CSU Ventures

Speeding Technology to the Global Marketplace

Advanced Electric Drive Vehicle Education Program: CSU Ventures

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CSU Ventures
June 11, 2011

Project ID:ARRAVT033

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Project start date: Dec 2009
- Project end date: Dec 2012
- Percent complete:
  - 24% in February 2011
  - 34% in May 2011

Barriers

- Parochial processes at educational institutions
- Acceptance of new training methods and approaches
- Budget and resource considerations at secondary schools and colleges

Budget

- Total project funding
  - DOE share: $4,999,834
  - Contractor share: $1,497,599
  - Fully funded in Dec 2009

Partners

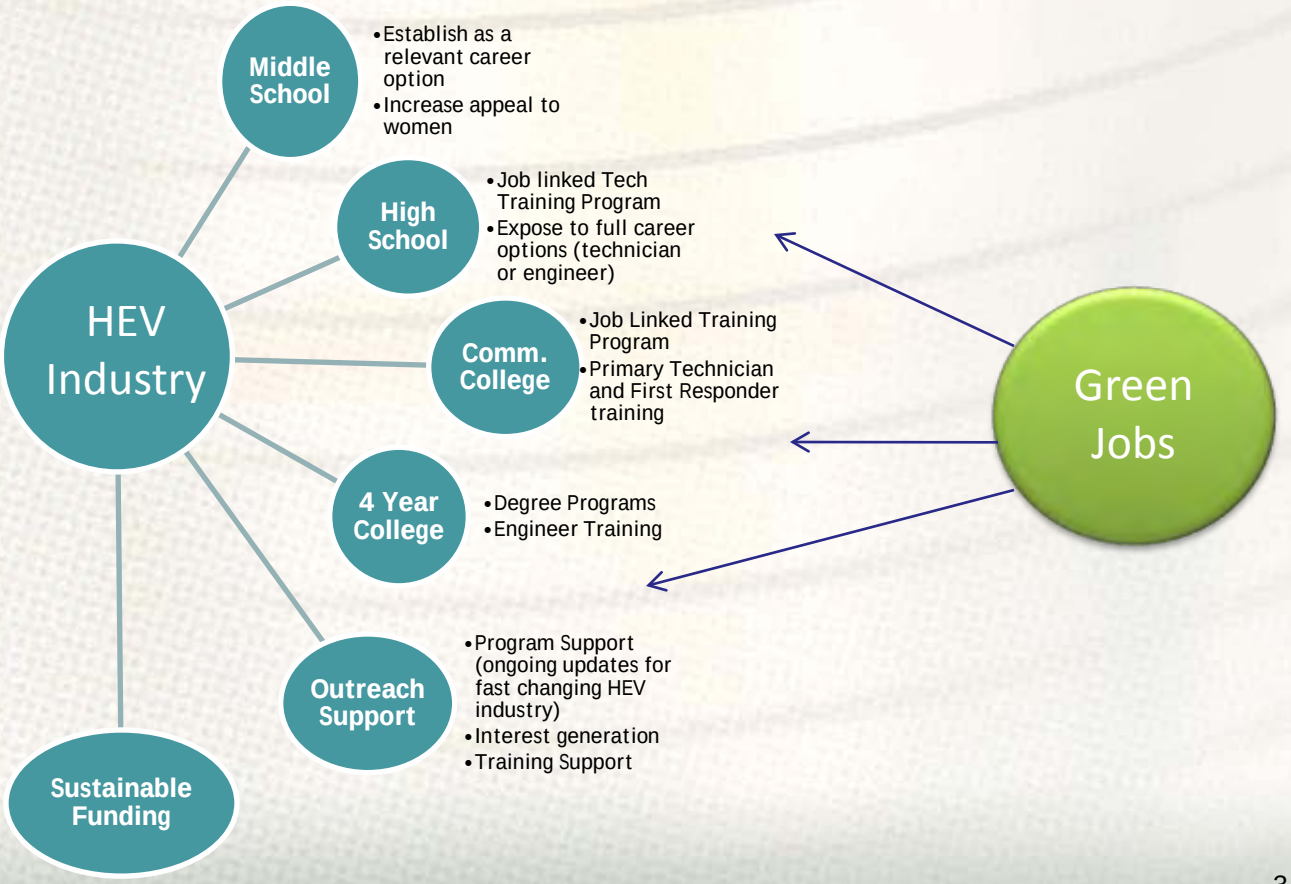
- Interactions/collaborations:
  - OEMs, US Army, USMC, Colorado Governor's Energy Office (CO), CO and WY TAG, Veterans for Green Jobs , Poudre School District (Larimer County, CO)
- Project team:
  - Colorado State University (CSU), Georgia Tech (GT), Ricardo, MRI, Arapahoe Community College, Douglas County Education Foundation

Relevance: Objective

Objective: A virtual continuous cycle to engage and train students, create jobs, help the HEV segment speed time to market and increase consumer confidence.

