PITA PROGRAM HELPS TO FULFILL VISION FOR FUTURE OF TECHNOLOGY AND INDUSTRY IN PENNSYLVANIA

Governor Edward G. Rendell’s office recently released a statement that said, “Our goal from the beginning has been to pass a plan that will create jobs, retain talent, grow the economy and position Pennsylvania for success in the 21st century.” These objectives are not new to the Pennsylvania Infrastructure Technology Alliance (PITA). For the past seven years the PITA program has been working towards a very similar mission. Long before Governor Rendell unveiled his “Plan for a New Pennsylvania,” members of PITA were working to stimulate the growth of technology and industry in the Commonwealth. By forming an alliance between government, industry and academia, PITA is helping high-tech and traditional companies gain access to a trained and educated workforce. Now in its eighth year of operation, the program has evolved into a model for other economic development initiatives, focusing on two key program areas: technology development and education.

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PITA RECEIVES $5M FOR FY05

On July 4, it was announced in Harrisburg that the Fiscal Year (FY) 2005 Pennsylvania budget would award funding for the Pennsylvania Infrastructure Technology Alliance (PITA) at the $5 million level. Receipt of full funding will enable Carnegie Mellon University, Lehigh University and the Pennsylvania Department of Community and Economic Development (DCED) to continue and expand PITA’s unique and highly successful public-private economic development program.

With the receipt of full funding, PITA will begin offering Pennsylvania companies and research personnel the opportunity to participate in high impact projects. High impact projects are designed to provide significant near-term economic benefits for companies and consortia in Pennsylvania-specific areas of comparative advantage.

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Greetings from ICES! The following pages provide a brief update on some of our current activities and also feature a special highlight on the history and successes of the Pennsylvania Infrastructure Technology Alliance (PITA).

Sponsored by the Department of Community and Economic Development (DCED), ICES co-directs the PITA program with Lehigh University in Bethlehem, Pennsylvania. We believe that PITA’s efforts will help position the Commonwealth of Pennsylvania as a national leader in research and technology. By capitalizing on the resources of two major research universities, PITA is able to seed new ideas and address various technologies at all levels of development. This allows the program to be flexible and dynamic in its response to industry needs.

One such need is the growing demand for diversified and improved energy sources that are also environmentally friendly. Fuel cell technology is quickly becoming an important topic in industry, academia and the media and PITA is currently supporting a number of projects that are working to advance Direct Methanol Fuel Cell (DMFC) technology. The projects cover different research needs from system level integration, simulation and optimization, to development of novel processes for catalysts and emerging approaches for flow management. More information about these initiatives is included in this issue; however, if you would like more information please contact us.

An exciting chapter for the College of Engineering began on July 1 as we welcomed the leadership of our new Dean — Pradeep Khosla. Among the many honors and achievements that he attained at Carnegie Mellon and abroad, Pradeep was the founding director of ICES prior to his most recent appointment as Head of the Department of Electrical and Computer Engineering. Being witness to Pradeep’s undying enthusiasm for the success of research and academia at Carnegie Mellon, I have every confidence that his leadership will be fruitful and dynamic. All of us at ICES wish Pradeep great success in this endeavor!

This fall, ICES will host our annual Open House event, a great opportunity for all of our partners in industry, government and academia to learn more about our research and education activities and the various opportunities within the PITA program. This year’s Open House will take place on November 4, so please be sure to mark your calendar. Your participation is greatly valued!

ICES strives in its tradition of fostering a culture of innovation, creating knowledge and transferring technology. ICES also continues to provide a vigorous environment for defining and seeding the research areas of tomorrow and advancing innovative concepts in technology and education across the colleges of Carnegie Mellon.

