

UC Davis Fuel Cell, Hydrogen, and Hybrid Vehicle (FCH²V) GATE Center of Excellence

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***Presentation to the DOE Merit Review Committee
May 20, 2009***



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Outline – UC Davis GATE Center

- Brief History
- Main Goal & Objectives
- Focus research areas
- Classes
- Outreach and Publications
- Application Process
- Graduate Research Projects
- Summary

The Merging of the GATE Centers at UC Davis

GATE Fuel Cell Center of Excellence 1999-2004

GATE Hybrid Electric Vehicle Center of Excellence 1999-2004



**Fuel Cell, Hydrogen,
& Hybrid Vehicle
(FCH2V) Center of
Excellence**

2005-2010

FCH²V Goals & Objectives

Goals:

- *Train future engineers to ensure the United States remains competitive*
- *Conduct research in the area of advanced automotive technology*

Objectives:

- Support research of FCH²V technology (graduate fellowships, selected with a *competitive* proposal process)
- Support dissemination of FCH²V research results & knowledge (publications, outreach and workshops)
- Support curriculum development around FCH²V technology (expand and enrich course offerings)
- Support industrial/government collaboration of FCH²V technology (workshops, graduation placement, internships)

Cross Training for Transportation Leaders

Energy and Transportation Policy

Emissions Control

Hydrogen Production

Aerodynamics

Energy Efficiency

Transmissions

Life-Cycle Analysis

Internal Combustion

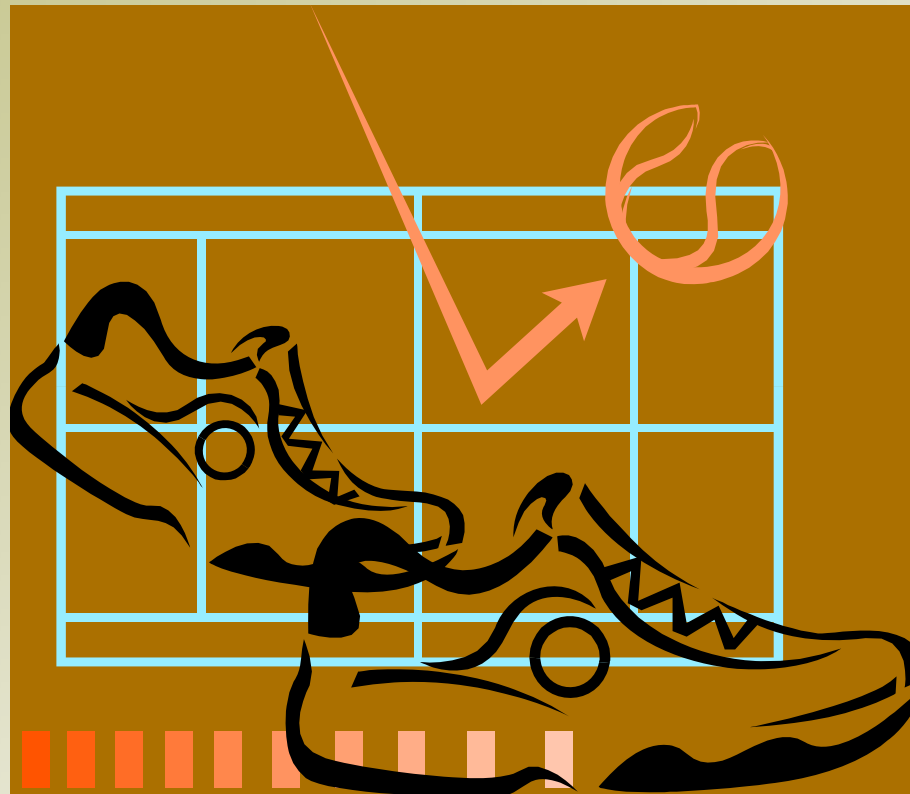
Instrumentation

Advanced power cycles

Fuel Cell Chemistry

Batteries and Capacitors

Hybridization



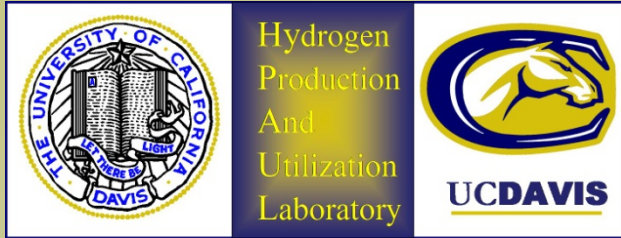
Collaboration of Departments:
ITS and College of Engineering

