## Automotive Futures Affiliate Program

### Affiliate Members

- Argonne National Labs
- BorgWarner Inc.
- Bosch Corporation
- Denso Corporation
- FCA LLC
- Ford Motor Company
- ITS America
- Oracle Corporation
- UAW-Ford
- Valeo North America, LLC
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Research Partners

**IT Organizations**
- HP
- IBM
- Oracle Corporation
- Siemens-PLM

**OEMs**
- FCA LLC
- Ford Motor Company
- General Motors
- Nissan Tech Center
- Toyota Tech Center

**Government/NGOs**
- Argonne National Labs
- CALSTART
- CARB
- Energy Foundation
- Federal Motor Carrier
- The Hewlett Foundation
- ICCT
- NRDC
- Michigan DOT
- NREL
- NSF

**Government/NGOs**
- Union of Concerned Scientists
- US Army-TARDEC
- US DOT
- US EPA
- US DOE
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Research Partners

**Suppliers**
- BASF
- BorgWarner
- Bosch
- Chevron
- Continental
- Denso
- Dana
- Delphi
- Dow
- Eaton
- JATCO

**Suppliers**
- JCI
- Lear
- Magna
- Means
- Michelin
- Peterson Spring
- TRW
- Yazaki
- Visteon
- Valeo

**Consultants**
- AT Kearney
- AVL
- FEV
- McKinsey
- Ricardo
- Roland Berger

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Automotive Futures
Current Research Programs

- Globalization
  - Shifting Strategies: The Big Three in ASEAN
  - Establishing Production in North America: Challenges for Overseas Assemblers and Suppliers and Implications for the Domestic Automotive Industry
- Workforce Planning for a Global Automotive Economy
- Inside China and Inside India reports
- Inside China conferences for 8 years
- Inside India, Brazil, Russia, Japan conferences
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Current Research Programs

• Powertrains
  • 2014-2015 Powertrain Strategies for the 21st Century Survey (Sponsor: Affiliates)
    • Survey results distributed to Affiliates
  
• Total Cost of Ownership: Comparing Diesel and Gas Vehicles (Bosch)
  • Based on resale value of 30K vehicles sold through Mannheim auctions in 2012 / 2013
  • Report available
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Current Research Programs

• ITS
  • Stuck in Traffic: Analyzing Real Time Traffic Capabilities of Personal Navigation Devices and Traffic Phone Applications
    • Final report available
  • Integrated Mobile Observations: Micro-level weather reporting using cell phones in MDOT vehicles (Sponsor: MDOT and FHWA)
    • Report available
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Current Research Programs

• ITS
  • Roadway Evaluation Project: Measuring road roughness via accelerometers in cell phones mounted in MDOT vehicles
    • Final report available
  • Deploying Safety Technologies in Commercial Vehicles
    • Familiarity and penetration currently and in the future of: Forward Collision Warning / Lane Departure Warning / Blind Spot Detection / ESC / Vehicle Communications
    • Final report available (Sponsor: ITS America)
Upcoming UMTRI-AF Conferences

• September 14, 2016: *The Future of Automotive IT: Driving Organizations, Vehicle Development, and Connected/Autonomous Vehicles.* Our 8th annual conference focused on the Business of IT shows the different sides of automotive IT and how it continues to change automotive organizations and vehicles.

• November 9, 2016: *Inside China: Understanding China’s Current and Future Automotive Industry.* Our 9th annual Inside China conference has traced the rapid rise of the Chinese auto industry. The largest automotive market in the world is such a unique market that it demands that we continue to examine both its current and future trends from a variety of perspectives: consumer choice, marketing, product development, government support and regulations, alternative energy, automotive research and development, industry structure, labor, economic impact, and manufacturing.
Upcoming UMTRI-AF Conferences

• February 15, 2017: *New Mobility Conference*. Our 3rd annual New Mobility conference in collaboration with UM-SMART will investigate new modes of transport that support sustainability as well as transport.

• April, 2017: In Celebration of UM’s 200th Anniversary: UMTRI-AF and the UM Japan Center will put on the conference that examines the past, present, and future relationship of the Japanese auto industry to the US and the UM.
The UM Alumni Discount

Alumni who sign up in advance for five conferences in a row receive a $250 discount
Conference Presenters/Schedule

9:00am  **Bruce Belzowski**, Managing Director, Automotive Futures, UM Transportation Research Institute

- **Sergio Muniz**, UMTRI AF Visiting Researcher (from Federal Technological University of Paraná, Brazil)
- **Jonathon Ratliff**, Manager of Zero Emission Vehicles at Nissan Technical Center
- **Janghwan Shin**, UMTRI AF Visiting Researcher (from LG, Korea)

