

ENERGY RESEARCH AT THE SCHOOL OF ENGINEERING AND TECHNOLOGY AT IUPUI

*CENTER FOR COAL TECHNOLOGY RESEARCH
ADVISORY PANEL MEETING*

**DR. RAZI NALIM
INTERIM ASSOCIATE DEAN FOR RESEARCH AND GRADUATE PROGRAMS**

APRIL 12, 2011

- IUPUI is a Research I university, with \$400M annual research income FY09-10.
- 30,000+ students in 250+ degree programs
 - 22,000 undergraduate, 8,000 graduate
 - students from 122 countries and all 50 states
 - 15% minorities ; 42% male, 58% female
- Operating Budget - \$1.2 Billion
- Over 7000 employees
- Indianapolis location gives IUPUI strong ties to central Indiana industry and businesses.
- IUPUI awards both IU and Purdue degrees. There are no IUPUI degrees.

- IUPUI is Indiana's Center for Health Sciences with
 - third largest medical school in nation
 - the largest nursing school in nation
 - Indiana's only dental school
- IUPUI has the largest Law School in Indiana.
- IUPUI has the oldest School of Physical Education in the nation.
- Ranked 8th best public university in the Midwest by Forbes magazine, 2009.

- Nineteen IU schools

- Business

- Liberal Arts

- Nursing

- Dentistry

- Medicine

- Informatics

- Art and Design

- Health & Rehabilitation Sciences

- Physical Education & Tourism Mgmt

- Honors College

- Library & Info Sciences

- University College

- Public & Environmental Affairs

- Education

- Social Work

- Journalism

- Law

- Graduate School

- Continuing Studies

- Two Purdue schools

- Engineering and Technology

- Science

- Seven Academic Departments offer AS to PhD
 - Electrical and Computer Engineering
 - Mechanical Engineering
 - Biomedical Engineering
 - Computer, Information and Leadership Technology
 - Engineering Technology
 - Design and Communication Technology
 - Music and Arts Technology
- 2010-11 Research Income: \$10.3M
- Students: 2,700+
 - 96% of incoming undergraduate students 19 or younger
 - 12% International
 - 10% of students pursuing graduate degrees

Mission Statement

The Richard G. Lugar Center for Renewable Energy (LCRE) is established to address the urgent societal need for clean, affordable and renewable energy sources

- **research**
- **education**
- **technology transfer**
- **sound public policy**



STRUCTURAL OVERVIEW

- **Anchored in the School of Engineering and Technology**
 - Key laboratory spaces, financial and admin support from E&T

- **Multidisciplinary Center**
 - Policy, Economics, and Law Working Group
 - Researchers from many different disciplines
 - Engineering & Technology, Medicine, Biology, Earth Sciences, Public & Environmental Affairs, Law, Political Science, Religious Studies / Philanthropic Studies, Business, Economics

- **Executive Committee**
 - Engineering, Public and Environmental Affairs, Technology, Medicine, Law

- **Advisory Board**
 - 23 members from Industry, National Labs, Universities, and Government

Research Areas

- Hybrid electric (HEV) and plug-in hybrid electric vehicles (PHEV)
- Fuel Cell Technology
- Hydrogen Generation and Storage
- Energy Efficiency & Reduced Environmental Impact
- Battery technologies
- Bio-fuel generation and applications
- Distributed power generation and smart grid
- Solar and Wind Energy
- Policy and societal issues

Disciplines Involved

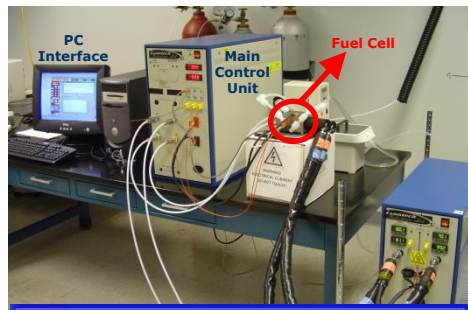
- Mechanical Engineering
- Biomedical Engineering
- Electrical Engineering, Power Grid Coupling
- Physics
- Chemistry and Chemical Biology
- Biochemistry and Molecular Biology, Medicine
- Polymer
- Combustion
- Computer modeling and multi-scale simulation
- Biology: energy generating plants
- Public and Environmental Affairs