FCH²V Center Research Areas

- Fuel Cell and Hybrid Component Level Research
 - Energy storage (batteries, ultracapacitors)
 - Continuously variable transmissions (CVT)
 - Emissions reduction with hybrid and hydrogen enabled technologies
 - Electronic Control systems
- Vehicle and Energy Systems Research
 - Vehicle systems modeling
 - Fuel cell auxiliary power units
 - System Integration
 - DOE Challenge X competition (Trinity)
- Fuel Pathway Analysis (STEPS Program)
 - Infrastructure economics
 - Environmental analysis



Leverages Existing Programs & Partners



H2 Production & Utilization Laboratory
<http://mae.ucdavis.edu/hypaul/index.htm>



H2 Pathways and STEPs Programs
<http://steps.its.ucdavis.edu/>



UC Davis Challenge X Team
<http://www.team-fate.net/>



FC Auxiliary Power for Trucks

Research and Training Facilities



- *Hybrid Vehicle Power Systems Lab (ITS-Davis)*



- *Hybrid Vehicle Design, Assembly and Test Labs (MAE)*



- *Hydrogen Production and Utilization Lab (MAE)*
- *On-campus Hydrogen Refueling Station (ITS-Davis)*

FCH²V Center Curriculum



- Advanced Energy Systems (Course and Lab)
- IC Engines (Course and Lab)
- Hydrogen Pathways – Technology, Pathways, Economics and Policy
- Fuel Cell Systems
- FCH²V Center Electives, 40 classes available:
 - Mechanical and Aeronautical Engineering (MAE)
 - Chemical Eng. and Materials Science
 - Biological Systems Engineering
 - Electrical Engineering
 - Transportation Technology and Policy (ITS-Davis graduate group)

Outreach and Publications

Comprehensive website for outreach purposes and as a research collaboration tool

The screenshot displays the website for the Institute of Transportation Studies (ITS) at UC Davis, specifically the GATE Center of Excellence. The header includes the ITS logo, the text 'INSTITUTE OF TRANSPORTATION STUDIES', and 'Fuel Cell, Hydrogen, and Hybrid Vehicle GATE Center of Excellence'. A search bar and a 'log in' link are also present. A navigation menu below the header lists: Home, Academia, Research, Education, Enrollment, Sponsors, and Alumni. The main content area is divided into two columns. The left column features a 'News from the Center' section with three items: '1) Five New Fellows Awarded in the GATE Center, August 2006', '2) Application for fellowship 2006 - 2007, July 2006', and '3) New Super-Efficient Plug-in Hybrid Unveiled, May 2006', followed by a link for 'Archived News'. Below this is a 'Current Fellows at the Center' section listing: Nils Johnson, PhD Student TTP; Eddie Jordan, PhD Student MAE; Wayne Leighty, MS Student TTP; Andrew Shabashevich, MS Student MAE; David Vernon, PhD Student MAE; and Jonathan Woolley, PhD Student MAE. The right column features a section titled 'TRAINING THE NEXT GENERATION OF AUTOMOTIVE ENGINEERS' with a sub-header. The text below describes the center's focus on research, education, industrial collaboration, and outreach within automotive technology, and mentions its funding by the Department of Energy. At the bottom of the page, there is a footer with contact information and a copyright notice for 2005.

ITS UC DAVIS

INSTITUTE OF TRANSPORTATION STUDIES
Fuel Cell, Hydrogen, and Hybrid Vehicle
GATE Center of Excellence

log in

Home Academia Research Education Enrollment Sponsors Alumni

News from the Center

- 1) Five New Fellows Awarded in the GATE Center, August 2006
- 2) Application for fellowship 2006 - 2007, July 2006
- 3) New Super-Efficient Plug-in Hybrid Unveiled, May 2006

Archived News

Current Fellows at the Center

Nils Johnson, PhD Student TTP
Eddie Jordan, PhD Student MAE
Wayne Leighty, MS Student TTP
Andrew Shabashevich, MS Student MAE
David Vernon, PhD Student MAE
Jonathan Woolley, PhD Student MAE

TRAINING THE NEXT GENERATION OF AUTOMOTIVE ENGINEERS

The UC Davis Fuel Cell, Hydrogen, and Hybrid Vehicle (FCH2V) GATE Center of Excellence established in 2005 is focused on research, education, industrial collaboration and outreach within automotive technology.

