UNIVERSITY OF MICHIGAN-DEARBORN

GATE
Center for Electric Drive Transportation

P.I. Name: Chris Mi

Presenter: Chris Mi

University of Michigan - Dearborn

June 10, 2015

Project ID #
TI020

Overview

Timeline

- Project start date: 9/1/2011
- Project end date: 9/30/2016
- Percent complete: 60%

Budget

- Total project funding: $1,249,977
  - DOE share: $999,981
  - Contractor share: $249,996
- Funding received in FY14: $209,948
- Funding for FY15: $214,611

Barriers

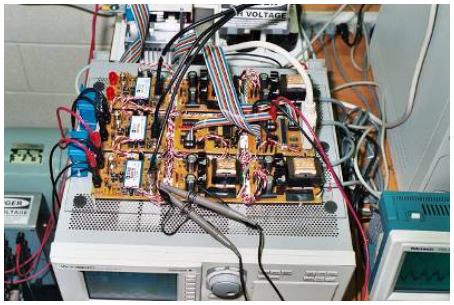
- Barriers addressed
  - Lack of trained engineers and scientists
  - Lack of advanced technology curricula
  - Automotive industry in high demand of knowledgeable and experienced workforce

Partners

- Chrysler, Ford, ANSYS, EDTA, Mathworks, DENSO, Hp Pelzer, dSPACE, PSIM, GaN Systems
- Project Lead: Univ. of Mich. Dearborn

Relevance/Objectives

- Establish concentrations in electric drive transportation in MS and Ph.D programs in Automotive Systems Engineering (ASE) at UM-Dearborn
- Develop and offer seven new courses
- Develop and offer a series of short courses
- Offer five graduate fellowships per year
- Enhance research in seven thrust areas
- Establish an Industry Consortium on EDV to support the above initiative