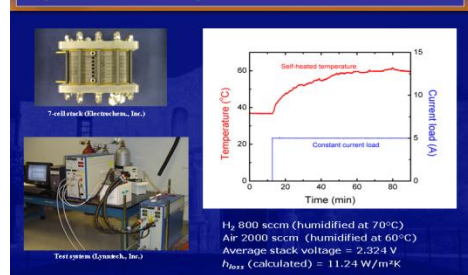
- Developed a validated theoretical model for designing novel catalysts with good activity and durability for the cathode of fuel cells,
- Developed non-Pt catalysts with O₂ electrocatalytic activity comparable with commercial Pt/C catalysts in alkaline media
- Filed several patents
- Published papers in top-ranked peer-reviewed international journals
- Additional remodeling of a state-of-the art research laboratory for fuel cell and membrane development. (~350K investment from school)
- Close relationship with U.S. Army Research Laboratory on Advanced Power Source for Future Soldiers research program.

The Richard G. Lugar Center for Renewable Energy

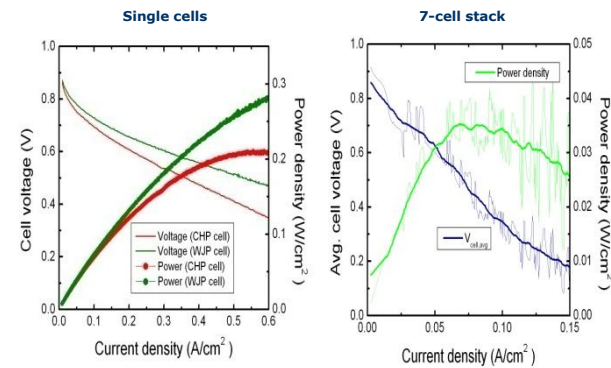
Fuel Cell Test System



Experimental Temperature Measurement



Performance of Single Cells and Stack



RESEARCH – BIOFUELS

IUPUI

RICHARD G. LUGAR CENTER
FOR RENEWABLE ENERGY

INDIANA UNIVERSITY-PURDUE UNIVERSITY

Indianapolis

- Predominantly tech-transfer
- Xylogenics – Start-up company by LCRE member Dr. Mark Goebel, signed licensing agreement with yeast producer Lallemand
- Anticipate that they will begin to sell Xylogenics yeast to starch ethanol plants in the first quarter of 2011
- An internal grant to modify the lipogenic yeast *Yarrowia* for enhanced production of biodiesel fuel
- Work presented at Purdue University PULSe program in September (Purdue University Interdisciplinary Life Science)

RESEARCH – BATTERY

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FOR RENEWABLE ENERGY

INDIANA UNIVERSITY-PURDUE UNIVERSITY

Indianapolis

\$3 million/ 2 year Program funded by Navy

Partnership with Crane NSWC, IUPUI, and Delphi Corporation to prevent critical battery failures (incl. fire)

- Cell and system level investigation of Li-Ion battery failure modes

- Goals: 1) to understand what causes specific failure modes, 2) to provide early warning detection of critical failures

RESEARCH – GRID

- Dr. Steven Rovnyak, completed work on mobile micro grids with I-Power Energy Systems on a U.S. Army CERDEC grant for Hybrid Intelligent Power Management Phase I.
- continuing work on pattern recognition for power system stability control

Energy Security as National Security: Challenges and Opportunities for the Midwest White Paper

in collaboration with Pew Environment Group

- Dr. Craig, Associate Professor of Religious Studies
- Dr. Pierre Atlas, Director of the Lugar Franciscan Center on Global Studies at Marian University
- Dr. Eric Dannenmaier, Associate professor of Law
- Dr. Gabriel Filippelli, Professor of Earth Sciences
- Dr. Jane Luzar, Dean IUPUI Honors College
- Carol Rogers, Director of Indiana Business Research Center
- Kyle Cline, General Manager, LCRE
- Dr. Alfred Ho, Associate Professor of Public Affairs

RESEARCH – H₂ GEN

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Indianapolis

- **Microfluidic platform to synthesize sculpted nanoparticles. Prototype microfluidic devices have been developed and silver nanoparticles have been synthesized**

