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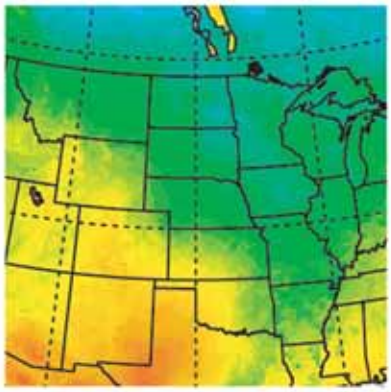
2005-06 Research Activities Annual Report
Office of the Vice President for Research









research on the environment

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President

During my tenure as president of this great university, I have watched Purdue's research enterprise expand to new levels of excellence. Purdue investigators create new knowledge through basic research and actively pursue new methods to apply those discoveries for the betterment of future generations. The world faces complex challenges to safeguarding our environment through new technologies that do not degrade our shared resources. Cutting-edge multidisciplinary research endeavors conducted with the latest technology are required to address the world's grand challenges. Purdue's faculty leads the way to answers. At Purdue, we view the entire process of education as an exercise in discovery. Purdue encourages the development of new coursework and research efforts that will stimulate the next generation to join this expanding research enterprise of uncompromising excellence.

— Martin C. Jischke, President

Provost

In five years our Strategic Plans have transformed Purdue University. Growing our research has been a central focus of our plans and, looking forward, it will continue to be a top priority. To meet our goals we have added faculty. We have constructed state-of-the-art research facilities. We have grown the infrastructure of our research initiative including staff support. We have launched exciting new centers, many of which live today in Discovery Park. All of this has had an impact. The interdisciplinary centers that have grown over the past five years concentrate in a substantial way to our success in discovery. They provide a compelling vision and attractive environment for our faculty, staff and students. They are essential to Purdue's future. The interdisciplinary research in Purdue's Discovery Park will play a key role in opening new horizons and bringing people together. All of Discovery Park is focused on moving our research out into the world around us. Discovery Park is creating a new model for the 21st century land grant university.

— Sally Mason, Provost

Research examining how sound in the environment can be used to assess biodiversity and human impacts on ecosystems are being conducted at Purdue University through funding from the Discovery Park Center for the Environment. Bryan Pijanowski, forestry and natural resources, is using state-of-the-art environmental monitoring equipment to record natural and human-produced sounds in and around Tippecanoe County. Software has been developed that quantifies the intensity and duration of different sounds and then categorizes them into three major sources: biophony (e.g., bird and insect sounds), geophony (e.g., wind and rain) and anthrophony (e.g., automobiles). Pijanowski and his students are examining how biophony, geophony and anthrophony vary in different ecosystems and how humans may impact wildlife distributions in different habitats.

Vice President for Research

At Purdue University, researchers are tackling pressing issues concerning the environment. They are working across disciplines leading to the discovery of new technologies and processes that will assist in the remediation of degraded environmental areas and improve our quality of life. Purdue investigators are keenly aware of the need to examine and integrate environmental integrity with economic development, and new technologies have already spun-off into products that are available for the public good.

This year's annual report highlights some of the research on the environment being pursued at Purdue and introduces the Center for the Environment in Discovery Park. In June 2005, a $2.5 million investment was made to establish the Center for the Environment from a $25 million Lilly Endowment for Discovery Park. By the end of 2006, in 18 months time, the Center had garnered nearly $19 million in research funding.

The multidisciplinary framework of Discovery Park's Center for the Environment brings together scientists, engineers, political scientists, and economists in new levels of collaboration. These kinds of partnerships have the potential to result in discoveries that will lead to the best use of our natural resources.

Innovative research and discovery cannot happen without an educated society, and the commitment to teach a new generation of researchers is an important goal of Purdue's rich multidisciplinary environmental research program.

At Purdue, we place great value on encouraging partnerships with local and regional communities, educational institutions, businesses and government agencies. Past experience has taught us that collaborations enhance outcomes and increase the success rate for all stakeholders working towards a common goal. We look forward to increased opportunities in collaboration that inspire students and researchers to seek solutions to the challenges we face together.

— Charles O. Rutledge, Vice President for Research

"The Center for the Environment is striving to replace the traditional notion that environmental stewardship is a cost of doing business, ...

We have a new paradigm — that protecting environmental integrity is essential to prosperity."

John Bickham
Director of Purdue's Discovery Park
Center for the Environment

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Discovering solutions to environmental

Engaging multiple stakeholders to create dynamic synergies in the research and learning process is a guiding principle at Purdue University.

Synergy
The combined effect of multiple parties working together is greater than the sum of its individual parts.

Experts from multiple fields of study work together, build collaborative teams and engage stakeholders outside the university.