For up-to-date information about ICES and our education and research activities, please visit our website at www.ices.cmu.edu. Many thanks for your continued readership!
PITA FOSTERS DEVELOPMENT OF FUEL CELLS AS POWER SOURCE OF THE FUTURE

With the support of the Pennsylvania Infrastructure Technology Alliance (PITA), an emerging group at ICES is making waves in the world of fuel cell research. By focusing on the advancement of Direct Methanol Fuel Cell (DMFC) technology, these PITA-supported research initiatives will help industry develop more efficient and less cumbersome electronic products.

“The key issue in industry today is energy density,” explained Mechanical Engineering Professor Shi-Chune Yao when asked about the increasing number of Department of Defense (DoD) and PITA projects that are working with DMFCs.

More compact than other fuel cells, DMFCs are portable energy sources that power electronic devices by generating usable electrical energy through a chemical reaction of a fuel with a catalyst. Although the technology is still relatively new, DMFCs have already been used to successfully power mobile phones and laptop computers. As this technology matures, major players in the electronics industry such as Samsung and NEC Corporation are racing to commercialize DMFC-powered products by the end of 2004. The following PITA-supported research initiatives are helping to further that cause.

NOVEL SOL-GEL APPROACHES TO NANOCRYSTALLINE NOBLE METAL CATALYST POWDERS AND NANOTUBE STRUCTURES FOR DMFCs

In partnership with DuPont, Materials Science Professor Prashant Kumta and Mechanical Engineering Professor Shi-Chune Yao are investigating novel sol-gel approaches for synthesizing high specific surface area catalysts for catalytically oxidizing methanol. Their goal is to find a simple, economic and efficient process for fabricating catalysts that can oxidize methanol.

An efficient catalyst significantly lowers the loading of the catalyst on the carbon support which reduces the cost of the fuel cell and increases the life and durability of the fuel cell. Identification of a method that will yield such catalysts has considerable promise in fulfilling the vision of powering the automobiles of tomorrow with direct methanol fuel cell (DMFC) technology.

“DuPont already owns the technology for the electrolyte membrane that is used in DMFC, [which is] another key component,” explained Professor Kumta. He believes that this partnership will provide DuPont with a simple approach to fabricating highly efficient catalysts and will enable them to commercialize the DMFC technology.

Kumta credits the PITA program with laying the foundation that facilitated this research and the initial partnership with DuPont; he also projects that upon successful completion of this research, this project could eventually lead to the creation of jobs in Western Pennsylvania. At present, PITA funds are supporting the cost for one graduate student and DuPont is providing the initial materials, supplies and testing capabilities.

Above: A two-dimensional schematic picture of a direct methanol fuel cell (DMFC).

“This research is only the beginning of a long-lasting collaboration with DuPont which has the potential to grow big and lead to large funding being available from other federal and corporate sectors,” said Kumta. “It is the hope that the current collaboration will foster such ambitious activities purely from the potential benefits that can be envisaged from the initial promising results.” For more information about this research, please contact Professor Kumta at kumta@andrew.cmu.edu.

SIMULATION AND OPTIMIZATION OF DIRECT METHANOL FUEL CELLS (DMFCs)

Chemical Engineering Professors Myung S. Jhon and Lorenz T. Biegler and Mechanical Engineering Professor Cristina Amon are working to construct simulation and optimization tools for DMFCs that take into account catalytic reactions in the electrodes and transport phenomena in the polymer electrolyte membrane (PEM). Optimization is employed to obtain better performance, high energy efficiency and cost-competitiveness.

Cong Xu is a chemical engineering graduate student who is working extensively with PEM fuel cells, such as DMFCs. “Fuel cells have the advantage of high power density, high efficiency and zero or ultra-low emissions, which are promising to ease our concerns [about] fossil energy and [the] environment,” commented Xu.

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PITA Program Helps to Fulfill Vision for Future... (continued from cover)

The PITA program was formed in 1997 as a collaboration between the Commonwealth of Pennsylvania, Carnegie Mellon University and Lehigh University to assist the Commonwealth and its companies in increasing operating efficiency and to enhance economic development across Pennsylvania. Within the first year, PITA had partnered with more than 20 Commonwealth companies to collaborate on 26 different projects. During this time, PITA also assisted with the signing of two technology licensing agreements and the creation of a start-up company.