EDUCATION – SOLAR

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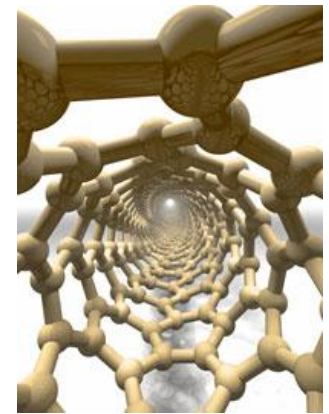
Indianapolis

- Founding member of the Midwest Solar Training Network (MSTN), part of the U.S. DOE Solar Instructor Training Network and Midwest Renewable Energy Association (WI)
- Improve the quality and accessibility of solar installation training and expand the nation's trained solar workforce.
- Workshops on solar energy are planned for the summer of 2011
- 2 training modules for MSTN and 2 courses for a proposed Sustainability Certificate at IUPUI.

Other School of ET Energy Research Resources

Mission:

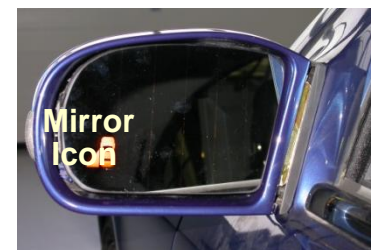
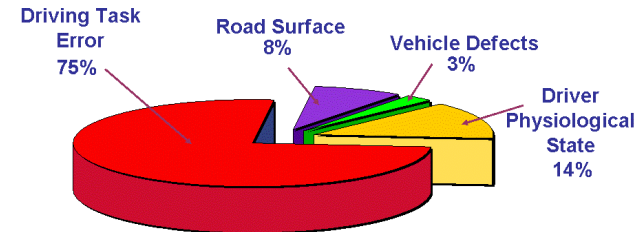
- enable, through innovative interdisciplinary research and educational programs, the development of nanotechnology-based systems for biomedical, energy, environmental, information technology and other applications, and
- provide solutions which, through translation of research into practice and technology transfer, contribute to social well being and economic growth.



Mirror
Icon

- Mission: Advance the Use of Active Safety Systems to Reduce Vehicle Crashes and Save Lives
- Partners:
 - IUPUI (Engineering and Technology, Health & Rehabilitation Sciences, Informatics, Kelley School, Medicine, Science, SPEA)
 - Delphi Corporation
 - Purdue University West Lafayette, IU-Bloomington, Rose-Hulman
- Current projects:
 - Countermeasures to Fatigued Driving
 - Coding of Video Data from Driving Simulator
 - Instrumentation testing in Simulator

The Safety Reality: Accidents Are Caused by the Driver



Visible Alerts



Audible Alerts

Electrical and Computer Engineering

- **Digital signal processing and communications**
 - Biometrics and pattern recognition
 - Medical Imaging
 - Real-time DSP and applications
 - Video compression and secured video transmission
 - Wireless communications
- **Intelligent transportation and active safety systems**
 - Human-machine interface and interaction
 - Intelligent sensors and sensing system for active safety
 - Testing and evaluation of active safety systems
- **Micro- and nano-electronics and VLSI design**
 - Nano-electronics and nano-technology
 - VLSI and ASIC design

Mechanical Engineering

- Lugar Center for Renewable Energy
- Advanced Engineering and Manufacturing Lab
- Advanced Materials Lab
- Combustion and Propulsion Lab
- Computational Fluid Dynamics Lab
- Dental Biomechanics Lab
- Mechatronics Lab

Advanced Engineering and Manufacturing Lab

- PDM-based integrated and optimum design & manufacturing
- Process control and intelligent CNC machining systems
- An SBIR/STTR Project: Advanced Virtual Manufacturing Lab for Research, Training, and Education Purposes. Also sponsored by NSF and Indiana 21st Century Fund



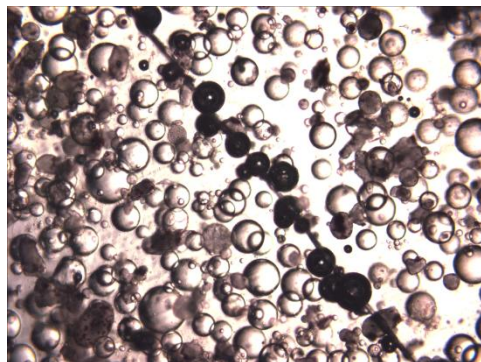
Objective: The creation of an Advanced Virtual Manufacturing Lab (AVML) for accurate and realistic simulation of a physical the-art manufacturing