Impacts

1. Increased student enrollment
2. Increased training effectiveness in HEV segment
3. Fill projected job shortages
4. Catalyst to quality job creation
5. Speed HEV segment time to market
6. Help industry gain needed infrastructure
7. Wider adoption as industry best practice



Relevance: The ~~Problem~~ Opportunity

Automotive Industry Status:

- **Projected 40% to 50% shortage of qualified vehicle technicians over the next 5 to 10 years[1].**
- **Estimated shortage of 60,000 qualified technicians[2] currently.**
- **This situation is further complicated by:**
  - the introduction of new propulsion technologies such as hybrid-electric vehicles (HEV), all electric vehicles (EV), and their associated support systems.
- **Shortage of qualified mechanical or vehicle engineers to support industry**

"Kent Niederhofer can't find enough mechanical engineers to work for him — in southeastern Michigan. You know, where Detroit is, with its 13.3% unemployment rate. Niederhofer is president of the American branch of Ricardo, an engineering consultancy that designs the power trains of some of the coolest stuff around: Bugatti sports cars, huge wind turbines and unmanned aerial vehicles."[3]

Bottom Line: Industry is suffering from an aging workforce and a decade of poor and unrewarding employment opportunities

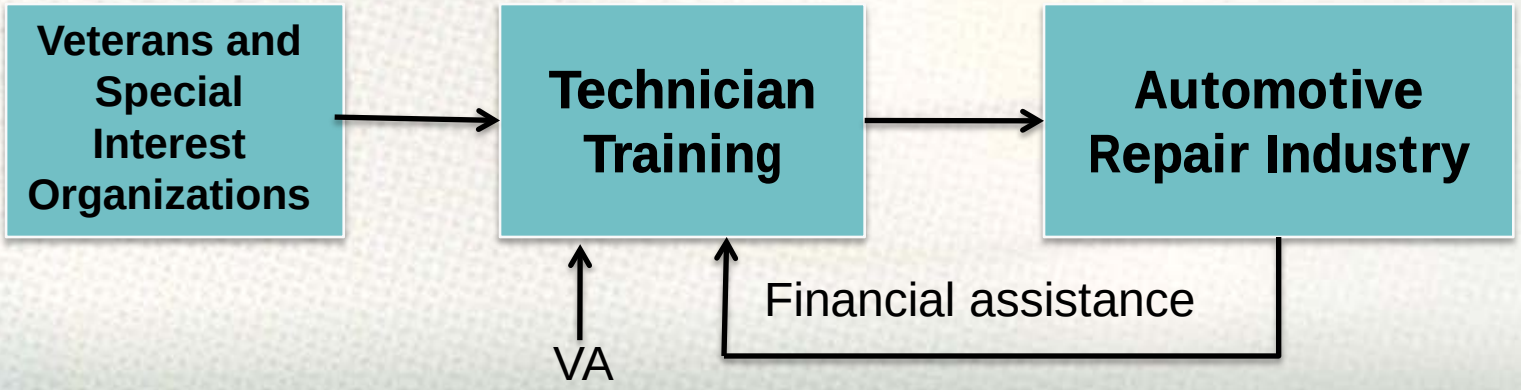
1. http://www.citytowninfo.com/education-articles/career-exploration/mechanic-shortages-looming
2. http://www.doityourself.com/stry/techniciansshortage
3. http://www.time.com/time/business/article/0,8599,2040964,00.html#ixzz1G22Cj4Qe

Relevance: STEM and Jobs

- **The United States continues to lag behind in Science, Technology, Engineering and Mathematics (STEM) on the world stage***
  - Through the introduction of relevant examples and technologies in middle school and high school, interest in STEM may be encouraged (model following International Society for Neuroscience – Brain Awareness Week)
  - Through student job site visits and outreach with students and parents, opportunities in the automotive and PHEV fields are being communicated (Career Connect)

*On the 2006 Program for International Student Assessment (PISA) mathematics assessment, the United States ranked 24th out of 30 countries belonging to the Organization for Economic Cooperation and Development (OECD), which represents the world's most advanced countries; and 17th out of 30 on science.