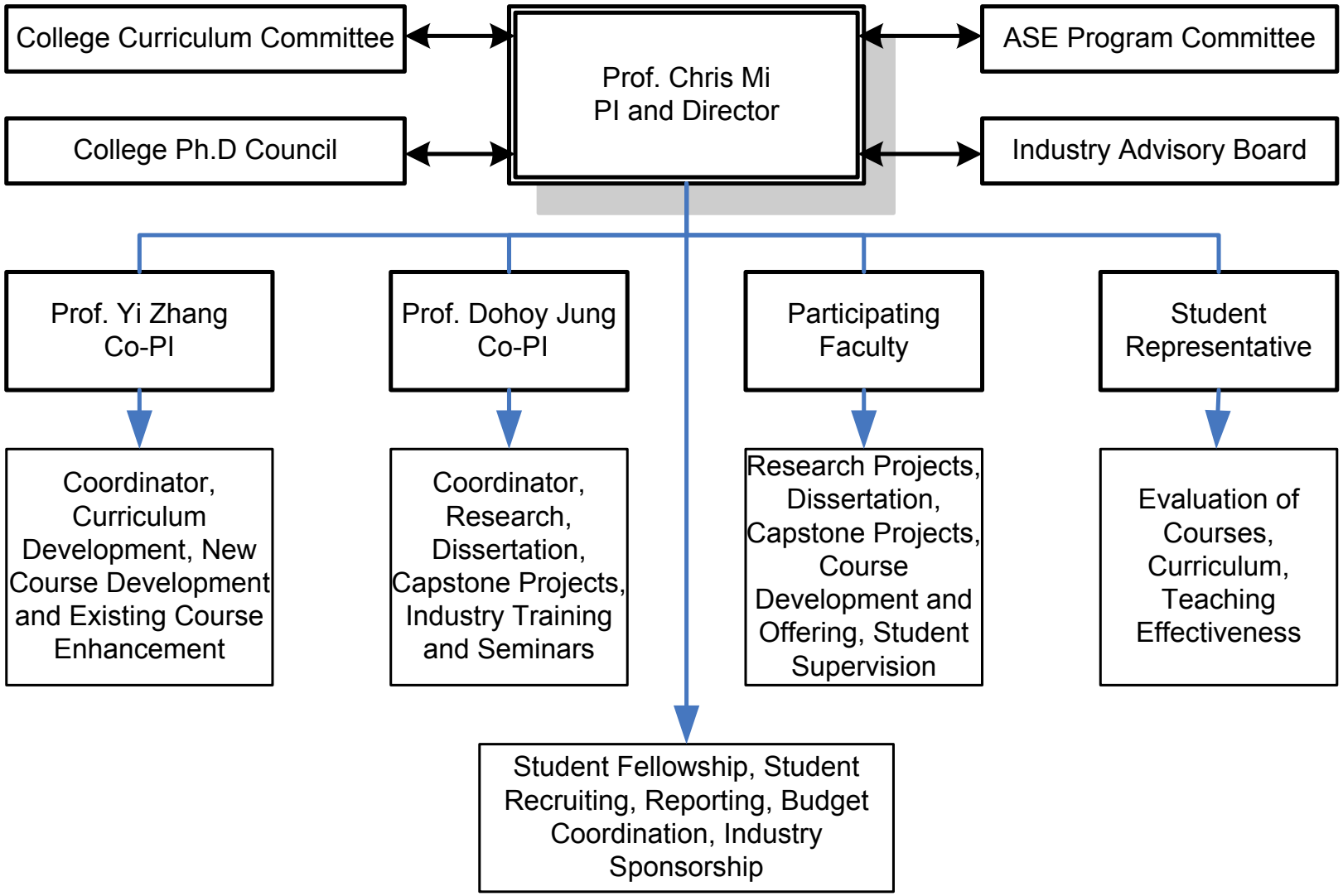
Milestones – Year 3

Third Academic Year (09/01/2013-08/31/2014)	
Milestones	Results
Offer the last two additional new courses	Offered 2 new courses
Refine and offer the new/revised course	Offered 5 courses
Recruit four to six graduate students	Total 8 students
Offer industry training programs	Offered 3 tutorial/short course
Publish conference and journal papers	Published five papers
Annual IAB Meetings	Two meetings per year
Organize Center Annual Conference	Offered WPT workshop

Milestones – Year 4

Third Academic Year (09/01/2014-08/31/2015)	
Milestones	Results
Refine and offer the new and revised course as regular courses	Offered 1 new course
Recruit four to six graduate students for the GATE program fellowships	Total 12 students
Offer industry training programs	Offered tutorial/short course
Publish conference and journal papers	Published five papers
Annual IAB Meetings	Two meetings per year
Organize Center Annual Conference	Offered WPT workshop in July 15, 2015
Defend Ph.D Thesis	Scheduled for August 2015

Approach - Center Management



Ph.D Concentration in Electric Drive Transportation

- Required Courses
  - ASE502: Modeling of Automotive Systems
  - ENGR799: Doctoral Dissertation
  - ENGR798: Seminar
- Elective Courses: select 4 concentration courses listed below and 3 additional elective courses
  - ASE502 Energy Storage Systems
  - ECE5462 Hybrid Electric Vehicles
  - ASE566 Vehicle Thermal Management
  - ASE5791 Vehicle Power Management
  - ECE646 Adv. Electric Drive Transportation
  - ASE501 Energy Conversion Systems
  - ASE557 Powertrain NVH Analysis
  - ISE567 Reliability Analysis
  - ECE517 Advanced Electric Drives
  - ASE548 Automotive Powertrains II
  - ECE615 Adv. Power Electronics

MSE Concentration in Electric Drive Transportation

- Required Courses
  - ASE 698 Capstone Project or ASE 699 Master's Thesis
  - ASE500 Automotive Systems Engineering
  - ASE587 Automotive Manufacturing Proc
- Elective Courses: select 4 concentration courses listed below and 2 additional elective courses
  - ASE 502 Energy Storage Systems
  - ECE 5462 Hybrid Electric Vehicles
  - ASE 566 Vehicle Thermal Management
  - ASE 5791 Vehicle Power Management
  - ECE 615 Adv. Power Electronics
  - ECE 646 Adv. Electric Drive Transportation
  - ASE 557 Powertrain NVH Analysis
  - ISE 567 Reliability Analysis
  - ECE 517 Advanced Electric Drives
  - ASE 548 Automotive Powertrains II
  - ASE 515 Vehicle Electronics II
  - ECE 532 Automotive Sensors & Actuators

Accomplishments: Development of New Courses

Fourth Academic Year (09/01/2014-08/31/2015)		
Course #	Course Name	Results
ESE501:	Energy Conversion Systems	Offered multiple times
ESE502:	Energy Storage Systems	Offered multiple times
ECE615:	Advanced Power Electronics	Offered multiple times
ECE646:	Advanced Electric Transportation	Offered multiple times
ECE517	Advanced Elec. Drives	Offered multiple times
ASE 557:	Powertrain NVH - Offered	Offered multiple times
ASE 566:	Vehicle Thermal Management	Offered multiple times
ECE5791	Vehicle Power Management	Offered Winter 2015

Accomplishments: Enhancement of Four Existing Courses

Third Academic Year (09/01/2014-08/31/2015)		
Course #	Course Name	Results
ASE548	: Automotive Powertrains II	Offered multiple times
ECE5462	Hybrid Electric Vehicles	Offered multiple times
ECE517	Advanced Electric Drives	Offered multiple times
ISE567	Reliability Analysis	Offered multiple times
Short courses, trainings, and seminars		Offered multiple topics and multiple times