Researchers specializing in environmental studies extend across Purdue's colleges and campuses. This report features only a few of the areas in which Purdue investigators are focusing their attention on the environment. They are actively seeking ways to assess the long-term fate and use of materials, establish air emissions standards for livestock industries, mitigate the impact of transportation noise in the environment, remediate contamination in our soil, understand the molecular processes between gene-environment interactions, establish best management practices in watersheds, decrease human health risks associated with exposure to parasites in the environment, as well as map the carbon footprint of fossil fuel emissions in the U.S., and predict and prepare for changes in our climate, and many more.

Agricultural Air Quality

Indiana state climatologist and Purdue researcher, Dev Niyogi, along with leading researchers from North Carolina State University, Duke, USDA and the Ecological Society of America wrote an article titled "Emerging National Research Needs for Agricultural Air Quality" for the newspaper *Eos* (Transactions, American Geophysical Union, January 2006). The authors predict that in 50 years the Earth's population will increase from 6.9 billion to 9 billion, which is creating an enormous demand for agricultural commodities. Emissions from confined animal feeding operations are a growing environmental concern leading regulators and policy makers to focus on mitigating the harmful effects.


Al Heber

Al Heber, agricultural and biological engineering, was selected to lead a $12.9 million study over the next five years to help the U.S. Environmental Protection Agency establish air emissions standards for the livestock and poultry industries. To conduct the study, Heber recruited scientists from other universities and deployed monitoring teams with fully equipped mobile labs. They are collecting data at selected farms over a 24-month period on particulate matter emissions, ammonia, hydrogen sulfide and volatile organic compounds. Outdoor manure storage facilities also are monitored.

"The EPA will be able to see how emissions change with time of day and season in combination with other factors and incorporate that information into the regulations the agency develops," Heber said. "Studying emissions from existing commercial facilities is the best way to gather data that will, in the long term, address air quality and other environmental concerns." For more information on this study, visit, http://news.uns.purdue.edu/html4ever/2005/050302.Heber.epa.html.

Transportation Noise

The issue of environmental noise has affected communities across the nation resulting in limiting economic growth in the transportation infrastructure. Billions of dollars have been spent on remediation efforts, and yet, noise continues to fuel community resistance to expansion of the transportation infrastructure, particularly for airports and highways. Patricia Davies and Bob Bernhard from mechanical engineering have been appointed to the National Academy of Engineering's "Technology for a Quieter America" project. Bernhard and Davies, along with other experts at Purdue from diverse areas spanning aviation technology to health sciences, are studying noise generation and propagation, annoyance and complaint levels. The goal is to reduce the impact of noise in the environment by changing technologies or operations and making recommendations to Congress and governmental agencies about noise policy.

Life Cycles and the Fate of Materials

Leading researchers at Purdue recognize the need to assess the long-term fate of commonly used compounds and emerging materials. Concern over the range of synthetic compounds that have been detected in wildlife, human blood, air, river water, sediments and sludge brings together researchers from environmental chemistry, veterinary pathology, biology and engineering to determine the life-cycle of chemical compounds in our environment. Linda Lee, agronomy, and doctoral student, Jin Liu, along with Loring Nies, civil engineering, study synthetic alkyl polyflourintated compounds that are widely used as stain retardants in carpets, upholstery and protective coatings. The results from their work provide a scientific base to assist in making responsible, regulatory decisions concerning the fate and use of these compounds.

Civil engineers Inez Hua and Thomas Seager, and political scientist Leigh Raymond, are collaborat-

concerns

ing on an NSF-funded project to investigate life-cycle and policy aspects of brominated flame retardants (BFRs). These compounds enable manufacturers of plastics, furniture, and other products to meet stringent fire-resistance requirements in an economical manner. However, there has also been some concern about the environmental safety of BFRs. This research project investigates potential pathways of BFRs to the environment from products during use or after disposal, as well as the perspectives of different stakeholder groups involved in the manufacture, use, and regulation of BFRs and products that contain them. The results of this study will contribute to the development of educational programs in sustainable engineering and policy, aid regulators with pressing policy decisions, strengthen ties between academia, government, industry and non-governmental organizations, and result in a more robust framework for investigation of other environmental policy and decision making problems.

Marisol Sepúlveda, forestry and natural resources and civil engineering, is an ecotoxicologist. With funding from the Indiana Department of Environmental Management and the EPA, she studies how industrial pollutants, such as mercury and PCBs, affect Indiana's wildlife. Research results shed light on how this exposure affects developing embryos in heron populations statewide. The results will help the state plan future remediation efforts in the Grand Calumet River basin in northern Indiana and other sites across the state. For more information on this study, visit, http://axe.agriculture.purdue.edu/agricultures/past/fall2005/spotlight5.htm.

