow Award, North American Colleges and Teachers of Agriculture, 2003

Leslie L. Christianson

Teaching Excellence Award, University of Illinois Department of Agricultural Engineering, 1987, 1991
Andersen Consulting Award for Excellence in Advising, University of Illinois College of Engineering, 1989, 1990, 1991
Stanley H. Pierce Award, University of Illinois College of Engineering, 1989
Paper Award, American Society of Agricultural Engineers, 1994
Paper Award, American Society of Heating, Refrigeration and Air-Conditioning Engineers, 2003
Fellow, Academic for Entrepreneurship, University of Illinois, 2005

Richard C. Coddington, Emeritus

Teaching Excellence Award, University of Illinois
Department of Agricultural Engineering, 1988, 1992
Amoco Award for Innovative Teaching, 1991

Richard A. Cooke

Dissertation Research Award, Virginia Polytechnic
Institute and State University Chapter of Sigma Xi, 1995
J. Kent Mitchell Teaching Excellence Award, University
of Illinois Department of Agricultural and Biological
Engineering, 2005

Steven R. Eckhoff

Dow Outstanding Young Educator Award in the Midwest
Region, American Society for Engineering Education,
1986
Kansas State University Presidential Lecturer, 1986, 1987
Outstanding Paper in Cereal Chemistry Award, Corn
Refiners Association, 1989
Research Fellowship, Corn Refiners Association, 1990,
1991
Teaching Excellence Award, University of Illinois
Department of Agricultural Engineering, 1993
Excellence in Teaching Award, American Association of
Cereal Chemists, 1999

Bruce Elliott-Litchfield

Andersen Consulting Award for Excellence in Advising,
University of Illinois College of Engineering, 1989,
1993
Teaching Excellence Award, University of Illinois
Department of Agricultural Engineering, 1990
Everitt Award for Teaching Excellence, University of
Illinois College of Engineering, 1991
Research Fellowship, Corn Refiners Association, 1991
Young Faculty Award for Excellence in Teaching,
University of Illinois College of Agriculture, 1992
A. W. Farrall Young Educator Award, American Society
of Agricultural Engineers, 1993
University Scholar, University of Illinois, 1994
Engineering Council Advisors List for Outstanding
Advising, University of Illinois, 1995
Faculty Award for Excellence in Research, University of
Illinois College of Agricultural, Consumer and
Environmental Sciences, 1996
Collins Award for Innovative Teaching, University of
Illinois College of Engineering, 1997
Harriet and Charles Luckman Undergraduate
Distinguished Teaching Award, University of Illinois,
1997

Team Award for Excellence, University of Illinois College
of Agricultural, Consumer and Environmental Sciences,
2001

Distinguished Teacher/Scholar Award, University of
Illinois, 2003

Ted L. Funk

Outstanding Program Team Award in Extension,
University of Illinois College of Agriculture, Consumer
and Environmental Sciences, 1999
Sustained Excellence in Extension Programming,
University of Illinois College of Agriculture, Consumer
and Environmental Sciences, 1999
Professional Staff Award for Excellence, Innovation and
Creativity, University of Illinois College of
Agricultural, Consumer and Environmental Sciences,
2003
Campus Award for Excellence in Public Engagement,
University of Illinois, 2004

Carroll E. Goering, Emeritus

Fellow, American Society of Agricultural Engineers
Outstanding Technical Paper Awards, American Society
of Agricultural Engineers; honorable mention, 1985,
1990, 1992
Outstanding Technical Paper Awards, American Society
of Agricultural Engineers, 1985, 1990, 1992
Everitt Award for Teaching Excellence, University of
Illinois College of Engineering, 1986
Senior Faculty Award for Teaching Excellence, University
of Illinois College of Agriculture, 1994
Paul A. Funk Recognition Award, University of Illinois
College of Agricultural, Consumer and Environmental
Sciences, 1996
Massey-Ferguson Award, American Society of
Agricultural Engineers, 2001
Cyrus Hall McCormick Jerome Increase Case Gold Medal
Award, American Society of Agricultural and
Biological Engineers, 2005

Tony E. Grift

Superior Paper Award, American Society of Agricultural
Engineers, 2002, 2003
Information and Electrical Technologies Division
Outstanding Paper Award, American Society of
Agricultural Engineers, 2003
Japanese Society for the Promotion of Sciences
Fellowship, 2005

Alan C. Hansen

Paper Award, Outstanding Technical, American Society of
Agricultural Engineers, 1990