Since then, PITA has enabled over 350 technology development projects with more than 100 Pennsylvania companies and agencies, involving over 200 graduate students and more than 300 undergraduate students in project courses with Pennsylvania partners. The technology development program has expanded from its initial focus on physical infrastructure, information technology, and product and process design to include biomedical engineering, environmental technology, nanotechnology, clean-energy technology and initiatives that create competitive advantages for both baseline industries and start-up companies. PITA’s education and outreach initiatives provide workforce training opportunities important to both high-tech and traditional companies across Pennsylvania. These activities have helped further the mission of Harrisburg’s new campaign “Pennsylvania: Stay Invent the Future,” which aims to retain the highly skilled graduates that are educated in this state.

PITA is able to achieve its measurable successes by focusing on technology development projects that involve academia as well as industry and government agencies. In these projects, students, faculty and industry partners learn from one another and develop working relationships, which become a mechanism for retaining well educated graduates to work in innovative technology areas for companies in the Commonwealth.

“Our sponsorship and active participation in PITA led to the development of project course 39-605/6. Through this course, we had the golden opportunity to meet the best students, sell them on Neolinear, and hire four top-notch graduates in the first two years, including two Ph.D.s. We did this in a tight job market, beating out both Intel and Texas Instruments,” said Charles Buenzli when asked about the benefits of the PITA program. Buenzli is the CEO of Benchmark Photonics and the former CEO of Neolinear, Inc., both of which are located in the Pittsburgh area.

The program continues to engage an expanding number of Commonwealth companies, agencies and consortia throughout Pennsylvania. Its collaborations have facilitated the creation of six new Pennsylvania companies, enabled three technology licenses and spawned the award of eight patents and four provisional patents, all seeded from various PITA-supported technologies. Program officials are working with a number of regional economic development groups in an effort to engage additional companies with technology development needs and to create a more favorable environment for potential emerging companies. PITA has developed a remarkable portfolio of cutting-edge technology projects and progressive educational programs. This year PITA provided funding to 65 technology and education projects between Lehigh and Carnegie Mellon Universities.

“PITA helps us to develop the fundamental knowledge for higher risk projects that we would not undertake otherwise,” commented Robert Coraor, Manager of Technology Transfer for Air Products and Chemicals, Inc. located in Allentown, Pennsylvania. “The skill sets and technical synergy of Lehigh University and Carnegie Mellon faculty enabled by PITA funding have provided Air Products with invaluable knowledge transfer and has resulted in spin-off technology development. We also benefit by establishing working relationships with students who become Air Products employees of tomorrow.”

PITA is jointly administered by the Center for Advanced Technology for Large Structural Systems (ATLSS) at Lehigh University and the Institute for Complex Engineered Systems (ICES) at Carnegie Mellon to ensure that the program is able to benefit areas across the Commonwealth. For more information about the PITA program, please contact Professor Cristina Amon, Co-Director of the PITA program and Director of ICES at camon@cmu.edu.
ELECTRONICS COOLING RESEARCH OF CRISTINA AMON FEATURED IN IEEE SPECTRUM

ICES Director Cristina Amon was cited in the May 2004 issue of IEEE Spectrum, a publication of the Institute of Electrical and Electronics Engineers, in an article on one of the most challenging issues facing the electronics industry today, “the thermal management of computer chips.” The article, entitled “Beat the Heat,” discusses Amon’s group research on miniaturized evaporative cooling, currently being investigated as part of a DARPA-sponsored research project, which utilizes MEMS technology to successfully cool overheated chips. The integrated system is under development to provide a cost-effective and viable alternative to high-heat flux chip cooling techniques, which are not currently available to PC manufacturers due to technological challenges and expenses associated with mass production. The article can be viewed at www.spectrum.ieee.org/WEBONLY/publicfeature/may04/0504ther.html. ■ by Emily Nicholson