- **Focus on a job funnel path for under represented groups such as veterans, women and Native Americans**



Relevance: Job Creation and Placement

Support of the President's Jobs Initiative :

- **Automotive technician jobs:**
  - Automotive technician jobs already exist…do not need to be created, only filled.
  - Automotive technicians can not be out-sourced.
  - Number of vehicles on road continues to increase (approximately 150M vehicles -7% -10% new technology vehicles entering market per year, goal of 1million by 2015).
  - Jobs not minimum wage and easily expand to $70,000 to $80,000 per year with experience.
- **Increased opportunities for women in traditionally all-male work force/ environment (1.6% women by occupation[1]).**
- **Approximately 25% of our returning veterans are unemployed (the National Guard is higher).**
- **With changes in technology, opportunities exist for disabled workers and Wounded Warriors.**

1. Women in the Labor Force: A Databook, USDOL Report 1018 Sept 2009

Approach - Summary

Summary - Create a multi-linked approach that combines PHEV education from secondary through postgraduate/professional courses.

- **Secondary Schools**
  - Educate secondary school teachers on PHEVs
  - Provide examples for inclusion in science and math classroom lectures
  - Provide hands-on exploratory lab boxes
- **Technician Training**
  - Incorporate PHEV concepts in technician training
  - Explore new ways to train technicians using virtual reality.
  - Add PHEV safety for technicians and first responders
- **Develop courses for undergraduate, graduate and professional education**
- **Develop an outreach program that reaches the students and community.**
- **Create job-filling paths directly targeting under-represented groups**

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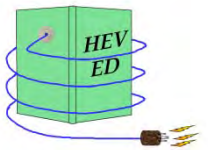
Approach – Secondary School Teacher Education Program

Rationale of approach: maintain sustainable education by training teachers to integrate the fundamental principles of PHEVs in existing curriculum a) updates & enhances STEM; b) provides teachers with opportunity for professional development c) includes 21st century workforce skills

Industry Needs → PHEV Core Concepts → State/Nat'l Education Standards

"fact sheet" of important principles that underlie HEV technology

"How to incorporate HEV Ed into the 6th-12th grade classroom"

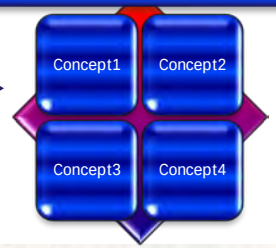


Partnership w/ district schools:
Poudre School District (Larimer County) & Douglas County Education Foundation

Teacher Continuing Education Training
ONSITE

- Lecture Series
  - •Overview
  - •Technical components
- Workshop
  - •Demonstrations +
  - •Exercises +
  - •Experiments for the classroom
- Internet Links & Resources
  - •Professional contacts
  - •academic
  - •workforce/Community Colleges
  - •Industry

PHEV Curriculum Activities



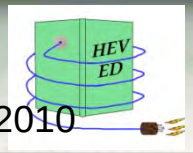
Archive for future/remote use (webinar)

Take back into the classroom

Training offered to all teachers and counselors to better integrate information across disciplines

Approach / Accomplishments – Secondary School Teacher Education Program

Milestones & Projected Timeline



Sept 2010

- Attended STEMapalooza (local Science& Engineering Outreach Event) to gather proof of concept on potential outreach approaches
- Finalized outline of Educational Outreach approach for middle & high schools

Nov 2010

- Obtained informal feedback & interest from local teachers & administration regarding potential of 6-12th grade PHEV Ed Outreach/Teacher training
- Identified availability of potential STEM partners:
  - e.g., CSU-CNS-Educational Outreach Center, CSU Clean Energy Cluster, Colorado Clean Energy Cluster

Dec 2010

- Established formal partnerships with School districts

Career Connect – Approximately Every Month at DC High Schools

Jan 2011

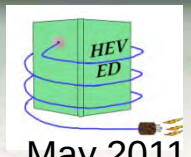
- Established relationship with Fort Collins Museum & Discovery Science Center
- Began to Identify PHEV Core Concepts (CC)
- Align CC to Educational Standards

Mar 2011

- Obtain input from teachers regarding Teacher Training Workshop for incorporating PHEV Ed into existing curriculum
- Begin organizing existing lessons & creating prototype curriculum activities (labs, classroom exercises) for Teacher Training Workshop

Career Connect has had 4 sessions at 3 different businesses for 23 students

Milestones & Projected Timeline



Apr 2011

Finalize PHEV Ed Core Concepts & their alignment with Educational Standards

May 2011

-Formal announcement of Teacher Training & Workshop Summer Program to PSD & DCSD through district sites & STEM sites

-Recruitment of teachers/counselors via school visits by STEM coordinator

Develop PHEV Ed presentations for Teacher Training Workshop:

-"Overview of PHEV CC"

- "How to incorporate PHEV ED into the current classroom"

June 2011

-Finalize speakers for Teacher Training Workshop

-Review presentation materials

-Identify workshop partners for teachers

July 2011

Finalize Teacher Workshop curriculum classroom demos/activities

Aug 2011

Teacher Training Workshop Summer Program

Aug-2011-May 2012

-Implementation of PHEV Ed in the classroom by the participating teachers

-assist them in their efforts (CSU engineers, industry professionals, grad students)