Several studies concerning the environmental fate of nano-sized materials are being carried out at Purdue. Ron Turco, agronomy, along with colleagues from food science, earth and atmospheric sciences and 4-H, received funding for one of the first major studies investigating the environmental fate of carbon-based manufactured nanoparticles. The testing of these manufactured nanomaterials looked for toxicity to soil microbial communities — which often are first indicators of damage to the ecosystem. Early results from this study indicate that while the introduction of carbon-based nanomaterials into a variety of controlled soil communities showed little impact on soil microbial activities, long-term observations are still needed.

Discovery Park

John Bickham

Center for the Environment

The Center for the Environment is an interdisciplinary research center in Purdue's Discovery Park. The Center aims to establish guidelines on how to protect the environment while sustaining a global economy. Researchers working with the Center study ways to model and predict the impact of human activity on ecosystems, monitor environmental quality, and manage natural resources, with the goal of developing technologies that will create a cleaner environment. The Center also serves as a focal point for creating collaborative partnerships between university researchers, community groups and governmental agencies to investigate equitable solutions to land-use and environmental issues.

Within the past 100 years, we have witnessed the degradation of our environment due in large part to human behavior – from the depletion of natural resources to the alteration of the global climate. Some of the challenges we are confronting include: an unprecedented rate of extinction of living species; the disappearance of entire ecosystems and communities of organisms; the loss of renewable natural resources; and increasing global temperatures that could trigger devastating climatic shifts around the world. As a result of these challenges, we face new problems like the emergence of new diseases passed from animals to man, the loss of agricultural and fisheries resources necessary to feed our ever-growing population, and the loss of the pristine streams, forests, deserts, plains and montane habitats and the wildlife that defined and shaped the character of this country from its inception to the present.

Solving these problems may seem to be an insurmountable task, but their solutions are not beyond our reach and require an interdisciplinary approach. Purdue University's Discovery Park represents a new model for the promotion of interdisciplinary research and development. The Center for the Environment possesses one of the country's largest and most talented concentrations of environmental scientists and engineers, comprised of 132 faculty participants from 30 departments and nine colleges across three campuses. This faculty is helping to meet environmental challenges across the globe by documenting the biodiversity of Central America's rain forests; assessing the effects of a 2,000-ton mercury spill on the shore of the Caspian Sea; measuring air emissions from swine, poultry, and dairy operations across the United States; developing innovative technologies for cleaner soil, air, and water, and the beneficial use of wastes; helping create a strategic plan for riverfront development in Lafayette-West Lafayette, Indiana; and by leading scores of other research projects and educating the next generation of scientists, engineers, teachers and responsible citizens.

Since coming to Purdue after a 30-year career on the faculty at Texas A&M University, it was inspiring to me to observe the remarkably optimistic view and entrepreneurial attitude the people of Indiana have toward environmental issues. In Indiana people seem to say "We can do things differently, better, and clean up the environment at the same time." This optimism is apparent in the faculty at Purdue, the government, and the people of the state. I believe that the future will bring solutions to our problems and that this university will lead the way to many of them.

John Bickham
Director of Purdue's Discovery Park
Center for the Environment

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Human Health and Disease

Researchers from the departments of forestry and natural resources and veterinary pathobiology at Purdue as well as from Ohio State University and Wheaton College are working together to develop a cost-effective treatment regime for controlling the prevalence of raccoon roundworm in rural and urban environments, thereby improving quality of life for the general populace by decreasing human health risks associated with exposure to this parasite. The ultimate goal of the project, led by Gene Rhodes in forestry and natural resources, is to establish a strategy for the distribution of medicated baits that when eaten will deworm wild raccoons and minimize the probability of human infection by this potentially lethal parasite. This project is built upon a foundation of previous research by members of the research team and has revealed a wealth of critical information about the ecology of both the parasite and its raccoon host in the agricultural landscapes of northern Indiana. The successful development of treatment strategies for raccoon roundworm will lead to improved quality of life for individuals living in areas where raccoon roundworm exposure is a threat and will also provide economic development opportunities through the creation of a service industry for delivering parasite treatments in both rural and urban environments.

James Beasley

Soil Remediation

Contamination of soils with heavy metals is fairly common in areas of heavy industry, mining, refining, and manufacturing. When metal concentrations exceed regulated limits, the typical approach is to remove the contaminated soil and bury it in a landfill designed for hazardous materials. A Purdue research team is pursuing an alternative to landfilling in which the metals are treated with benign amendments that fix the metals in place and greatly reduce the opportunity for further spread of the contamination. Paul Schwab, Cliff Johnston, and Darrell Schulze of agronomy and Kathy Banks of civil engineering have been funded by the Department of Defense to study soils highly contaminated with metals. They have tested the additions of phosphate fertilizers, lanthanum, cerium, and manganese to soils with high concentrations of lead, cadmium, arsenic, and chromium. They were quite successful in "fixing" all the metals with the exception of arsenic, which continues to remain elusive.

Soils in a metal contaminated wetland being sampled by Darrell Schulze, agronomy.