AVML Featured in *Indiana Business Magazine* (May 2007)

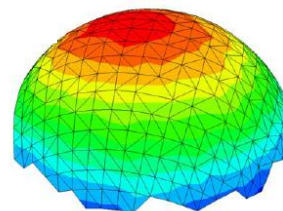


Advanced Materials Lab

Multifunctional
Composites

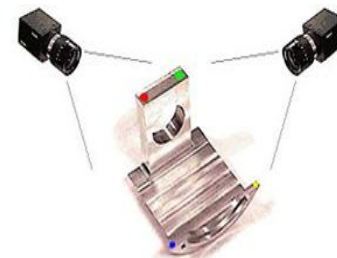


Material Degradation



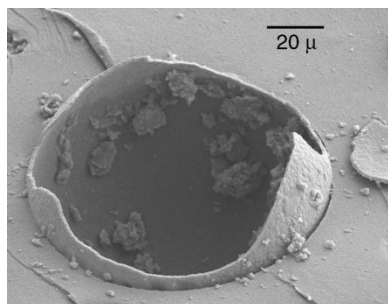
Elastomer Degradation

Experimental
Mechanics

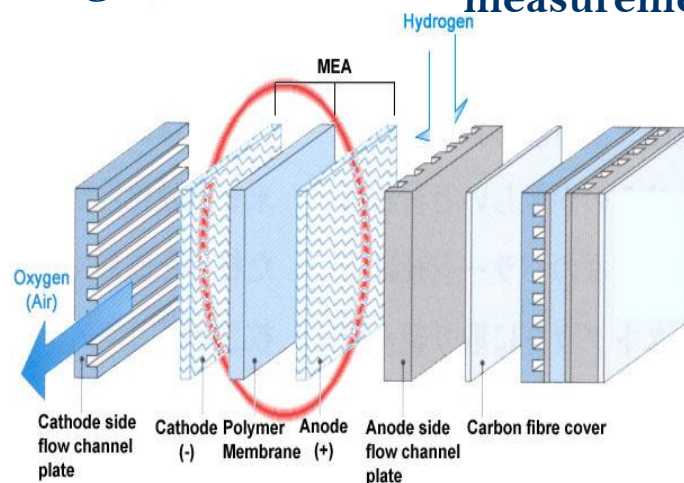
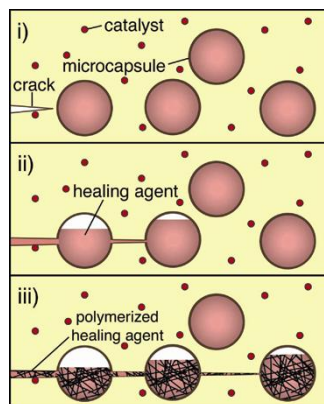