A systems integration philosophy is guiding the FCH2V Center's education and research activities. The center is using its knowledge and understanding of systems to identify critical research needs and design efficient and effective research and education initiatives. It is integrating the latest thinking on fuel cell and hybrid vehicle systems with hydrogen energy systems modeling. The focus is on training students to approach their work from both micro and macro perspectives — to understand vehicle design at the component as well as systems integration level.

The Center of Excellence is funded by Department of Energy for five years and the center is currently building an industrial partnership to provide opportunity to participate in training the next generation of advanced automotive engineers.

GATE Center of Excellence

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<http://gate.its.ucdavis.edu>

Application process

1. An updated CV
2. Current academic transcript
3. Complete twelve month research plan
4. Letter of sponsorship from a participating professor

Research Plan Components

1. *Research plan description*
2. *Expected contributions*
3. *Research Methodology*
4. *Literature review*
5. *Timeline and Deliverables*
6. *Interim publications*
7. *Interaction with other researchers*
8. *Personal Education Plan (as it relates to the research)*
9. *List of advisors and role each one will play in your research, including outside (non-academic) contacts*

GATE Graduate Fellowships

Competitive Award 2008 - 2009

- Douglas Saucedo – Electric-Turbo-Generator (ETG) Internal-Combustion-Engine (ICE) Modeling for Drive-Trace Vehicle Simulations
- David Kashaveroff – An Investigation of Stratified and Hybrid Mode Reformation for Fuel Cell Applications
- Jason Greenwood - Hydrogen Enriched Mixed Alcohol Combustion in IC engines

Applications due April 15, 2009 for the 2009-2010 academic year

GATE Graduate Fellowships

Competitive Award 2005 - 2006

- David Vernon - Hydrogen Enrichment Via Chemical Recuperation to Increase Efficiency and Reduce Emissions in Engines.
- Brett Williams - Light-Duty Hydrogen-Fuel-Cell Vehicle Adoption in California: Early Markets, Vehicle-to-Grid Power, and “Mobile Energy” Innovation.
- Bryan Jungers - Improving the ITS-Davis Fuel Cell Vehicle Modeling Program (FCVMP): Incorporating Scalability, Transient Effects and Environmental Impact Analysis.
- Matt Caldwell – Hydrogen Production from Unpurified bio-derived alcohol mixtures: fundamental investigation of ATR and economic and infrastructure pathway analysis

Competitive Award 2006 - 2007

- Eddie Jordan - Hydrogen enriched ethanol combustion in IC engines
- Nils Johnson - Potential for coal-derived hydrogen with CCS
- Brett Williams – Hydrogen-Fuel-Cell Vehicle Adoption: Early California Markets, Vehicle-to-Grid Power, and “Mobile Energy” Innovation
- David Vernon – Thermal integration and system design for utilizing waste heat and exhaust gases
- Jonathan Woolley - Characterizing the hydrogen conversion trends associated with auto thermal reformation of octane ethanol mixtures.

GATE Graduate Fellowships (Continued)

Competitive Award 2007 - 2008

- Andrew Shabashevich – Analysis of Waste Heat Recovery from Light-Duty Hybrid Electric Vehicles
- David Vernon – Thermal integration and system design for utilizing waste heat and exhaust gases
- Eddie Jordan - Hydrogen enriched ethanol combustion in IC engines
- Wayne Leighty - Structural Econometric Modeling of the Investment Timing Game in Alaska Oil and Gas Exploration and Development

UC Davis GATE Students

GATE Center (Year)	M.S. Candidates	Ph.D. Candidates
1999	1	1
2000	3	0
2001	6	1
2002	6	1
2003	2	0
2004	5	2
2005	0	4
2006	2	3
2007	1	3
2008	2	1

Organizations that hired graduates:

UTC Fuel Cells, Ballard, Daimler, General Motors, Ford, Nissan, Toyota, Volkswagen, Agilent, ISE Corp., Aerojet, Electric Power Research Institute (EPRI), United Defense, Eaton, California Fuel Cell Partnership (CaFCP), IAV Automotive Engineering Inc., REII,



Summary / Key Lessons

- GATE program has expanded and strengthened the automotive technology research and education programs at UC Davis
- Leveraging with other programs allows for increased resources for research and strong interaction with other researchers
- Competitive process for student research awards works very well
- GATE builds human infrastructure

FCH²V GATE Center - Building human infrastructure

