Discovery With Delivery Metrics
Purdue University's Discovery Park

Purdue University's Discovery Park was created in 2001 to transform how knowledge is generated, integrated, and applied in local, regional, state, national, and global businesses and communities. Discovery Park is an integrated, interdisciplinary hub of eleven centers created to support discovery and learning and drive the delivery of innovation.

Purdue University's Strategic Plan, approved in 2008 under President France Córdova, explicitly establishes three synergistic priorities for the University: Discovery with Delivery, Launching Tomorrow's Leaders, and Meeting Global Challenges. This document reflects metrics for the pivotal role that Discovery Park plays in Purdue's capabilities to deliver innovative discoveries to the marketplace and to society.

For the fiscal year 2007-2008, Discovery Park delivered the following:

1. **444** submitted grant proposals for a total of **$391,083,924**
2. **240** awarded grant proposals for a total of **$73,824,236**
3. **$68,196,051** of awarded grant proposals were new; **$5,628,186** were continuing proposals
4. **80** industrial proposals for **$8,004,069** were awarded to faculty/projects associated with Discovery Park
5. **11** proposals, each for over $1 million, were submitted; **3** proposals were funded over $10 million
6. **31** disclosures were completed with **4** licenses/options
7. **4** new start-up companies were facilitated (this figure is for the calendar year 2007)
8. **703** peer reviewed publications resulted from faculty and projects connected with Discovery Park (this figure is for the calendar year 2007)
9. **452** graduate students were funded for Discovery Park projects
10. **184** undergraduates were funded for Discovery Park projects
11. **$1,383,927** was spent to improve facilities and equipment for the Purdue University campus

Examples of this data follow on the next pages.

GRANT PROPOSALS and AWARDS

Interdisciplinary research on the Purdue campus has increased substantially through Discovery Park. The 444 proposals submitted in fiscal year 2007-08 included 69 different collaborative areas within Purdue University; the 240 awards for that time period reflect 45 collaborative areas at Purdue University. These 45 areas encompass departments from all ten academic colleges/schools as well as several administrative areas like Information Technology and the Office of Engagement. Interdisciplinary collaboration is one of the hallmarks of Discovery Park.

Federal agencies and programs provide significant opportunities for large, interdisciplinary grants; hence, it is not a surprise that federal agencies are a big source of the funding for Discovery Park. Federal agencies and programs account for 51% of the sponsored funding for Discovery Park; state funding accounts for 21%.

In addition to the sponsored funding provided to Discovery Park from industrial sources--$8,004,069 for this time period, several Discovery Park Centers also developed important partnerships with corporations. These partnerships often led to sponsored funding for faculty research. For example, the Bindley Bioscience Center has 19 corporate partners. Their work with companies has led to five SBIR (Small Business Innovation Research), STTR (Small Business Technology Transfer), or 21st Century Awards. The Cyber Center held two industrial workshops in 2007-08 that were attended by 169 industrial participants. The Burton D. Morgan Center for Entrepreneurship includes partnerships with 45 companies whose active participation has resulted from either the Certificate in Entrepreneurship and Innovation Program or the Technology Realization Program.

Selected examples of funded proposal titles include:

Social, Economic, and Political Aspects of US Ethanol Policy, Energy Center, $749,961, National Science Foundation

Network for Computational Nanotechnology, Birck Nanotechnology Center, Cyber Center, $18,241,665, National Science Foundation

Accelerating Nano-scale Transistor Innovation through Petascale Simulation, Birck Nanotechnology Center, Cyber Center, Network for Computational Nanotechnology, $1,599,205, National Science Foundation

Advanced Methods in NMR-Based Metabolomics, Bindley Bioscience Center, $1,470,580, PHS-NIH NAT Inst. Ofc General Medical Sciences

Spray & Combustion of Gelled Hypergolic Propellants, Energy Center, $6,250,000, Army Research Office

PRISM: Center for Prediction of Reliability, Integrity and Survivablity of Microsystems, Energy Center, Birck Center for Nanotechnology, $17,000,000, US Dept. of Energy