Non-contacting
measurement

Self-Healing Polymers



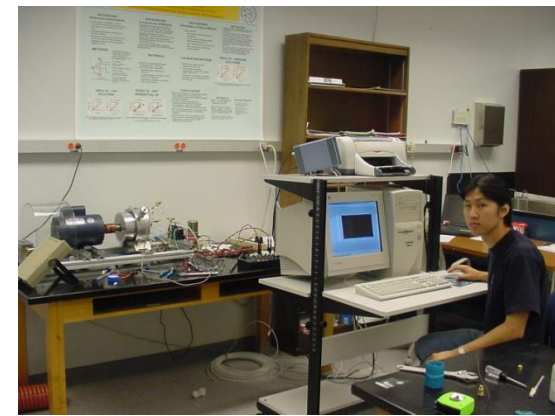
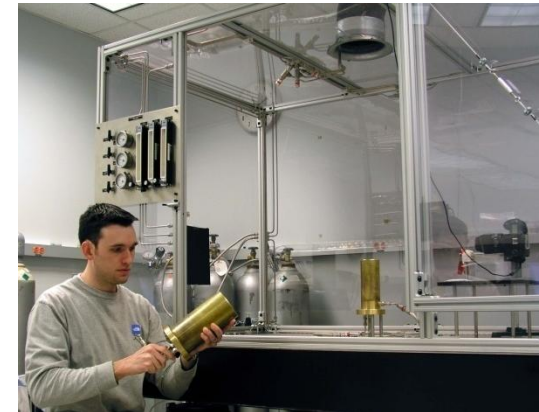
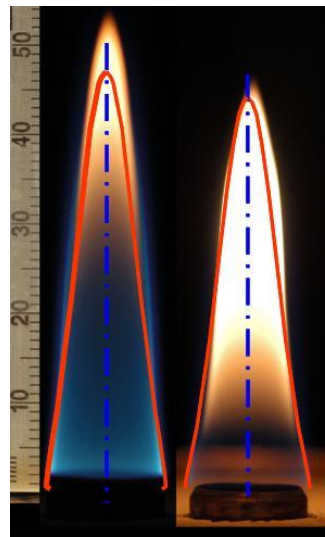
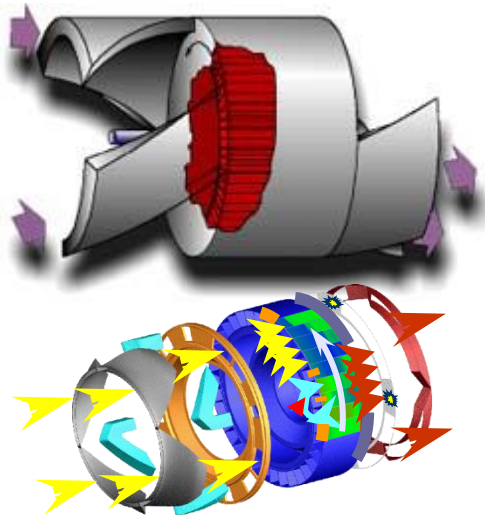
Microcapsule



PEM Durability

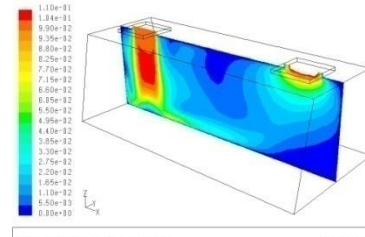
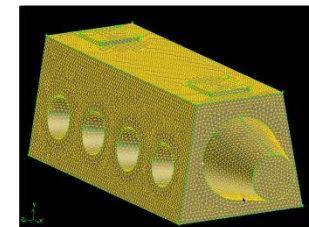
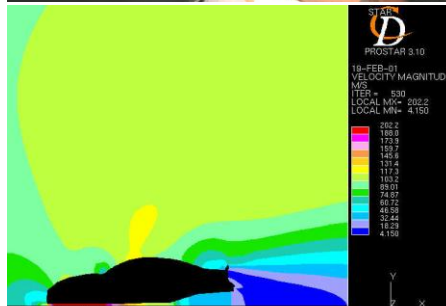
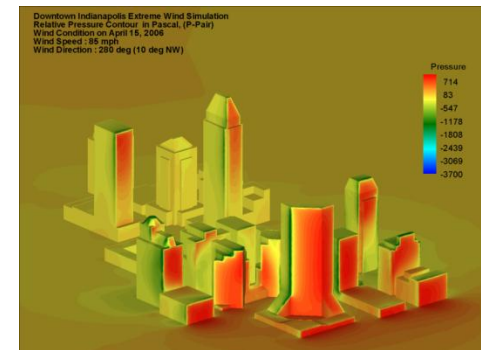
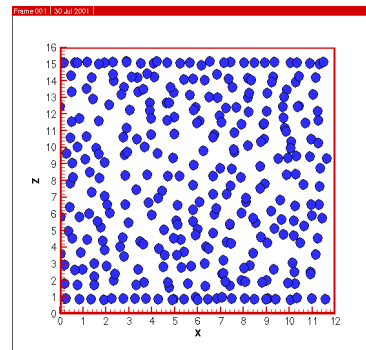
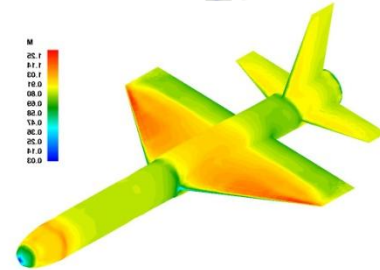
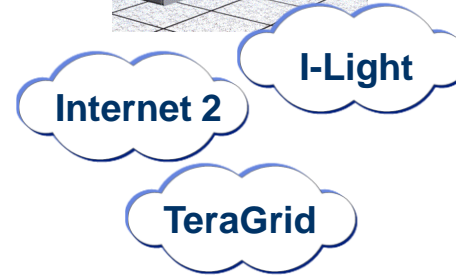
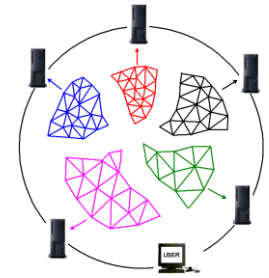
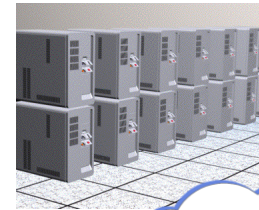
Combustion and Propulsion Research Lab