2014 Fall Courses

- ECE510: Vehicle Electronics I - 16 in-class, 3 online
- ECE517: Advanced Power Electronics & Electric Drives - 16 in-class, 8 online
- ECE541: Intro to Elec. Energy Systems - 25 in-class, 20 online
- ME552 Intro to Electrical Energy Systems - 25 in-class, 20 online
- ESE500 Sustainable Energy Systems - 25 in-class, 20 online
- AENG 547 Automotive Powertrains I - 28 total in-class, 32 total online
- ME570 Noise, Vibration, and Harshness of Electric Vehicles, (NVH) - 33 in-class, 15 online

2015 Winter Courses

- ECE5791 Vehicle Power Management, 10 students
- ECE510 Vehicle Electronics I - 6 in-class, 9 online
- ECE 515 Vehicle Electronics II - 10 in-class, 6 online
- ECE542 Introduction to Power System Management and Reliability - 3 in-class, 2 online
- ECE5462 Hybrid Electric Vehicles - 24 in-class, 9 online
- ME548 Automotive Powertrains II - 19 in-class, 16 online
- ME577 Energy Conversion Systems - 4 in-class, 8 online
- ISME 567 Reliability Analysis - 15 in-class, 8 online

Accomplishments: Industry Partners

- Chrysler Group, LLC.
- Ford Motor Company
- DENSO International
- ANSYS, Inc.
- The Mathworks
- dSPACE
- Hp Pelzer
- EDTA
- PSIM
- GaN Systems

- Member benefits
  - Non Exclusive, royalty free IP for internal use
  - Access to recent, not-yet-published GATE Center research
  - Access to GATE Center prepublications and presentations
  - Early access to intellectual property by GATE Center
  - Access to the GATE Center facility
  - Serve on the Industry Advisory Board
  - Attend GATE Center annual conference , free or discounted attendance of seminar, short course, training
  - Networking opportunities
  - Jointly proposals to federal programs,
  - Priority access to students for internships
  - Guest lectures & seminars for GATE Center

Accomplishments: Workshop and International Events

- Hosting the Future Energy Challenge event in July 13-15, 2015
  - A total 24 teams applied
  - A total of finalist teams from internationally will participate in the competition
  - Grand prize sponsored by IEEE at $10000
  - Additional Awards sponsored by IEEE, PSMA and industry
- Organize a one-day workshop on wireless power transfer on July 15, 2015
  - Sponsorship by ANSYS and IEEE

Accomplishments: GATE Fellows

- One MS student graduated
- Eight full time Ph.D
- Three part time Ph.D students
- Seven passed qualify
- Four dissertation proposal exam passed
- Fall 2015, nine new applications

Accomplishments: Five-year Education Plan for Course Offerings

Course #	Course name	Faculty	Year 1	Year 2	Year 3	Year 4	Year 5
ESE501	Energy Conversion	Ratts		X	X	X	X
ESE502	Energy Storage	Mi	X	X	X	X	X
AE557	Powertrain NVH	Cherng		X		X	
AE566	Vehicle Therm. Man.	Jung, Li		X	X	X	X
ECE5791	Power Management	Murphey			X		X
ECE646	Adv. Power Elec.	Mi		X	X		X
ECE517	Electric Drives	Kim		X		X	
ECE5462	Hybrid Vehicles	Kim	X	X	X	X	X
AE548	Powertrain II	Zhang	X	X	X	X	X
ISE567	Reliability	Xi		X	X		X
Total courses offered per year			3	9	8	7	8

Accomplishments: On Out Reach and Professional Seminars

- Chris Mi developed and delivered a class for the IEEE e-learning initiative on wireless power transfer
- Chris Mi delivered a few seminars on wireless power transfer, including one at Stanford University, one at the IEEE Bay Area Chapter, one at University Udine Italy, one at Queen's University Belfast, one at Cranfield University UK.
- D. Jung, "Gasoline Engine Combustion, Knock, and Preiginition," Hyundai Motor Group R&D Division, Hwaseong-si, Gyeonggi-do, Korea, Sep. 15-19, 2014.
- Jung, D. and Lee, B., "Fuel Economy Improvement during Cold Start Using Recycled Exhaust Heat and Electrical Energy for Engine Oil and ATF Warm-up," Denso International America, Inc., Southfield, MI, November, 21, 2014.
- Jung, D., "Review of Powertrain Technology Trends in the US: Past, Present, and Future," Seoul National University, Seoul, Korea, September, 29, 2014.
- Jung, D., "Review of Powertrain Technology Trends in the US: Past, Present, and Future," Hanyang University, Seoul, Korea, September, 30, 2014.
- Jung, D., "Review of Powertrain Technology Trends in the US: Past, Present, and Future," KAIST, Daejeon, Korea, October, 1, 2014.
- Special issue of IEEE TIE on Wireless Power