Oct 2011

-1st Follow-up Report due from participating Teachers of how/when they will incorporate summer Workshop resources into their classes

-adjust /assist in any barriers or pitfalls

June 2012

2nd Follow-up Report due from participating Teachers of how/when they incorporated summer Workshop resources into their classes

Evaluate 2011 Summer Teacher Training Workshop

-revise and REPEAT Summer Teacher Training Workshop in 2012; invite back available teachers to address new attendees

Potential for "PHEV Awareness Week" at schools; hands-on activity exhibits created by students for students & community; outside speakers/guests/exhibits from civic groups & industry

Approach / Accomplishments for Technician Training

- Technician Training – PHEV safety has been integrated into the automotive degree and paramedic certificate programs – more than 100 college students have been exposed to his new material
  - All vehicles and equipment ordered and received at both ACC and Ponderosa High School (via Douglas County Education Foundation)
  - Short course for practicing technicians completed and offered 3 times
    - Failed to enroll critical number in course twice (OEMs offering their own courses to their dealers)

- First Responder Training put on hold pending resolution of teaming with NFPA (recommendation from 2010 Merit Review)
  - Participated in technical review of WVU – NAFTC First Responder Training program in July 2010
  - Attended NFPA workshop in November 2010

- Virtual Reality Training Component – has been delayed
  - 3D drawings required and in process of being obtained
  - Will hold course in March 2011 regardless of enrollment

Approach/Accomplishments - Undergraduate, Graduate and Professional Courses

- Survey and meet with industry to determine educational requirements/topics for inclusion in courses
  - Status: Survey in progress with draft available at review
- Develop undergraduate PHEV course and share between CSU and GT
  - HEV Powertrains course taught Fall 2010 through distance learning, with location at GT and delivered through technology to CSU. This course will also be taught Spring 2011 semester at CSU campus
  - Vehicle Energy Storage System Design course in development and scheduled to be taught Fall 2011 semester, both at CSU as well as through Distance Learning, for credit at GT
- Develop graduate courses as listed below:
  - Simulation-Based Design of Hybrid-Electric Vehicles course is being developed and will be taught in Spring 2012 at GT distance learning offered to CSU
  - Control Engineering in Hybrid-Electric Vehicle Propulsion Systems is being developed and will be taught in Fall 2012 at GT with distance learning offered to CSU
  - Transportation Electrification course scheduled Fall semester 2011 at CSU with distance learning offered to GT
  - EV/HEV Computational System Design course scheduled for Spring semester 2012 at CSU with distance learning offered to GT
- Develop professional short courses
  - PHEV/HEV short course 80% complete – ready summer 2011
  - Additional PHEV short courses will be defined based on survey results
  - Course for engineers on Maintenance Theory and Practices for Vehicles/PHEVs offered summer 2011

Projected Outcomes & Integration of Overall Outreach Program

Douglas County Educational Foundation — Community Support for Learning Excellence

HEV ED

Poudre School District

Teacher training

Incorporates PHEV core content into current courses for enhancing STEM curriculum

HEV Exhibit for programs at schools, museums & community events

Middle & High school students

College Engineering Students taking newly formed HEV courses, involved with Summer Teacher Training Workshop & demos in the classroom, opportunity to participate in public education events

Arapahoe Community College

Fort Collins Museum & Discovery Science Center

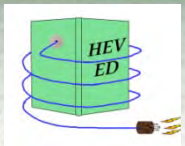
High/Middle School students involved with HEV exhibit at museum public programs

- Social Media
- Web – getev.org
- Community Events
- Colorado Clean Energy Cluster and more!

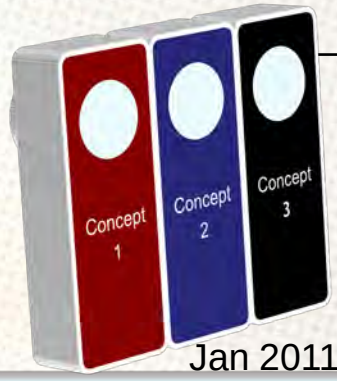
<u>Higher Ed Engineering & Auto Tech programs</u>
-high school students are better prepared to enter higher educational programs

<u>Several layers of integration across organizations</u>

Approach / Community Outreach: Public Exhibits



HEV Core Concepts



Creation of PHEV Exhibits for Public Programs at local Museums & Community events

e.g., Ft Collins New West Fest, Nelsen's Old Town Car Show, Rocky Mountain Sustainable Living Fair, STEMapalooza, Odyssey 2012

"Innovation Center" (under construction - opening 2012) of Fort Collins Museum & Science Discovery Center

-highlights local projects (e.g., Clean Energy research at CSU-Clean Energy Cluster)

-5000 sq feet, of traveling exhibit space

-potential for temporary exhibit in new space following new building opening;

Jan 2011

Established relationship with Fort Collins Museum & Discovery Science Center

Began to Identify PHEV Core Concepts (CC)-what should the general public need to know about PHEV technology?