In another study, phytoremediation is used to decontaminate cyanide from soil. Cyanide-bearing chemicals can be introduced into soils through the processing of ores, gasification of coal, and deicing road salts. Free cyanide is known to be highly toxic, and suspicions are rising about other industrial chemicals containing cyanide. A Purdue research team led by Paul Schwab and Gebisa Ejeta from agronomy and Kathy Banks of civil engineering has been examining the use of plants to remove the cyanide from soils and render it harmless. The plants being studied include cyanogenic species – those that accumulate cyanide during their growth cycle but later degrade them. These plants have shown promise for remediating cyanide-contaminated soils by removing the contaminant from the soil and accumulating it in the plant tissue. The cyanides are decomposed by the plant's unique enzyme system, thus eliminating concerns about spreading the contaminant after consumption by grazing animals. The researchers are looking forward to testing these plant-based remediation approaches in the field.

Watershed Models Used for Hydrological Processes

Management of sediments and associated contaminant losses over watersheds is an important problem for hydrologists and environmental engineers. Purdue engineers Mazdak Arabi, Bernie Engel and Rao Govindaraju are very interested in establishing the benefits of best management practices (BMPs) in watersheds. By using state-of-the-art modeling tools and optimization methods, they answer two important questions (i) which BMP should be selected, and (ii) where should it be placed in a watershed, so that the best possible results are obtained for meeting water quality standards while minimizing costs.

Gene-environment Interactions

The environment influences our health and well-being, and yet, we know that not everyone responds to the environment in the same way. Individual responses are due to differences in our genes. Researchers are exploring the basis for an individual's response to a variety of factors in our environment, such as chemicals and microbiological agents in our soil, water, and in the foods we eat. For instance Debbie Knapp and Larry Glickman, veterinary medicine, study why Scottish Terriers are more likely than other dog breeds to get bladder cancer when they are exposed to common lawn chemicals and why hyperthyroidism in older cats is so common and has been associated with cats eating foods packaged in cans containing certain chemicals in their lining. By understanding the molecular basis of this process, they hope to improve the health of companion animals and to translate this information to benefit humans. David Salt, horticulture, studies the genetic basis for how plants accumulate both essential and toxic mineral elements. This work will identify improved varieties of food plants that could avoid toxic elements while accumulating beneficial mineral nutrients.

Drs. Debbie Knapp, Andy Abbo, second year resident, and Albert.

Gene-environment interaction research at Purdue examines the genetic variation inherent in all living organisms in order to identify traits that can be used to make plants useful for bioremediation or to fuel the development of novel foods and therapeutic agents that could lead to improved human and companion animal health.

Predicting and Preparing for Climate Change

Climate Modeling

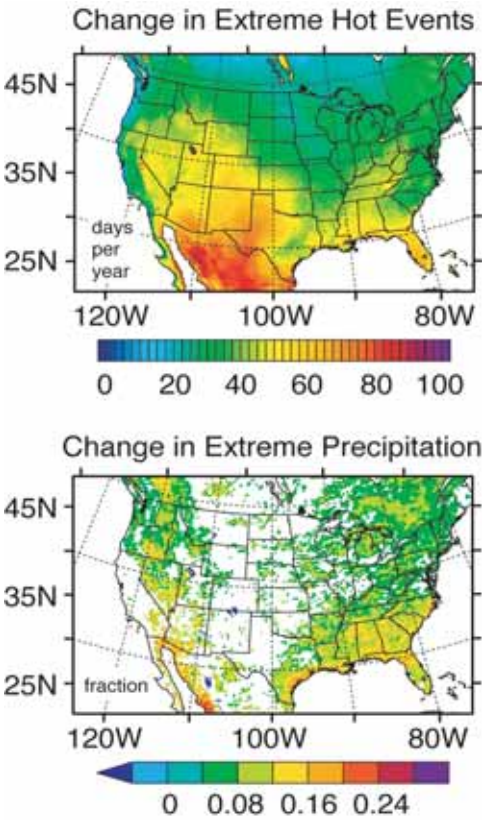
The Purdue Climate Change Research Center (PCCRC) brings together researchers from all academic units to develop an integrated understanding of the global and regional impacts of climate variability and change. Mapping the carbon footprint of fossil fuel emissions in the U.S., simulating sub-daily extreme rainfall events in future climates, and reconstructing past climates to better understand future modern global warming are a few of the many research investigations being carried out in the center.

Matt Huber, earth and atmospheric sciences, and doctoral student Ryan Sriver developed climate change models based on new calculations from data collected over the last 40 years. Their model confirms reports by two other leading research institutions (MIT and the Georgia Institute of Technology) concluding that rising sea-surface temperatures are linked to a trend of more globally intense tropical cyclone activities. Huber's research findings provide a tool for officials and scientists seeking insights into the potential damage that could be caused by storms. (http://news.uns.purdue.edu/html4ever/2006/060530.Huber.cyclones.html)

Urbanization is altering the global landscape at an unprecedented rate. Utilizing both simulated and observed streamflows from several large urbanized watersheds and their sub-basins within the Upper Great Lakes region, the work by Laura Bowling, agronomy, explores how changing spatial extents of urban and forested areas affect episodic, hydrometeorological events both for current and projected land use.The central objective of this project is to study the interactions between land cover change, weather, and surface hydrometeorology, with a specific focus on the impacts of urbanization within the Upper Great Lakes region.