Indiana Center for Assistive Technology, Regenstrief Center for Healthcare Engineering, E-Enterprise Center, $1,486,346, Indiana Family and Social Services Administration

Mapping the Condition of Diporeia Insights to Mechanisms of Designs, Center for the Environment, $569,513, Great Lakes Fishery Trust

Electronic Field Trips in Comparative Biology, Discovery Learning Center, Bindley Bioscience Center, $749,754, Howard Hughes Medical Institute

PATENTS/LICENSES/DISCLOSURES

Discovery Park was conceived to drive the delivery of discoveries to society. To facilitate the discovery, development, and delivery processes, Discovery Park has created a pipeline to move new technologies and new ideas from the laboratories to the Purdue Research Parks. This innovation pipeline provides staff support for faculty research to identify new markets and new funding sources. Discovery Park provides programs to assist faculty, staff, and students with a broader and deeper understanding of the unique complexities associated with a start-up company. The Burton D. Morgan Center for Entrepreneurship provides coursework and training for faculty, staff, and students interested in entrepreneurial issues.

The metrics for Discovery Park reflect facilitation of 31 completed disclosures with 4 licenses/ options. Discovery Park contributes significantly to Purdue University's accomplishments in technology commercialization.

Following are two examples of disclosures that grew out of research at Discovery Park. While both of these examples are in the biotechnology sphere, Discovery Park staff are working with faculty technologies in many areas. Discovery Park's contributions to the biosciences and biotechnology areas are worth noting, however.

GSIST and GILISA Labeling Strategy. Quantification of intracellular metabolites is seen as a key step in furthering the understanding of cellular carbon metabolism. Researchers at Purdue University have designed a new high throughput method to identify and quantify key intracellular carbon metabolites. Their new method utilizes Group Specific Internal Standard Technology (GSIST) and a Global Isotope-labeled Internal Standard Addition (GILISA) labeling strategy. Their GILISA labeling strategy utilizes unique internal standards, allowing for direct quantification of known metabolites and relative abundance of unknown metabolites. This technology allows researchers to separate, quantify, and identify all carbon metabolites in a single 30 min LC-MS run, including sugars with identical molecular weights, due to the labeling strategy. The precise quantification of the changes in metabolite concentrations is critical to systems biology, and holds the promise of identifying important relationships between these molecules, protein, and other gene products. A more complete understanding of these relationships may hold the key to unraveling complex disease states. Dr. Jiri Adamec, Assistant Professor with Purdue University's Bindley Bioscience Center, was the lead inventor on this technology, collaborating with Dr. Fred Reigner, Professor of Chemistry at Purdue University, and Dr. Wen-Chu Yang, a post-doctoral research assistant in the Department of Chemistry, Purdue University.

Biomarkers for Cancer Metastasis. Metastatic cancer occurs when cancer cells break away from the primary tumor and travel through the bloodstream or lymphatic system and form a new tumor elsewhere in the body. Researchers at Purdue University have developed a method utilizing proteomics to identify altered protein expression levels present in metastatic tumors, and not primary tumors. They are developing this technology to identify key biomarkers in metastatic tumors. This technology could be used as a noninvasive and inexpensive way for physicians to predict metastasis and plan treatments accordingly. The multi-disciplinary Purdue research team consisted of Dr. Sulma Mohammed, Associate Professor of Cancer Biology with Purdue University's School of Veterinary Medicine, collaborating with Catherine Riley, a graduate research assistant, Dr. Jiri Adamec, Assistant Professor with Purdue University's Bindley Bioscience Center, Elwood Walls, a Continuing Lecturer with Purdue's Department of Biological Sciences, Dr. Xiang Zhang, also with Bindley Bioscience Center, and Charles Buck, Director of Operations of Bindley Bioscience Center.