Accomplishments: On Out Reach and Professional Seminars

- Zhimin Xi, Research seminar: "Design of Engineering Products, Systems, and Processes with High Reliability, Quality, and Resilience"; Oakland University; 11am - 12am, Nov. 7 2014; about 30 people.
- Zhimin Xi, Seminar with discussions: "Statistical model validation for reliable product design"; Medtronic, Minneapolis; 9am - 12am, Feb. 27, 2015; about 15 on site and >20 online.
- Yasha Yi, "Field enhancement of guided-mode resonance in tapered silicon nitride nanorod array", Boston, MA, Nov. 2014, ~40 people.
- Yasha Yi, "Coupled photonic systems between core-shell nanoparticle and integrated microresonator", Boston, MA, Nov.2014, ~40 people.
- Yasha Yi, "Integrated nano photonics for next generation thin film photovoltaic cells", Orlando, FL, Jan. 2015, ~100 people.
- Yasha Yi, "Bio-inspired nano optoelectronics for high performance biomedical imaging applications", Shanghai, CN, Jan. 2015, ~60 people.
- Yasha Yi, "Renewable energy introduction to IEEE honored societies students", Dearborn, MI, Apr. 2015, ~30 people.

IAB Curriculum Committee

- Curriculum committee formed in August, 2012
- Meet twice a year
- Committee Members
  - Industry Member
    - Wensi Jin (Chair, Mathworks)
    - Ming Kuang (Ford)
    - Zed Tang (Ansys)
    - Mark Zachos (DG Technologies)
    - Mahendra Muli (dSpace)
  - Faculty Member
    - Chris Mi (Director, ECE)
    - Dohoy Jung (ME)
    - Yi Zhang (ME)

- Purpose:
  - ✓ Make the graduates' skills relevant for the industry
  - ✓ For IAB members to interact around the curriculum between the bi-annual GATE meetings
  - ✓ Make sure the curriculum covers relevant subsystems outside powertrain.
  - ✓ Make sure the curriculum reflects how software engineering and systems engineering are done in the industry
  - ✓ Help shape the curriculum as a way to influence students' directions
  - ✓ Find ways to involve industry speakers in the GATE teaching activities
  - ✓ Help identify short and long term needs and prioritize courses based on them

IAB Curriculum Committee Meeting (November, 2014)

- Vehicle Power Management (ECE 5791): a newly developed course for the center
- Automotive Powertrain II (ME548): an existing course with enhancement for the center curriculum objective
- Jan Ladewig suggested covering planetary gear in Automotive Powertrain II. Prof. Yi Zhang will consider this suggestion. Wensi Jin recognized that this is a unique course offered at graduate level. Chris Mi informed that Yi Zhang and he are writing a text book on this subject.
- Brian Wynne suggested developing a course on standardization related electric drive transportation.

Proposed Future Work

- Actively recruit GATE Fellows
- Promote industry partners and secure additional membership
- Offer scheduled courses in the curriculum.
- Organize GATE Annual meeting and bi-annual IAB meeting
- Promote GATE Center at related conferences, exhibit at ANSYS Annual Conference and ITEC Conference
- Continue to offer industry training programs
- Develop capstone projects
- Present at conferences and publish results in journals
- Overcome limitations, increase visibility, enhance resource usage, leverage internal resources and external funding

Summary

- Developed and offered all new courses for the EDT concentration in the ASE program
- Revised and offered the contents of all existing courses
- Offered all classes online for distance learning students
- Recruited 8 graduate students for the GATE program fellowships and 4 part time students
- Signed 8 industry partners supporting the GATE Center
- Leveraged funding from college for lab upgrades
- Leveraged funding for projects involving GATE fellows
- Organized the bi-annual industrial advisory board meeting
- Host the International Future Energy Challenge Event and one-day Workshop on wireless power transfer for electric vehicle applications

Project Personnel

- Chris Mi: PI, ECE, (313) 583-6434, chrismi@umich.edu
- Yi Zhang: Co-PI, Mechanical Engineering, (313) 593-5539, anding@umich.edu
  - Dohoy Jung, Mechanical Engineering
  - Yi Lu Murphey, Electrical and Computer Engineering
  - John Cherng, Mechanical Engineering
  - Ben Q. Li, Mechanical Engineering
  - Zhimin Xi, Industrial and Manufacturing Systems Engineering
  - Eric Ratts, Mechanical Engineering
  - Taehyung Kim, Electrical and Computer Engineering
  - Wencong Su, Electrical and Computer Engineering
  - Alex Yi, Electrical and Computer Engineering