In another study funded by the National Science Foundation, Noah Diffenbaugh, earth and atmospheric sciences, quadrupled the amount of spatial data collected to create climate models of unprecedented detail. The climate model forecast confirms an accumulating body of scientific evidence that suggests that changes in our climate will be significant enough to disrupt our national economy and infrastructure. The climate change model generated at Purdue has been cited as the "most detailed simulation of climatic change in the U.S." by Stanford professor, Stephen Schneider. (http://news.uns.purdue.edu/html4ever/2005/051017.Diffenbaugh.model.html)

"The Earth's climate is changing, and the results are having an enormous impact on the biology of our planet ..."
Paul Shepson, director of the Purdue Climate Change Research Center



The above graphics illustrate some of the changes in climate predicted for the 21st century by Purdue University's Noah Diffenbaugh and his team of scientists using a computer simulation. The colored bar for the top graphic indicates the number of days per year where temperatures are projected to rise above the current daily maximum temperatures for a given area. The simulation indicates that the entire continental United States will experience more intense heat waves, most dramatically in the desert Southwest. The figure below indicates that several areas, notably the Gulf Coast, will experience more storms that bring heavy precipitation. The colored bar indicates the contribution of the heaviest precipitation to the total precipitation, as a fraction. Regions that are white are not expected to change. (Purdue graphic/Diffenbaugh Lab)

There is a global effort to quantify the sources and sinks of carbon dioxide in the northern hemisphere, including the mysterious removal of a large amount of carbon dioxide from the Earth's atmosphere known as the "missing sink". PCCRC scientists are approaching this problem from a variety of ways and at scales that span from the molecular to the global. In a collaborative effort between aviation technology, chemistry, and earth and atmospheric sciences, Paul Shepson has developed a light aircraft platform that is used to measure the impact that nitrogen compound deposition from the atmosphere has on the uptake of carbon dioxide in forests. Through flight campaigns planned across North America, from the Midwest to the Alaskan Boreal Forest, Shepson's measurements will provide data that investigators like Qianlai Zhuang and Kevin Gurney, agronomy and earth and atmospheric sciences, incorporate into global and regional scale models to better understand the carbon exchanges between terrestrial ecosystems and the atmosphere.

A large-scale, NSF-funded Biocomplexity in the Environment research project aimed at understanding how societies in East Africa cope with climate change is in progress by Bryan Pijanowski and his students in forestry and natural resources (pictured above). Research is being conducted that combines complex computer simulations coupled to role playing games — an approach that assigns individuals roles where they act out their decisions under certain circumstances — across agricultural intensive areas of Kenya, Uganda and Tanzania. The work is one of the first that will integrate how society responds to both climate and land use changes at a regional scale. Early work suggests that cropping livelihoods are less resilient to climate changes than traditional pastoralist ways of life and that highly diverse agricultural strategies lead to less vulnerable livelihoods given uncertain climate changes.

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Learning

Understanding the dynamic, complex processes that link human activity and ecological systems is essential to improving the way we manage our natural resources and develop solutions.

Effective discovery and learning in the environmental area requires collaboration among biological, chemical, computational, physical, health, and social scientists, mathematicians, and engineers. Courses at the undergraduate and graduate level are opening new avenues for learning and discovery by examining the interfaces between these disciplines.

At the graduate level, the Ecological Sciences and Engineering Interdisciplinary Graduate Program provides students with an interdisciplinary/interdepartmental educational experience that integrates the science and engineering concepts needed to understand environmental and ecological phenomena.

Interest in the environmental and ecological field is increasing, and it is projected that there will be a 27 percent increase in the number of environmental engineering positions in the current decade. Purdue's College of Engineering has created a new academic division in the environmental and ecological field in response to that need. Inez Hua, civil engineering, serves as founding interim head of the new Division of Environmental and Ecological Engineering. The division will help foster research, offer seminars and give students a greater overall understanding of how engineering can improve the environment.

A newly developed freshman Pre-Environmental Studies Program has recently been established and will be administered through the College of Agriculture. The Pre-Environmental Studies program is intended to serve as a single portal for students entering Purdue with an interest in environmental studies who are uncertain as to the particular area or specific program of study in which they want to enroll. We believe this is the first of its kind in the country. This program will allow students during their first year at Purdue to take courses and explore more than a dozen majors related to the environment that Purdue offers. Students will be advised by a team of faculty representing programs from the colleges of agriculture, science, and engineering.