START-UP COMPANIES

Discovery Park connects faculty researchers with the Office of Technology Commercialization. Discovery Park also facilitates the creation of start-up companies based upon the work of the Technology Commercialization staff. One of the "big" mission areas of Discovery Park is the creation of a campus culture that is entrepreneurial. Discovery Park, through the Burton D. Morgan Center for Entrepreneurship and the Discovery Learning Center, supports several programs targeted at students, staff, and faculty for a better appreciation of the commercializable aspects of their work. These programs provide the educational tools essential to be a successful entrepreneur. Opportunities to learn about the world of venture capital and to network in these circles are offered. Students participate in the Interns for Indiana program which places them in start-up companies. Over 1400 undergraduate students have enrolled in the Certificate in Entrepreneurship and Innovation Program. Graduate students participate in the Technology Realization Program. Faculty and staff participate in the Academic Bootcamp and the Entrepreneurial Leadership Academy. All of these programs are Discovery Park investments in transforming Purdue's culture.

The tangible outcomes of these investments are start-up companies. Since 2001, Discovery Park has facilitated the development of 29 start-up companies. Most of these companies are located at the Purdue Research Park, but not all. These companies span many business sectors. In 2007 (calendar year), Discovery Park facilitated the development of four start-up companies.

Four Start-up Companies Facilitated in 2007 by Discovery Park

- AlGalCo
- Cytometry for Life
- Moerae Matrix, Inc.
- National Institute of Pharmaceutical Technology

Profiles for these four companies are provided following.

AlGalCo has the exclusive license from Purdue University to commercialize a new technology in which hydrogen gas can be generated simply by adding water to a solid alloy comprised of 95% common aluminum. Hydrogen is considered by many to be the ideal solution to our energy needs. It burns cleanly in a standard gasoline or diesel engine as well as in a fuel cell. The problem with hydrogen is that storage and transportation must be under very high pressure; until now. AlGalCo's solid alloy is completely safe, inert, and can be stored indefinitely at regular atmospheric pressure. The aluminum used for the alloy can be standard industrial grade or scrap aluminum from old cars and recycled beverage cans. After reacting with water, the aluminum becomes alumina which can be sold into a very active market. The other 5% of the alloy is gallium which serves only as a catalyst and is not consumed in the reaction. The process has been established to easily and inexpensively recover the gallium and incorporate it an unlimited number of times into fresh alloy. The first application is a one kilowatt in-home, emergency portable generator for medically fragile customers living in rural areas. Since hydrogen burns cleanly, gensets can be placed directly where they are needed and all necessary medical devices operated for as long as the grid is down. The successful Phase II preproduction genset demonstration may be viewed: www.youtube.com, AlGalCo I, Phase II demo. A five kilowatt genset to power an entire home as well as a water purification application is also ready for commercialization.

Cytometry for Life, is a not-for-profit Foundation that strives to reduce the cost of medical diagnostics in resource-limited countries. The focus of the organization is the devastating problem of HIV/AIDS in Africa where nearly 70% of the population (those in rural areas) do not have access to CD4 diagnostics and therefore fail to qualify for life-saving therapeutic drugs. In conjunction with the Purdue University Cytometry Laboratories within the Bindley Bioscience Center in Discovery Park at Purdue University, a very low cost diagnostics instrument has been developed that can be operated in rural regions and does not require utilities or extensive laboratory resources. In partnership with Purdue, Cytometry for Life strives to bring low cost diagnostics in a way that is useful and effective to resource-limited regions of the world. www.cytometryforlife.org

Moerae Matrix is a development-stage biotechnology company focused on creating novel, locally-active peptide therapeutics -- drugs that mimic or block active portions of proteins naturally produced by the body to mediate key biologic functions. Four compounds, currently in the preclinical stage, have been generated to date from Moerae's discovery platform. These drugs will be developed for high-value market applications in general surgery, oncology, rheumatoid arthritis and wound healing. Current corporate resources (SBIR, matching state and angel funds) have been utilized to establish proof of concept in animal models (lead drug) or animal tissues. The Company seeks $1MM to accelerate work in support of IND submission for its lead drug in surgical scar and adhesion prevention. The therapeutic drug IP is all held through PRF.