- Pulse Detonation Engine Experiments
- Advanced Propulsion Systems, Wave Rotor Technology
- Microgravity Flame Experiments
- Diesel Engine Cooling System Design
- Waste Heat Recovery Systems for Diesel Engines
- Computational and Experimental
- Collaboration with Purdue
- Funding by: Rolls-Royce, NASA, Cummins, and Indiana 21st Century Fund



Computational Fluid Dynamics Lab

- Parallel/Grid Computing for Large-Scale Problems
- Computational Fluid and Solid Dynamics
- Fluid-Solid Interactions
- Combustion Simulations
- Molecular Dynamics
- Funding by: NASA, Rolls-Royce, and Eli-Lilly

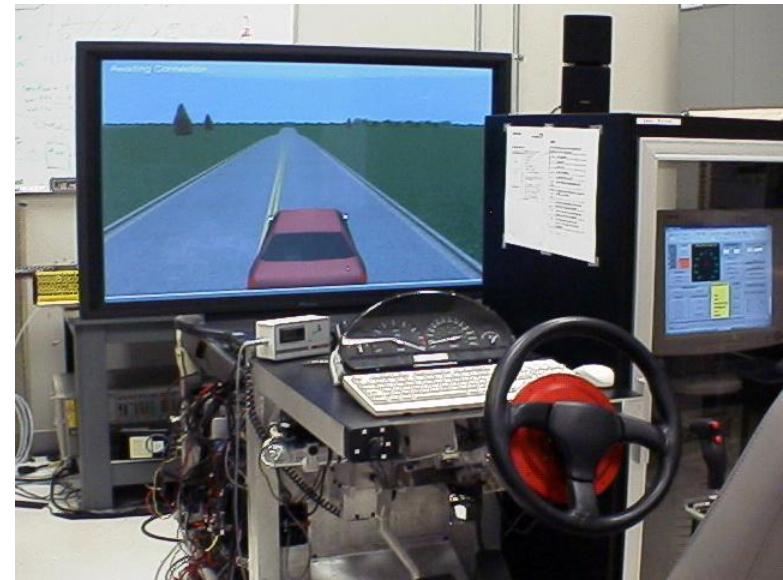
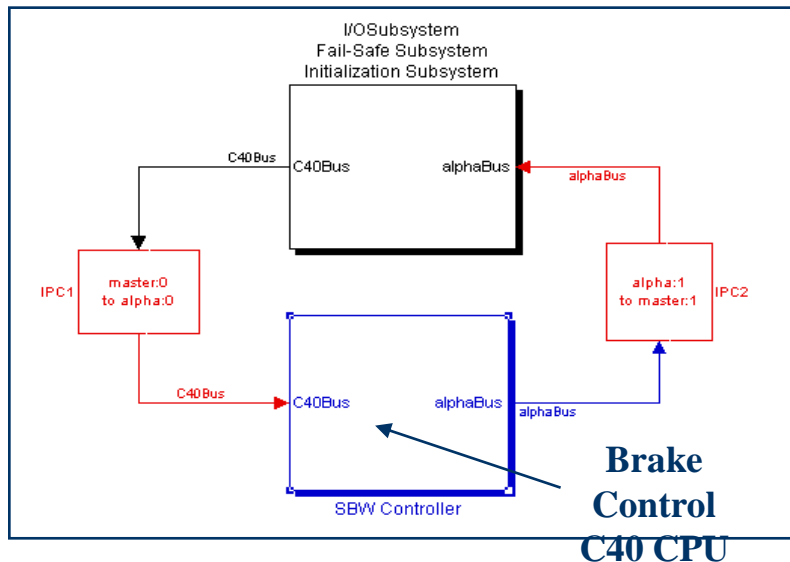