SMAILAGIC’S SENSAY CELL PHONE FEATURED IN WIRELESS REVIEW

An article on the SenSay cell phone project of ICES Research Professor Asim Smailagic was featured in the March 1 issue of Wireless Review. The article discusses the context-aware mobile phone’s major functions, including its ability to determine a user’s activity, location and availability based on information provided by light and heat sensors, an accelerometer, a microphone and a pre-programmed calendar. The article can be viewed at http://wirelessreview.com/ar/wireless_asim_smailagicresearch_professor/index.htm. ■ by Emily Nicholson

ICES-DEVELOPED CRITTER TEMPERATURE SENSOR RECEIVES MEDIA ATTENTION

The Critter Temperature Sensor developed by ICES Project Scientist Mike Bigrigg was featured in a segment on Pittsburgh news channel WTAE that aired on March 1. Additionally, an article entitled “CMU Engineer’s Tiny ‘Critter’ Could Save Your Hard Drive” appeared in the March 15 edition of the Pittsburgh Post-Gazette (viewable at http://www.postgazette.com/pg/04075/285931.stm).

The heat-sensitive Critter attaches to a user’s desktop computer in order to analyze the computer’s operating environment. The Critter’s ability to sense hard drive temperature fluctuation may lead to expansions in average hard drive lifespan and help reduce the high costs of data loss. Efforts to further develop the Critter to aid in energy monitoring, building management, emergency response, and security are currently underway.

While the Critter is presently running in various labs and offices throughout Hamburg Hall, Bigrigg and his team seek to deploy the sensor further across campus. For more information on the Critter Temperature Sensor, or to participate in the project by having the Critter installed on your computer, please contact Mike Bigrigg at bigrigg@cs.cmu.edu. ■ by Emily Nicholson

GROUNDWATER POLLUTION RESEARCH FEATURED IN PITTSBURGH POST-GAZETTE

An article in the April 1 edition of the Pittsburgh Post-Gazette entitled “Tiny Engineered Particles Could One Day Remove Common Pollutant,” highlighted the research of Civil and Environmental Engineering Assistant Professor Greg Lowry on the removal of hazardous materials from groundwater. This interdisciplinary project involves investigators from Chemical Engineering, Civil and Environmental Engineering, Physics, and Chemistry, and focuses on the development of iron particles in polymer shells that can eliminate underground build-ups of a metal cleaning solvent called trichloroethylene. The article can be viewed at http://www.post-gazette.com/pg/04092/294409.stm. ■ by Emily Nicholson
PITA Fosters Development of Fuel Cells... (continued from page 3)

The group plans to adopt a multilevel modeling approach, which includes the molecular level (PEM), the cell level and the stack-system level. Molecular simulation of the transport phenomena in the PEM or the catalytic reaction in the electrodes has been undertaken, which will provide more insight on the PEM’s structure-property relationship and help discover the mechanism for methanol oxidation and carbon monoxide poisoning.

The results of this study will also benefit and promote novel research projects for the Center for Advanced Process Decision-making Consortium at Carnegie Mellon. The Consortium is comprised of over twenty process and software companies including Aspen Tech, Air Products & Chemicals, Inc., Bayer, British Petroleum (BP), Dow Chemical, ExxonMobil and Sunoco Chemicals. Each of these companies will benefit from research in the area of modeling and optimization of fuel cells. For more information on this project, please contact Professor Biegler at lb01@andrew.cmu.edu.

WATER MANAGEMENT OF MICRO-SCALE DMFCs

Mechanical Engineering Professor Shi-Chune Yao and Professor Laura Schaefer, Mechanical Engineering, University of Pittsburgh, are investigating advanced water management of DMFCs to allow for the use of high concentration methanol. Their aim is to drastically increase the fuel cell’s power density by pumping back the excess water collected from the cathode side to the anode side.

This research will be conducted in partnership with the Pittsburgh Electric Engine Company. It is projected that this fuel cell development will enhance the company’s future expansion and result in the creation of additional jobs. The University of Pittsburgh and Penn State University are also working with ICES investigators to further this water management research.