National Institute for Pharmaceutical and Technology Education (NIPTE) is an independent, nonprofit organization representing 11 U.S. universities that are leaders in pharmaceutical science and engineering. In addition to Purdue, the other member universities are Duquesne University, Illinois Institute of Technology, Rutgers University, the University of Puerto Rico, the University of Connecticut, the University of Iowa, the University of Kansas, the University of Kentucky, the University of Maryland-Baltimore, and the University of Minnesota. The consortium was created specifically to work with the FDA and industry to enhance the way pharmaceutical products are being developed and manufactured by increasing the quality and education of best practices used.

Also in 2008, TrustBearer Labs began a new product, Identity Alliance, which had its roots in the Purdue Research Foundation's Office of Technology Commercialization and was facilitated by Discovery Park.

TrustBearer Labs is an authentication solutions provider with over 10 years experience developing products and custom software for trusted devices such as smart cards, biometrics, and USB tokens. Staff members include software engineers, project managers, and graphic/web designers with experience in all aspects of trusted device and security software development. TrustBearer Live, the company's flagship product, simplifies integration of trusted devices with web-based applications enabling instant deployment of online applications for trusted devices on a variety of platforms. TrustBearer Labs is located in downtown Fort Wayne, IN.

SCHOLARSHIP—PEER REVIEWED PUBLICATIONS

The first route for the delivery of new knowledge to society is through publications. Peer-reviewed publications contribute to faculty evaluations and university rankings. Peer-reviewed publications disseminate knowledge across the globe and become the foundation for the next generation of scholars. Discovery Park expands the publications of Purdue's faculty and students through cutting edge facilities, through the integrated, interdisciplinary teams that are the core of Discovery Park, and through administrative support for these teams. Discovery Park has expanded the research capabilities of Purdue and the delivery of knowledge from Purdue to the world. The peer-reviewed scholarship published by faculty affiliated with one of the Discovery Park Centers is making a mark: the identification of 703 peer reviewed publications by faculty affiliated with Discovery Park for the 2007 calendar year is a significant number.

In addition to this measurement of scholarship, other markers of knowledge delivery are important. The Cyber Center has contributed to the development of eleven new software systems. Both the Regenstrief Center for Healthcare Engineering and the Center for the Environment identified Ph.D. and Master's theses related to research facilitated or funded through their centers: Six for Regenstrief and five for the Center for the Environment.

Rather than the provision of a sampling of the scholarship across Discovery Park, this report highlights a publication from the Birck Nanotechnology Center which reflects a core value of Discovery Park—collaborative scholarship. Collaboration among faculty who conduct research in the Birck Center has risen dramatically. From 2005 to 2007, publications surged 26 percent to 191 from 151, while the number of joint publications more than doubled to 34 from 15. These figures reflect a significant jump in collaborative scholarship. Following is an example of this synergy from the Birck Nanotechnology Center:

> R. R. Lahiji, B. D. Dolash, D. E. Bergstrom, R. Reifenberger. 2007. Oligodeoxyribonucleotide Association with Single-Walled Carbon Nanotubes Studied by SPM. *Small* 11, 1912-1920.

Other examples of collaborative scholarship:

> Huff, T. B.; Hansen, M. H.; Tong, L.; Zhao, Y.; Wang, H.; Zweifel, D. A.; Cheng, J.-X.; Wei, A. (2007). Plasmon-resonant nanorods for two-photon luminescent imaging and photothermal therapy, Proc. SPIE 6448, 11. Oncological Sciences Center, Chemistry and Biomedical Engineering
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> Liu, J., L.S. Lee, L.F. Nies, C.H. Nakatsu and R.F. Turco. 2007. Biotransformation of 8:2 Fluorotelomer Alcohol in Soil and by Soil Bacteria Isolates, *Environ. Sci. Technol*. 41(23): 8024-8030. Research collaboration in microbiology, soil chemistry, and environmental engineering.
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> Rakesh Agrawal, Navneet R. Singh, Fabio H. Ribeiro, W. Nicholas Delgass. Sustainable fuel for the transportation sector. *Proceedings of National Academy of Sciences*, approved February 5, 2007. Energy Center.
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> Y. Zhao, J. C. Fleet, J. Adamec, D. E. Terry, X. Zhang, S. Kemeh, V. J. Davisson, C. M. Weaver. Effects of hindlimb unloading and bisphosphonates on the serum proteome of rats. *Bone*, Vol. 41 – Issue 4, pages 646-58. Bindley Bioscience Center, Foods and Nutrition, and Medicinal Chemistry and Molecular Pharmacology.