Silver Medal for Academic Achievement, South African Institute of Agricultural Engineers, 1990
 Silver Medal for Best Publication of the Year, South African Institution of Mechanical Engineers, 1992
 Silver Medal for Best Paper Published, South African Institute of Agricultural Engineers, 1992
 Faculty Award for Excellence in Teaching, University of Natal, Faculty of Engineering, South Africa, 1994, 1996
 Teaching Excellence Award, American Society of Agricultural Engineers Student Branch, University of Illinois, 2002
 Outstanding Advisor Award, Accenture Consulting, University of Illinois College of Engineering, 2003, 2005
 Outstanding Paper Award, Information and Electrical Technologies Division, American Society of Agricultural Engineers, 2003
 Everett Award for Teaching Excellence, University of Illinois College of Engineering, 2004
 Faculty Award for Excellence in Teaching, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2005

Michael C. Hirschi

Paper Reviewers Award, American Society of Agricultural Engineers, 1988
 Blue Ribbons (6), Educational Aids Competition, American Society of Agricultural Engineers, 1991 (3), 1994, 1998, 2004
 Early Career Award, Epsilon Sigma Phi Alpha Nu Chapter, 1992
 Young Faculty Award for Excellence in Extension, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 1995
 Teaching Excellence Award, University of Illinois Department of Agricultural Engineering, 1997
 Certificate of Excellence, American Society of Agronomy Education Materials Contest, 1998
 Accenture Consulting Outstanding Advisor Award, University of Illinois College of Engineering, 2000, 2001
 Academy of Teaching Excellence, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2002, 2003, 2004
 Karl A. Gardner Outstanding Undergraduate Advising Award, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2003

Prasanta K. Kalita

Research Excellence Award, Iowa State University, 1992
 Advisor of the Year, Kansas State University College of Engineering, 1996

Who's Who in Science and Engineering, 1996
 Most Outstanding Advisor of the Year, Kansas State University BAE Department, 1997
 Outstanding Kansas State University Instructor and Advisor K-State Mortar Board, 1997
Who's Who Among America's Teachers, 1998, 2000
 Finalist, President's Outstanding Advisor Award, Kansas State University, 1999
 Collins Scholar, The Academy for Excellence in Engineering Education, University of Illinois, 2000, 2001
 Teaching Excellence Award, American Society of Agricultural Engineering Student Branch, University of Illinois, 2002
 Outstanding Engineering Advisor, University of Illinois College of Engineering, 2002
 J. Kent Mitchell Teaching Excellence Award, University of Illinois Department of Agricultural and Biological Engineering, 2003
 Faculty Award for Excellence in Teaching, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2003
 Academy of Teaching Excellence, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2003
 Food and Agricultural Sciences Excellence in College and University Teaching Awards Program Nominee, U.S. Department of Agriculture, 2003
 Best Paper Award, International Association of Science and Technology for Development, 2003
 Outstanding Adviser Award, Accenture Consulting, University of Illinois College of Engineering, 2004
 Teaching Fellow Award, North American Colleges and Teachers of Agriculture, 2004
 Excellence in Teaching Award, United States Department of Agriculture Food and Agricultural Sciences, National Association of State Universities and Land-Grant Colleges, 2005

J. Kent Mitchell, Emeritus

Fellow, American Society of Agricultural Engineering
 Educational Aids Competition, American Society of Agricultural Engineers, 1972, 1975, 1979, 1984
 Alpha Zeta Outstanding Instructor, University of Illinois College of Agriculture, 1986
 Teaching Excellence Award, University of Illinois Department of Agricultural Engineering, 1986
 Everitt Award for Teaching Excellence, University of Illinois College of Engineering, 1987
 Faculty Award for Excellence in Teaching, University of Illinois College of Agriculture, 1989

Paul A. Funk Recognition Award, University of Illinois College of Agriculture, 1994
Honorary Badge, Warsaw Agricultural University (Warsaw, Poland), 2001
Hancor Soil and Water Engineering Award, American Society of Agricultural Engineers, 2002

Marvin R. Paulsen

Fellow, Committee on Institutional Cooperation, 2000-2001
Fellow, American Society of Agricultural Engineers, 2002
Andersons/NC-213 Grain Quality Research Award, 2002
Paul A. Funk Achievement Award, University of Illinois College of Agricultural, Consumer and Environmental Sciences, 2005

William H. Peterson, Emeritus

Appreciation Plaque, South Dakota Rural Electric Member Services Association, 1977
Certificate of Appreciation, Illinois Farm Electric Council, 1981
Blue Ribbons, Educational Aids Competition, American Society of Agricultural Engineers, 1981, 1983, 1987
Certificate of Merit, Illinois Electric Council, 1996

Robert E. Petrea

President's Award, National Institute for Farm Safety, 2004
Special Recognition Award, National Institute for Farm Safety, 2004