Sustainable Purdue

A course offered by PCCRC members, Leigh Raymond, political science, and Kevin Gurney, agronomy and earth and atmospheric sciences, incorporates the activities of discovery and learning into a graduate level course in public policy. The course is called Carbon Neutrality at Purdue, and the objective is to determine the magnitude of Purdue University's carbon footprint. A carbon footprint is a measure of the impact of human activities on the environment in terms of carbon dioxide units. The final project is a carbon management plan for the campus aimed towards achieving "carbon neutrality" at Purdue.

Revitalizing "Our Town"

An environmental outreach program from Purdue promotes turning hazardous sites into economic opportunities."Our Town" is an EPA-sponsored program with the goal of educating K-12 students about brownfields in their community and what can be done about them. Brownfields are sites that are not being redeveloped or reused because of real or perceived contamination. The Our Town Program created a curriculum for use in schools, which is broken down into five modules spanning late elementary through high school aged students.

"Ours is the first of its kind in terms of actually implementing brownfield redevelopment into a K-12 education program," says Dan Somerville, Purdue's Our Town program manager, but he and Kathy Banks, Our Town program director, hope to see schools working to reclaim brownfields on a nationwide basis.

"The basic initiative behind the whole idea was to help communities develop economic zones in areas that were unproductive," says Banks. "It's an interesting aspect because you think of brownfield development from an environmental perspective, but to be honest it is really an effort at economic development."

https://engineering.purdue.edu/Engr/Research/Focus/RevitalizingOurTown/

In addition to a university-wide dialog on the environment, experts at Purdue reach out to local and regional communities, businesses and industry, and government agencies.

Engagement

An essential component of the discovery and learning activities at Purdue includes sharing the knowledge gained from research and creating educational opportunities for larger communities. Purdue's Office of Engagement plays a critical role in this mission. Vic Lechtenberg, provost for engagement at Purdue, and Sam Cordes, both co-directors of the Purdue Center for Regional Development (PCRD), invited Bob McCormick from forestry and natural resources to speak at a workshop for regional development community leaders that examined innovative ideas for economic development and governance. McCormick introduced a new program, Planning with POWER (Protecting Our Water and Environmental Resources), at a state-wide educational program linking land use planning with watershed and natural resources planning at the local level.

Communities can choose how much involvement and help they require to address their interests and needs.

Purdue investigators provide the following expertise to assist local decision makers with environmental assessments:

- Long-Term Hydrologic Impact Assessment (L-THIA) — a tool that provides estimates of changes in surface runoff, recharge and nonpoint source pollution resulting from past or proposed land use changes;
- Residential on-site wastewater alternatives;
- Urban forestry and on-site tree conservation management;
- Stormwater, natural resource planning, and green infrastructure;
- Engaging Citizens as Stewards of Ecosystems (ECASE);
- Utilizing Upper Wabash Basin predictive model of land use change on natural resources to assist in making local planning decisions;
- Development and evaluation of ecosystem indicators for urbanizing Midwestern watersheds;
- Research examining seven watersheds in central Indiana that are in transition from rural to urban.

The Purdue Extension Land Use Team and the Indiana Conservation Partnership also are partners in Planning with POWER. Seed funding for the program originated from Purdue's Discovery Park Center for the Environment.

Helping Communities and Businesses Improve Environmental Performance

The Indiana Clean Manufacturing Technology & Safe Materials Institute (CMTI) at Purdue, directed by Lynn Corson, began operations in 1994 with the purpose of serving as the state's focal point for coordinating and deploying technical assistance, outreach, education, planning services and research to facilitate the adoption of pollution prevention/clean manufacturing strategies by Indiana manufacturing facilities. CMTI has provided technical assistance to thousands of Indiana manufacturers in all manufacturing sectors and offers special expertise in plastics (including fiber reinforced plastic), wood products, metal finishing, metal and plastic coatings, foundries and motor vehicle parts manufacturing. CMTI has helped manufacturers reduce the generation of environmental waste by over 7,400 tons while reducing costs for these same companies by an estimated $14 million.

Working with the Community — a Center for the Environment project

Researchers from landscape architecture, soil microbiology, forestry and natural resources, engineering, and chemistry are working together with community leaders and the public to create a strategic plan for establishing the Wabash as a healthy major river that could provide quality recreation and economic value to the state. The project, led by Kim Wilson in landscape architecture and Ron Turco in agronomy, is called Living Laboratories on the Wabash. It is focused on river corridor planning and restoration design that connects natural processes and cultural needs, ultimately leading to informed choices about land use and management practices. The living laboratory will be used by researchers implementing new technologies for monitoring and detecting water quality. In addition, community-based research will share information about restoration initiatives and applications, and a learning environment will provide a variety of instructional settings on the river where students of all ages can learn about the Wabash River Corridor.