Feb 2011

Outlined plans for Exhibit #1

-**Mockup of HEV without the body of the car** to illustrate the inner workings of HEVs by using a static display of system components

-Power/energy flows through the system at different phases in the vehicle's performance will be demonstrated by a series of LEDs

Mar-May 2011

Create HEV Exhibit

-obtain components (assistance from Ricardo,OEM,auto parts reps)

-assemble supports/frame with components & external LEDs

-compartmentalized for travel

-Review with Ricardo & Museum reps for accuracy & optimum public reception

Beginning Summer 2011

Display Exhibit:

-community locations & events

- Museum

-Teacher Training Workshop

-schools

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Approach / Veteran Outreach for Jobs

Mar 2011

Identified

existing Veteran Resources & Services organizational Events

Form partnership with Veteran Services Groups:

Participate in agenda of Veteran Events already established:

- Local (FOCO/Littleton area) Vet. of foreign wars, American Legion, Rotary, Senators events, Governors events for vets
- Larimer & Arapahoe/Douglas County Workforce Centers
- CO Vet Services
- Fed Vet Services, TAPS

Form partnership with Higher Ed pre-enrollment representatives to assist at event:

- CSU, ACC

Apr 2011

Created

an informational presentation about PHEV Core Concepts, auto industry/workforce needs

Highlights challenges in the industry and technology; industry & DOL projections

Describes various levels of workforce : from auto tech, master tech to engineering research

Relates the requirements/abilities needed for each job

Explains "How to get there" for each job; requirements & further training; ACCs HEV short course for experienced auto techs, to AA degree, to CSU Undergraduate Graduate/Masters degree program

Includes videos/ animation/exhibit or guest speaker where appropriate

May 2011 -Dec 2012

Coordinated

efforts with representatives from ACC & CSU Veterans resources/financial aid/pre-enrollment/recruitment programs

ACC & CSU provide overview of GIBill /financial aid program

Provide information on how to apply; review website, demonstration

Provide handouts about information presented

Present

PHEV Pipeline Program --Partner with ACC & CSU to present information at events sponsored by other veteran service organizations

Larimer County Workforce Workshop/other events

Rotary, Vet of For Wars, Am Legion events

Congressional/Governor's sponsored Vet events

CO Vet events

Federal Vet events/training websites

Follow-up & evaluate

with CSU & ACC veteran services/financial aid program reps and participating veterans to evaluate our informational pipeline program

Formal Independent Evaluation

Institutional exchange of data enrollment

surveymonkey.com

Approach / Accomplishments for Underrepresented Groups

- **Approach - follow similar model for women and Native Americans as with veterans**
- **Accomplishments**
  - Meeting with local advocacy organizations
    - Colorado and Wyoming National Guard (TAG) ref vets
    - CSU student veterans groups and CSU Veteran Program Office
    - Society of Women Engineers (SWE) at CSU
    - Colorado State University Society for Advancement of Chicanos and Native Americans in Science (CSU-SACNAS)
  - Met with the Colorado Department of Labor and Governor's Energy Office to discuss job creation
  - Meetings in progress with major corporations and local automotive repair organizations to develop scholarship programs/work-study internship, and employment opportunities
  - Exploring relationships with tribal colleges and American Indian Higher Education Consortium
  - Integrating into Georgia via GT and exploring national presence/effort
  - There are no "Go/No-Go" events for this effort

"Never, Never, Never Give Up" Winston Churchill

Collaboration & Coordination

- **Internal Partners**
  - CSU and Georgia Tech: Research universities developing and teaching courses (undergraduate and graduate) that will be co-taught at both institutions.
  - CSU School of Occupational Therapy: Investigation methods of changing automotive technician maintenance approach to allow for more disabled workers to participate. CSU OT School is a major participant with the VA working with Wounded Warriors.
- **Collaborators: working with the following organizations**
  - Veterans for Green Jobs: Funnel process to focus returning veterans into this industry. Approaching public and private organizations for support.
  - WVU-NAFTC and NFPA on First Responders training
  - Purdue on use of EV Hub (part of HUBzero)
  - Colorado Clean Energy Cluster to co-host regional Odyssey with WVU in 2012
  - Working with numerous agencies/organizations, both Government, Not For Profits and industry for job development
- **Future Collaborations**
  - Will explore with other grant awardees about sharing course materials and possible co-teaching courses