“PITA has been very helpful to support our effort on the key exploratory studies, which may lead to more thorough studies supported by other agencies,” said Professor Yao about PITA’s role in this research initiative. For more information on this project, please contact Professor Yao at scyao@cmu.edu. ■ by Dana Hilinski with Cong Xu, Larry Biegler, Myung Jhon, Prashant Kumta, and S.C. Yao

For more information about the PITA program, please visit www.ices.cmu.edu/pita

Merging Nanoscopic Science with Biology... (continued from cover)

interaction and the physiological processes behind illnesses like cancer and heart disease.

According to Mechanical Engineering Assistant Professor Philip LeDuc, the principal investigator on the project, understanding the nanoscience behind molecular interaction, as well as the spatial constraints of cellular environments, is critical to the development of predictive models, new technologies and computational methods that can aid in the diagnosis and treatment of severe medical problems. The objectives of the project are to use computational and mathematical simulation tools to produce reliable models of molecular, cellular and physiological interactions that will be used to study the mechanisms of disease.

“One of the most exciting areas of the unknown involves the way the body, cells, and molecules interact in areas like diseases,” says LeDuc. “In order to be able to address these highly complex biological behaviors, we need to investigate them with a new approach and an associated set of tools that integrate computational and nanotechnology engineering methods with the life sciences.”

The medically relevant results of this research could potentially assist pharmaceutical companies in drug therapy development, as well as aid computational biology and bioinformatics industries in understanding the biocomplexity of emergent behaviors involved with the onset of disease.

While the project is still in its infancy, important advancements are being made. Several abstracts have been published and three papers have been submitted to archival refereed journals. Additionally, LeDuc’s work in this area has been recognized by the prestigious National Science Foundation CAREER Award, which acknowledges the significant academic contributions of younger faculty by providing funding to highly innovative research programs. The current PITA-sponsored investigation developed out of LeDuc’s CAREER-supported project “Understanding Cellular and Molecular Mechanics with Nano/Microtechnology.”

As an engineer leading a biological research project, LeDuc stands at the forefront of interdisciplinary biotechnology and hopes that his team’s progress will continue to blur the lines between the sciences. By bringing together experts in various fields of study, this PITA project could very well contribute to a better understanding of disease prevention and lead to improved human health. ■ by Emily Nicholson with Philip LeDuc
ICES PROFESSOR CO-ORGANIZES GLOBAL TECHNOLOGY EVENT IN INDIA

ICES Research Professor Eswaran Subrahmanian was one of the primary organizers of the Workshop on Information and Communication Technologies for Sustainable Development, which took place in Bangalore, India from January 14-16, 2004. The global event, co-organized by Drs. V.S. Arunachalam, Raj Reddy, and Rahul Tongia of Carnegie Mellon and Dr. N. Balakrishnan of the Indian Institute of Science, was developed to provide a forum for technologists, economists and policy makers to create a research and development agenda and identify test-bed projects for the use of information and communication technology (ICT).

Over 90 participants from 25 nations attended the workshop, which was sponsored by the National Science Foundation, World Bank, the Development Gateway Foundation and the United Nations. Attendees worked in groups to discuss issues like empowerment and e-governance, education, poverty reduction, human development, and infrastructure in order to address the “digital divide,” a term used to describe the disparity in information technology access and use that exists between developed and less-developed countries. The workshop’s invited speakers, included Nobel Prize-winner Professor Joseph Stiglitz of Columbia University, Professor Richard Newton of the University of California, Berkeley, Dr. Peter Freeman of the National Science Foundation, and Dr. Nitin Desai, former Under Secretary General of the United Nations.

For more information on the conference or ICT research, please contact Eswaran Subrahmanian at sub@cmu.edu.

by Emily Nicholson with Eswaran Subrahmanian
Pennsylvania Infrastructure Technology Alliance

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