GRADUATE STUDENTS WORKING ON DISCOVERY PARK PROJECTS

The transfer of knowledge and skills to Purdue students is an important facet of Discovery Park's capabilities. Discovery Park links faculty from every Purdue discipline in collaborative projects, and these projects involve and educate numerous graduate students. These collaborative, interdisciplinary teams expand the educational experiences of Purdue's graduate students and better prepare them for the faculty and research roles they will soon assume. The Bindley Bioscience Center housed 93 graduate students and the Birck Nanotechnology Center housed 188 graduate students in 2007-2008. Many more graduate students work from offices and labs around the campus on integrated, interdisciplinary Discovery Park projects. Following are samples of graduate student projects:

Ruchith Fernando, Department of Computer Sciences
"Design and Development of a cceHUB Data Framework to Support the Uploading and Exploration of OMIC Data," Oncological Sciences Center

Daniel Fagerman, Civil Engineering
"In-situ Nitrogen and Phosphorus Sensing Using Diode Laser Raman Spectroscopy," Center for the Environment

Jessica O'Leary, Charles Jischke, Jon Gortat, Mary Ann Albrecht, Clayton Stobbs, and Susan Campbell, all MBA students, "SynergisT: Product Development Recommendations," Burton D. Morgan Center for Entrepreneurship, project in collaboration with Dr. James Morre, Department of Medicinal Chemistry

Xiaojun Chen, Educational Technology, "Evaluating Knowledge Transfer within VHA's Clinical Improvement Services," Regenstrief Center for Healthcare Engineering

Alan Brockman, Mechanical Engineering
"Biological Hydrogen Production and Chemical Hydrogen Storage," Department of Energy's National Renewable Energy Laboratory, Energy Center

Dinelia Rivera-Burgos, Chemistry
"Ëvaluation of Immunoaffinity Capture Based LC/LC-MS/MS Platforms," project in collaboration with Dr. Fred Regnier, Chemistry, funded by National Cancer Institute grant, Bindley Bioscience Center

UNDERGRADUATE STUDENTS WORKING ON DISCOVERY PARK PROJECTS

Enhancing learning for Purdue's undergraduate students is also a key mission of Discovery Park. In addition to the development of new curricula and courses (reflected in the Launching Tomorrow's Leaders metrics), Discovery Park consciously designs and supports programs to involve undergraduate students in the interdisciplinary research projects of Discovery Park faculty. The Discovery Undergraduate Research Internship (DURI) Program, administered through the Discovery Learning Center, is the centerpiece for undergraduate research. The DURI Program placed 102 students on interdisciplinary Discovery Park teams in the 2007-2008 fiscal year. Several Discovery Park centers include additional undergraduate students on faculty or center projects.

Mohd Rahmad, Electrical and Computer Engineering
"Building cceHUB Tools from Statistical and Population-based Research Codes for Cancer Care Engineering," Oncological Sciences Center

Kelly Collins, Elementary Education, College of Education
"The National Science Digital Library (NSDL) Video and Image Data Access (VIDA) Project," Discovery Learning Center and Center for the Authentic Practice of Science in Education

Shelby Koonce, Pharmacy
"Low birth weight and drinking water quality: a spatial epidemiological investigation," Center for the Environment

Jillian Jwienat, Health Sciences and Lindsey Morgenson, Pharmaceutical Sciences, "Rural Health Planning and Community Development in Kewanna," Regenstrief Center for Healthcare Engineering

John Farris, Chemical Engineering
"Splitting water with Al-Ga Alloys," Energy Center

Sheryl Woods, Biological Sciences
Ongoing project to discover microbial secondary metabolites that modulate intracellular pathways and possess drug-like properties, Bindley Bioscience Center

Additionally, the Oncological Sciences Center supports the Cancer, Culture, and Community Program which connected 95 undergraduate students directly with the featured writer/artist brought to campus.