Photos by Jonah Duckles

Quality of life issues directly impact economic performance.

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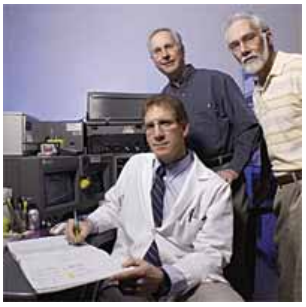
Discovery to Commercialization

Purdue's Office of Technology Commercialization assists scientists with the process of moving new technologies developed at Purdue into the public sector. Listed here are some examples of technologies that have the potential to improve water quality.

UV Water Disinfection System

Three investigators from across campus created the right combination for developing a cost-effective UV water disinfection system that can eliminate microorganisms that threaten drinking water supplies. Ernest "Chip" Blatchley III (seated), civil engineering; Donald Bergstrom (center), medicinal chemistry and molecular pharmacology; and J. Paul Robinson (right), biomedical engineering and immunopharmacology, and director of Purdue's cytometry laboratory formed a research collaboration to develop a method to measure the distribution of UV doses. The ability of a UV system to disinfect drinking water depends on the "dose" of UV delivered to the microorganisms in the water. Patents are in the works, and there is widespread interest in the process from water utilities across the country.



InMass Technologies, Inc.

Because wetlands cannot be drained or developed, there is much interest in defining whether a specific tract of land qualifies as a wetland. A device was invented by Purdue agronomists, Donald Franzmeier and Byron Jenkinson, that indicates if tested ground meets the criteria of a wetland soil. The instrument, called the Indicator of Reduction in Soils (IRIS) is being marketed by InMass Technologies, Inc., a start-up company located in the Purdue Research Park.

Agri Processing Services, LLC

Purdue researcher, Bud Harmon, animal sciences, and Timothy Ortman, Agri Processing Services LLC, won second place in the Opportunity for Indiana Business Plan Competition hosted by Purdue in 2005 for their plan to develop Agri Processing LLC. The plan was based on Harmon's patented cost-effective process that allows food processing plants to recover fats, proteins, phosphorus and/or carbohydrates from their wastewater stream. Advantages include cleaner wastewater, reduced tipping fees at landfills, and a valuable by-product that can be sold as an animal feed supplement. Agri Processing Services, LLC, is located in Carmel, Indiana.

A Look Underground

For Joe Sinfield, an assistant professor in civil engineering, the chance to quickly identify compounds underground is the driving force behind his desire to miniaturize laboratory equipment that can be taken straight to the fields. Shown above in the lab with Oliver Colic, a graduate student in electrical and computer engineering, Sinfield is very much a cross-disciplinarian pursuing the development of a real-time, mobile *in situ* sensing system capable of monitoring levels of compounds such as nitrogen and phosphorous in farmland effluent, animal wastes, and cultivated soils using optical spectroscopic techniques.

"Traditionally," he says, "to do this type of assessment, we'd collect field samples at a limited number of dispersed locations and perform in-laboratory analysis using a range of wet chemistry and bench-top spectroscopic techniques. That approach, however, is expensive, time-consuming, and limited in value due to the inherent spatial variability of the quantities under investigation and the limited amount of information gathered from the few samples that can be cost-effectively analyzed."

This work, utilizing recent advances in diode laser technology and fiber optics, promises real-time capabilities on site, provides greater spatial resolution and convenience at as little as one-tenth the cost.

— by Lisa Hunt Tally
https://engineering.purdue.edu/CE/Feature/LookUnderground/

A New Class of Detector

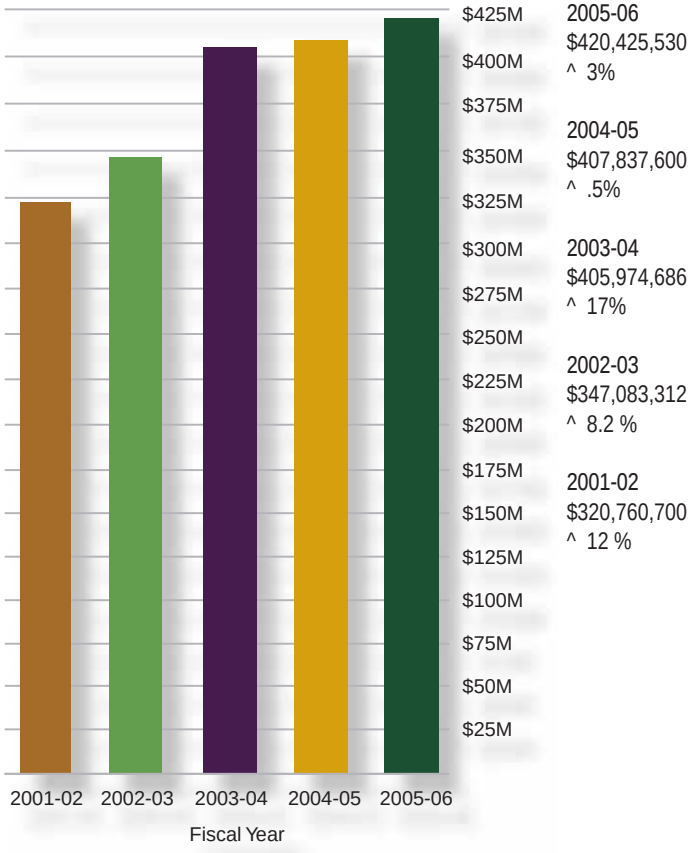
A technique developed at Purdue, called desorption electrospray ionization (DESI) eliminates the pretreatment steps to prepare samples for mass spectrometer analysis enabling accurate identification of pathogens in a matter of seconds. The combination of the DESI pretreatment method with portable mass spectrometers, which are under development at Purdue, promises a new class of compact detectors. Such a detector could quickly analyze foods, medical cultures and the air in hospitals, subway stations and airports, says Graham Cooks, chemistry, and leading developer of the shoebox-sized mass spectrometer.