Major Milestones for Year 2

Month/Year	Milestone or Go/No-Go Decision
March 2011	Demonstration of first level virtual reality training. (delayed, moved next milestone to October 2011 based on receiving 3D drawings and ACC courses for filming). Go/No-Go will depend on value added and be decided in June 2011.
May 2011	First Responder training and NFPA interaction/collaboration
July 2011	Beta testing of outreach collaborative space. Implement by December 2011 (on schedule). Inclusion and porting to EV Hub will be decided in July 2011
September 2011	First short course offering. Go/No-Go decision…is enrollment sufficient to pay for course offering? (on schedule)
	Other schedules are contained in individual topical areas.

Future Activities

- **Year 2:**
  - Complete approval for graduate certificate in Electric Transportation (CSU).
  - Complete development of laboratory facilities at CSU to support university-level education program and courses developed under this grant (equipment privately funded).
  - Develop training animations of technicians properly repairing virtual vehicles for playback on a dedicated computer with a Head Mounted Display.
  - Continue college level course development.
  - Continue outreach and development of collaborative space for education and community.
  - Continue interaction and cooperation with other grant awardees so as to leverage effort and breath of courses.
  - First responder training will be offered throughout Colorado and portions of Nebraska and Wyoming.
  - Developing a complementary automotive technician program for Ponderosa High School through efforts with Douglas County Education Foundation
  - Integrate under represented groups into the educational objectives and job creation

Summary

The CSUV Team is:

- On target on all programmatic and technical fronts.
- Overcoming the parochial processes at educational institutions through the sharing in course development and multiple delivery sites
- Fostering the acceptance of new training methods and approaches through the integrated outreach plan, development of PHEV core concepts, and incorporation of industry requirements into the educational process
- Bringing community – education – industry together to solve multiple problems.
  - Jobs for veterans, women and Native Americans
  - Qualified personnel to fill the shortage of automotive technicians
  - Rethinking maintenance methodology for the partially disable and Wounded Warriors
- Addressing our national need for improved STEM motivation through relevant, contemporary examples in our secondary schools

"The CSUV Team is on target for developing PHEV related jobs today and in the future."

Technical Back-Up Slides

Technical Accomplishments and Progress

- **Progress Made on Simulation-Based Design of HEVs Graduate Course**
  - Graduate student hired in January, 2010
  - Rapid progress on simulation of 1-Mode (e.g., Prius) and 2-Mode (e.g., GM) HEV power-split architectures
  - SAE Paper accepted (right)
  - Over 80 slides produced for direct course use, based on simulations presented in the SAE paper
  - Fully dynamic simulator completed for the Toyota Prius using Mathworks® Simscape simulation software
  - Investigation underway for simulating multi-scale events: resonance excitation of powertrain components, dynamic balancing of ICE torque fluctuations using electric machines controller, etc.

SAE Paper: 11PFL-0790

Backward-Looking Simulation of the Toyota Prius and General Motors Two-Mode Power-Split HEV Powertrains

John P. Aratz, Michael J. Leamy, Jerome Meisel, Kenneth Cunefare, David Taylor
Georgia Institute of Technology, Atlanta, GA 30332 USA

ABSTRACT

This paper presents a comparative analysis of two different power-split hybrid-electric (HEV) powertrains using backward-looking simulations. Compared are the front-wheel drive (FWD) Toyota Hybrid System II (THS-II) and the FWD General Motors Allison Hybrid System II (GM AHS-II). The Toyota system employs a one-mode electrically variable transmission (EVT), while the GM system employs a two-mode EVT. The road-load parameters defining each system are used to calculate the required mechanical power at the driven wheels necessary to follow a given drive-cycle. Admissible engine operating states are sought based on component performance limitations and the required mechanical power at the driven wheels. Each unsteady combination (IC) engine operating point defines an accompanying battery power output consistent with the constraints of the electric machines. The design approach is to exhaustively search all admissible states and minimize an instantaneous cost function based on engine power and battery power, at each time instant of the drive-cycle. Two cost functions are considered which weight battery power usage using either a linear or an inverse-tangent function of the current state of charge. Selected operational states are then compared against each other based on the flexibility and power delivery capabilities of the powertrains. Optimal choices for each cost function are determined with the assistance of a charge sustaining rules mechanism by fuzzy logic. Finally, the optimal choices are used to determine the expected efficiency of both powertrains considered.