FACILITIES/TOOLS/EQUIPMENT

The facilities afforded through Discovery Park to support research and new discoveries make a critical difference for faculty, staff, and students. In addition to the over $100 million in buildings at Discovery Park, the tools and equipment added contribute significantly to Purdue's research agenda. Since all of the equipment in Discovery Park is shared, the resources here are leveraged far more broadly than is typical when discussing laboratory space and equipment. Additionally, Discovery Park provides technical staff to support complicated and sensitive instruments and manage data.

In 2007, Discovery Park added $1.4 million worth of equipment to the Purdue University campus, much of it in Discovery Park. Since the inception of Discovery Park in 2001, Discovery Park has added $27 million worth of tools and equipment to our campus. Some of the most notable equipment includes:

High throughput genetic analysis

Discovery Park has contributed to next generation sequence analysis platforms now on campus. The SOLiD and 454 next gen sequencers provide capabilities for describing the genome sequence of new species and of genetic modifications created in the laboratory and in nature. As a compliment to these systems for determination of DNA sequencing, specific variations can be interrogated quickly, cheaply and in parallel with the GeXP analysis system in the Bindley Center. This system is an integrated platform for simultaneous detection of multiple genes or gene variants from many different samples. In the same experiment, the system can analyze DNA sequence, DNA modifications such as mutations and single nucleotide polymorphisms as well as mRNA expression.

Applications include: (a) Detect and describe distinct species in populations of soil and water bacterial populations, (b) Characterize genetic differences in cancer cell lines exposed to anti-cancer drugs, and (c) Characterize expression of neurotransmitter receptor gene sequences in cells that model nervous system communication. The users for these two pieces of equipment are interdisciplinary. The SOLiD system is especially important to researchers across the campus. Discovery Park, often, is a contributing investor to enhance the purchase of equipment by Purdue. For example, the GeXP system was purchased through a vendor award to Bindley Bioscience of $65K plus cost shares with Bindley Bioscience Center, the Oncological Sciences Center, and the Purdue Cancer Center to reach the total of $130K.

Complimentary tools for metabolomics

Characterization of the presence and quantity of small molecule metabolites in complex biological samples is the specialty of the Bindley Metabolite Profiling Facility (MPF). A suite of mass spectrometers specialized for different aspects of small molecule detection have been obtained in cooperation with investigators across campus. Lilly Endowment award funds augmented an NSF major research instrumentation award to enable the MPF to obtain multiple high sensitivity metabolomics instruments and a data handling and storage system to ensure data archiving. Two triple quadrupole mass spectrometers for ultra-high sensitivity analysis of specific metabolites in the sample were obtained in 2008 via consortium funding from 4 Purdue Colleges and the Provost's office. The new triple quads provide direct connection of data between existing metabolomics platforms (time of flight and ion trap mass spectrometers) via the integrated nanochromatography 'chip cube' system that was first available for complex biological sample analysis in the Bindley center.

Applications include: (a) Detect trace concentrations of vitamin D and its analogs in human samples, (b) Define metabolites associated with muscle wasting (cachexia) in cancer patients, (c) Identify active therapeutic molecules in medicinal herbs, tea and fungi, and (d) Precisely define concentration of specific cancer biomarker proteins. MPF users are campus wide, especially Science, Engineering, Pharmacy, Agriculture, Consumer and Family Sciences, Liberal Arts. The purchase of the triple quadrupole mass spectrometers reflects the collaborative leveraging of Discovery Park. The equipment was purchased via the Provost equipment matching funds in 2008 with contributions from Bindley Bioscience Center, and the

Colleges of Pharmacy, Science, Agriculture and Consumer and Family Sciences (Lead unit for Provost equipment RFA) to reach the total cost of $400K.