Mechatronics Lab: Advanced Vehicle Control Systems

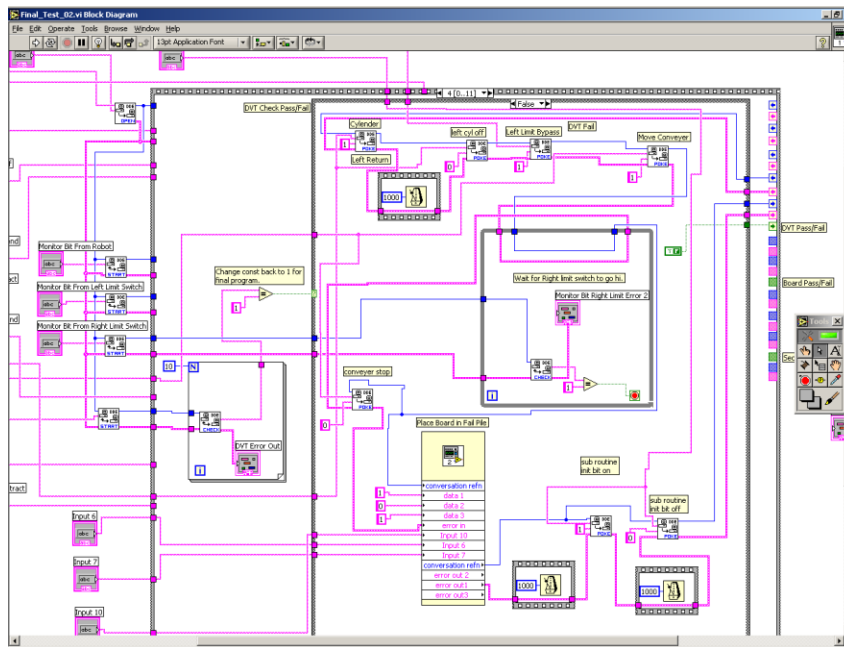
- Modeling, Simulation, and Control of Mechatronics Systems
- Fault Detection/Diagnosis & Management
- X-By-Wire System Modeling & Control
- Vehicle Dynamics & Control
- Micro-Electro-Mechanical System (MEMS)
- Fuel Cell / Hybrid Vehicle Control
- Manufacturing Process Control
- Funding by: Cummins and Delphi



Drive-By-Wire system simulator and On-Demand All-Wheel-Drive system hardware-in-loop bench

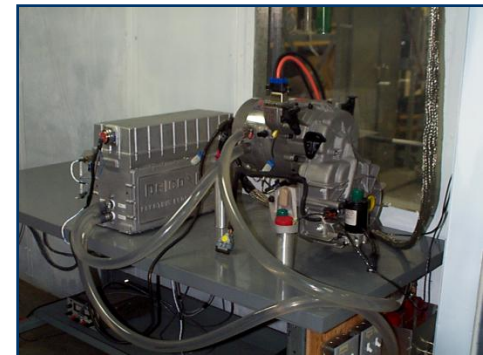


Engineering Technology Applied Research



- Instrumentation
- PC-based Data acquisition, processing and display software using LabVIEW
- Data acquisition interface board selection, signal conditioning and sensor selection
- RFID Solutions

- Motor sports, advanced automotive and vehicle systems and transportation technology
 - Hybrid and fuel cell vehicles
 - System control design and optimization
 - Energy storage and control systems
 - Power electronics and controls
 - X-by wires
 - Modeling and simulation



THANK YOU!