Luis F. Rodriguez

Postdoctoral Research Fellowship, National Research Council, NASA, 2004

John C. Siemens, Emeritus

Blue Ribbon, Educational Aids Competition, American Society of Agricultural Engineers, 1985
Agronomic Educational Material Publication, American Society of Agricultural Engineers, 1992
Senior Faculty Award for Excellence in Extension, University of Illinois College of Agriculture, 1993
John Deere Gold Medal Award, American Society of Agricultural Engineers, 1999

Vijay Singh

Young Faculty Excellence Award, National Corn Refiners Association, 2003
New Holland Young Research Award, American Society of Agricultural and Biological Engineers, 2005

Lei Tian

Novel Academic Idea Award for Young Faculty, Jilin University of Technology, 1988, 1989
Nominee, CGS Award for Most Distinguished Dissertation of the Program, Department of Biological and Agricultural Engineering, University of California at Davis, 1995
Nominee, Kinsella Memorial Prize, University of California at Davis, 1995
Nominee, University Microfilms International Distinguished Dissertation Award in Mathematics and Physics and Engineering, University of California for National Council of Graduate Schools, 1995
Outstanding Accomplishment of Training on Teaching College, University of Illinois College of Agricultural, Consumer and Environmental Sciences Academy of Teaching Excellence, 1997
Honorable Mention for the Graduate College of Outstanding Mentor Award, University of Illinois College of Graduate Studies, 1999-2000
Superior Paper Award, American Society of Agricultural Engineers, 1999-2000
Faculty Fellow, National Center for Supercomputing Applications, University of Illinois, 2000-2001

K. C. Ting

Fellow, Ralph and Mable Hunter, 1978-1979
Certificate of Appreciation, American Society of Agricultural Engineers, 1991, 1999, 2000
Certificate of Appreciation, Taiwan Agricultural Mechanization Research and Development Center, 1991
Best Paper Award, CIOSTA-CIGR (International Agricultural Engineering Society), 1993
Best Paper Award, American Society for Plastics, 1993
Team Award for Excellence in Research, Cook College/ New Jersey Agricultural Experiment Station, Rutgers University, 1996
Honorary Professor of the National Bio-Environment Engineering Laboratory of the Ministry, China Agricultural University, Beijing, P.R. China, 1996
Cook College/Alpha Zeta Professor of the Year, Rutgers University, 1997
Japanese Government Research Award for Foreign Specialists, 1999
Paper Award, American Society of Agricultural Engineers, 2000
Fellow, American Society of Agricultural Engineers, 2001
Fellow, American Society of Mechanical Engineers, 2002
Certificate of Appreciation, Mie University, Japan, 2003

Xinlei Wang

Paper Award, American Society of Heating, Refrigeration and Air-Conditioning Engineers, 2002

Qin Zhang

Best Paper in the Decade Award, Transactions of Chinese Society of Agricultural Engineering, 1995

General Electric Scholar, University of Illinois College of Engineering, 1998

Collins Award for Innovative Teaching, University of Illinois College of Engineering, 1999

Information and Electrical Technologies (IET) Division Select Paper Award, American Society of Engineers, 2001

Best Paper Award, SCI Control Systems, World Multi-Conference on Systemics, Cybernetics and Information, 2001

Fellow, National Center for Supercomputing Applications, 2002

Adjunct Chair Professor, College of Engineering, China Agricultural University, 2003

Adjunct Professor, College of Biological Engineering and Food Sciences, Zhejiang University, China, 2003

Fellow, Japanese Society for the Promotion of Science, 2004

Adjunct Professor, College of Mechanical Engineering, Department of Mechatronics, Yanshan University, China, 2004

Select Paper Award, Information and Electrical Technologies Division, American Society of Agricultural and Biological Engineering, 2005

Faculty Research Award, University of Illinois, College of Agricultural, Consumer and Environmental Sciences, 2005

Yuanhui Zhang

Outstanding Paper Award, American Society of Agricultural Engineers, 1989, 2001

Honorarium Professorship, Beijing University of Agricultural Engineering, China, 1994

Honorarium Professorship, Shandong Institute of Technology, China, 1994

Everitt Award for Teaching Excellence, University of Illinois College of Engineering, 1997

General Electric Scholar, University of Illinois College of Engineering, 1997

Blue Ribbon Award, American Society of Agricultural Engineers, 1998

Teaching Excellence Award, University of Illinois Department of Agricultural Engineering, 1999

Superior Paper Award, American Society of Agricultural Engineers, 2001

Annual Paper Award, American Society of Heating, Refrigeration and Air-Conditioning Engineers, 2002
Fellow, National Center for Supercomputing Applications, 2004

Bliss Faculty Scholar Award, University of Illinois College of Engineering, 2005