INTRODUCTION

The three fundamental HEV architectures in use today are series, parallel and power-split. The operation of the IC engine and electric machines in each architecture ultimately dictates the powertrain's efficiency. Since IC engines are more variable in their efficiency than electric machines, it suffices to consider that IC engine operation which qualitatively maximizes overall powertrain efficiency. Parallel architectures employ a highly efficient mechanical path to transmit input IC engine power to the driven wheels. Engine speed and efficiency is therefore constrained by a finite number of fixed-gear (FG) ratios to three equivalents. IC engine operation is best suited for steady-power delivery (e.g. highway driving at constant cruising speed) as opposed to dynamic power delivery (e.g. urban or transient driving). For dynamic power delivery over a large range of vehicle speeds, a finite number of FG ratios can result in potentially inefficient engine operation. In series architectures, the IC engine operates independently of the road-load conditions providing steady, highly-efficient operation. Series electro-mechanical power delivery is best suited for urban driving with significant vehicle speed fluctuations. However, electro-mechanical power delivery is less efficient than mechanical due to energy conversion losses. Power-split designs combine the advantages of single path architectures, such as parallel and series, by providing two power paths between the IC engine and the driven wheels through gearing and EMs.

Since their introduction in the early 1970's [1], electrically variable transmissions (EVTs) have evolved into two distinct configurations found in common use today: namely the one-mode and the two-mode EVT. The historical development of power-split transmission gearing and evolution can be found in [2]. One-mode EVTs have been extensively studied, specifically as they pertain to the THS-II input-split hybrid powertrain system. Detailed descriptions of their basic operations can be found in [3, 4]. Due to energy conversion losses in the electrical energy path, engine operation on the engine optimal operation line may not minimize fuel consumption in power-split hybrids. Other studies have quantified their transmission efficiency, and in doing so, have shown that a critical value of a speed ratio can be defined which demarcates the onset of power circulation loops [5]. By considering transmission losses and engine specific fuel consumption, system operating points maximizing fuel consumption can be found [6]. These results give rise to the approach of analyzing planetary gear hybrid powertrain optimal operation based on multi-objective optimization, evaluating both fuel and electric energy consumption. By evaluating both fuel and electric energy consumption, minimization of an equivalent energy consumption index results in operation nearly as efficient as the theoretical maximum performance obtained from

Technical Accomplishments and Progress

- **Progress Made on Dynamics and Control of Hybrid Electric Vehicles Course**
  - Graduate student hired May, 2010
  - Specific case study nearing completion based on a two-mode power-split hybrid electric vehicle powertrain
    - Derivation of the dynamic model
    - Derivation of equilibrium states and analysis of controllability properties
    - Design of regulating feedback controllers to stabilize commanded operating conditions
    - Computer simulation of transient and steady-state behavior
- **Progress on PHEV Short Course**
  - 8 lessons completed, each of 20-40 slides and accompanying narrative (in Word)
  - Topics: On-board energy storage, PHEV Architectures, ECVT Architectures, 1-Mode versus 2-Mode ECVTs, ECVT Analysis, PHEV Components, Induction Machines, Power Electronics

Community Outreach: Public Exhibits

Under Development March 2011-June 2011: Materials that can accompany HEV Exhibit

DELIVERABLES AT EXHIBITS *(as appropriate per venue)*

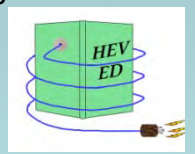
Public Engagement of HEV Technology

The exhibit will be used as a teaching tool public education & for 6-12th grade programs in hybrid & electric vehicle (HEV) technology. Our plan is to illustrate the inner workings of HEVs by using a static display of real or mock system components. Components will be arranged as in current vehicles, but without the body of the car. Our goal is to exhibit the components that make up the power and propulsion systems, including regenerative braking motors, generators, engines, wheels. A series of LEDs (to highlight specific components) will be used to illustrate the power and/or energy flows through the system at different phases in the vehicle's performance (start up, at stop lights, uphill, acceleration, low & high speeds, charging). The highlighted items and energy flows will be controlled separately, and the mock-up vehicle may be simulated to run by (hidden) power supplies that make a particular component active (i.e., the wheels). Audience will have access to buttons to highlight the actions of the components as part of this interactive display.

Game: True/False of PHEV Core concepts on gaming spin wheel
-----aimed to engage general public & increase knowledge about PHEVs, industry challenges, environmental impacts