State Campuses: Indiana University – Purdue University

IUPUI

SCHOOL OF ENGINEERING
AND TECHNOLOGY

A PURDUE UNIVERSITY SCHOOL
Indianapolis

•Indiana University Campuses

- IU President McRobbie in Bloomington
- IU PU Columbus is an extension of IUPUI
- Each campus has an IU Chancellor (ex IPFW)
- IU Bloomington and IUPUI are the two core campuses of IU system

•Purdue University Campuses

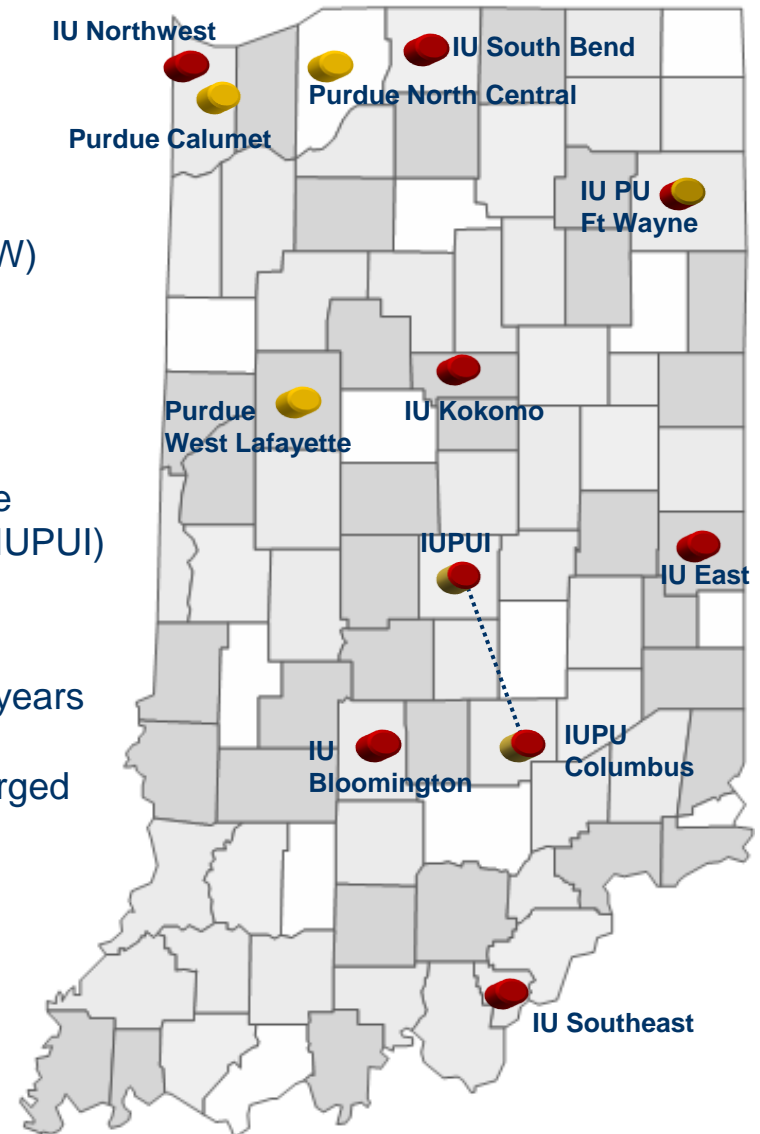
- Purdue President Cordova in West Lafayette
- Each campus has a Purdue Chancellor (ex IUPUI)

•IU & Purdue in Indianapolis

- Medical School and hospital complex - 104 years
- Purdue courses in Indianapolis since 1946
- IU and Purdue programs at Indianapolis merged in 1969 to create IUPUI

•Purdue School of Engineering & Technology, IUPUI

- Fiscal and Administrative policies from IU
- Academic policies from Purdue



- Technology degree programs

- Architectural Technology-AS
- Biomedical Engineering Technology-AS and BS
- Construction Engineering Management Technology-BS
- Computer and Information Technology-AS and BS
- Computer Engineering Technology- BS
- Computer Graphics Technology-AS and BS
- Electrical Engineering Technology-BS
- Interior Design Technology-AS and BS
- Mechanical Engineering Technology-BS
- Music Technology-MS and BS
- Music Therapy-MS
- Organizational Leadership and Supervision-BS
- Technology-MS

- Engineering degree programs
 - Biomedical Engineering-BS, MS, PhD
 - Computer Engineering-BS
 - Electrical Engineering-BS
 - Electrical & Computer Engineering-MS and PhD
 - Interdisciplinary Engineering-BS and MS
 - Mechanical Engineering-BS
 - Mechanical Engineering-MS and PhD
 - Motorsports Engineering-BS
 - Energy Engineering-BS