Much of the research funding was provided by NSF, the Office of Naval Research and by Prosolia through the *Indiana 21st Century Research and Technology Fund.*

2005-06 Research Data

Each year, researchers at Purdue compete for funding from a variety of state and federal agencies, foundations and industry. Proposals are developed by individuals and increasingly through collaborative partnerships with faculty at both Purdue and with other institutions. Creative minds working alone or in teams have resulted in years of consistent growth in sponsored program funding. Purdue's commitment to research and discovery is reflected in the following research expenditures for the 2005-2006 fiscal year.

Systemwide Research Expenditures



2005-06
$420,425,530
^ 3%

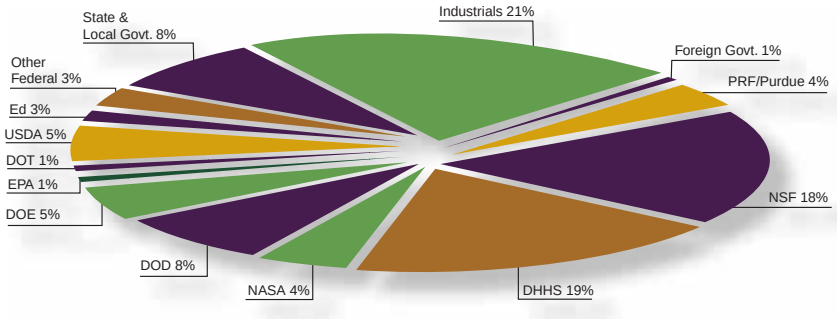
2004-05
$407,837,600
^ .5%

2003-04
$405,974,686
^ 17%

2002-03
$347,083,312
^ 8.2 %

2001-02
$320,760,700
^ 12 %

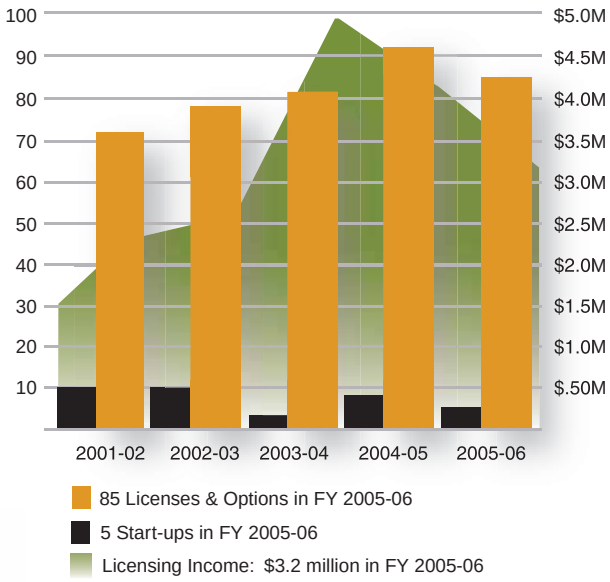
Sources of Research Funding by Sponsor



Office of Technology Commercialization Summary

The 2005-06 fiscal year has been highly successful for the Purdue Research Foundation in the arena of technology commercialization. The Office of Technology Commercialization (OTC) continues to establish itself as a strong and committed partner to Purdue's efforts to become a preeminent technology transfer organization and an important driver of economic development and value for the state of Indiana.

- Start-ups in FY 2005-2006: 5
- Licensing revenue: $3.2 million
- Number of licenses: 85
- Provisional patent applications filed: 134
- Regular patent applications filed: 78
- Patents issued: 33



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This report is not intended to be a comprehensive summary of environment-related research activities at Purdue University.
Purdue University News Service, Agriculture Communications, and the Engineering Communications Office contributed to this report.
Please visit the urls listed below for more information on research activities at Purdue.
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