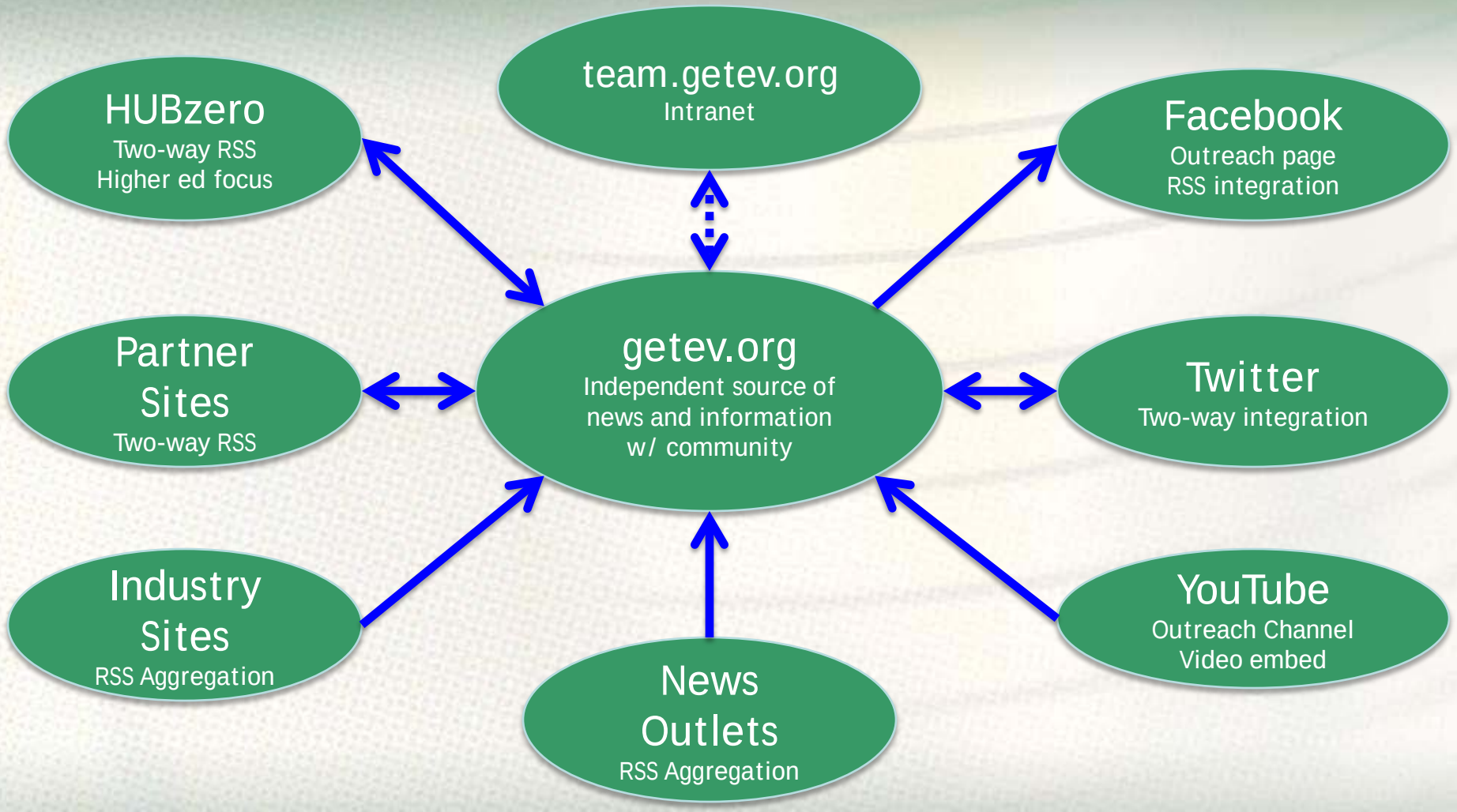
Handouts:

1) PHEV Core Concepts→ pocket pamphlet of THE HEV FACTS:*"What everyone should know about HEVs* w/ diagrams
2) HEV MYTHS→ pamphlet
3) Teacher Kits (CD): Core Concepts/Industry Needs aligned with Education Standards→ pamphlet/foldout
HEV Myths
Outline of "How to Incorporate HEV Ed into high/middle school courses: includes Lesson plans, demos/experiments/exercises, (as they are developed for the Summer Teacher Training Workshop) PowerPoint(s), links to websites, information of feeder system to higher ed opportunities/careers→ACC/CSU Program information about HEV Ed



4)PROGRAM INFORMATION re HEV Ed in higher Education: **A)** CSU HEV Engineering Courses offered→ pamphlet
B) ACC/FRCC Automotive Technology Associate Degree in Applied Sciences programs handouts → pamphlet

Outreach: Web and Social Media



Outreach: Web and Social Media

- **getev.org Features**
  - Social media integration
  - RSS aggregation and syndication
  - Media rich posts via WYSIWYG
  - Faceted search
  - Editorial workflow and content approval process
  - Branded as an independent resource to allow for flexible use across multiple orgs
  - Timeline
    - February: Plan
    - March: Design/Brand
    - April: Wireframe/Coding
    - May: Alpha Site/Test
    - June: Beta Site/Train
    - July: Release/Support