Break (20 minutes) Valeo 48V Technology Demonstrator Vehicle (Outside)
• **Ou-Jung Kwon**, Cell Chemistry Technical Expert, Electrified Powertrain Engineering at Ford Motor Company

• **Jacob Bemrich**, Systems Engineering Manager, Robert Bosch Battery Systems LLC

• **Ram Vijayagopal**, Argonne National Laboratory

• Conference Q&A

  1:30pm  Lunch

  2:30pm  Adjourn
Conference Questions

- What are manufacturer platform strategies for EVs?
- What do the platform strategies say about the evolution of EVs and the batteries that support them?
- How do manufacturers view the major EV challenges over the next 5-10 years?
- What improvements should we expect in the different parts of the EV powertrain? Which parts will show the most improvement?
Conference Questions

• What are the main competitive battery technologies that will compete for the next generation battery?

• What are some of the advantages and challenges of the future competitive batteries?

• What will be some of the battery technologies we should expect to see in the 2030 timeframe?

• How are manufacturers linking to universities to support battery production research?
Conference Questions

• What areas in particular are productive areas of outsourcing research to universities?

• What role will traditional automotive suppliers play in the development of the next generation battery?

• How do high voltage and 48 volt systems fit into the future EV paradigm?
Conference Questions

• How does the electric vehicle compare to a gas powered vehicle over the next 30 years when we take into account vehicle weight reduction, battery technologies, powertrain components, power and energy requirements, and powertrain energy and power densities.
Post Conference Mailing

Attendees:
• Link to presentations
• Link to 2016 GERPISA conference presentation titles

Affiliates:
• The above items
• Link to a document that shows the titles and abstracts from the 2016 GERPISA
• Link to the 2015 Company Powertrain Strategy Information Report
• Link to the analysis slides from the 2015 Company Powertrain Strategy Information Report

Bruce M. Belzowsk
Managing Director-Automotive Futures
University of Michigan
Transportation Research Institute
bbl@umich.edu
Corporate Average Fuel Economy Regulations

- In 2012, the federal government established new CAFE regulations for all manufacturers selling in the US
- Each manufacturer has their own annual goals based on the “footprint” of the vehicles in their fleets
- Total fleet goals for the US new vehicle fleet include:
  - 2016: 34.1 miles per gallon
  - 2020: 38.9 miles per gallon
  - 2025: 54.5 miles per gallon
Corporate Average Fuel Economy Regulations

- Government expected the companies to meet their fuel economy goals without much electrification (3%)
- In 2012, the manufacturers were unsure that consumers would accept the additional costs involved in the new technologies (government estimate: $1,700; industry estimate: $3,500)
- The government and industry agreed on a mid-term assessment that would take place during 2016-2017
- The government has tested many different technologies and a report is due in late June, 2016
Mid-Term Review: Draft Technical Assessment Report

- In this Draft TAR, the EPA GHG and NHTSA CAFE assessments both show that the MY2022-2025 standards can be achieved largely through the use of advanced gasoline vehicle technologies with modest penetrations of lower cost electrification (like 48 volt mild hybrids which include stop/start) and low penetrations of higher cost electrification (like strong hybrids, plug-in hybrid electric vehicles, and all electric vehicles).

- Given the rapid pace of automotive industry innovation, the agencies may consider effectiveness and cost of additional technologies as new information, including comments on this Draft TAR, becomes available for further steps of the Midterm Evaluation.
Based on various assumptions including the Annual Energy Outlook 2015 (AEO 2015) reference case projections of the car/truck mix out to 2025, the footprint-based GHG standards curves for MY2022-2025 are projected to achieve an industry-wide fleet average CO2 target of 175 grams/mile (g/mi) in MY2025, and the augural CAFE standards are projected to result in average CAFE requirements increasing from 38.3 mpg in MY2021 to 46.3 mpg in MY2025.

The projected fleet average CO2 target represents a GHG emissions level equivalent to 50.8 mpg (if all reductions were achieved exclusively through fuel economy improvements).
Powertrain Strategies for the 21st Century Survey

- A survey of powertrain experts from automotive manufacturers, suppliers, government, NGOs, academia, and consulting

- Asks for their predictions for 2020, and 2025.

- Follows our similar surveys from 2006, 2007, and 2012
Survey Demographics

Organizations: Total Number of Respondents = 72
- Vehicle Manufacturer: 24%
- Parts/Service Supplier: 42%
- Other: 34%
  (Other Includes: Academic Research, Government, NGOs, and Consultants)

Titles:
- CEO, President, VP: 17%
- Chief engineer, Chief technology officer/Director: 20%
- Manager: 34%
- Engineers, Technicians: 11%
- Researchers, Scientists: 18%
Survey Topics

• Fuel Prices in 2020 and 2025 ($)
• Penetration of Different Fuels in 2025: PC and LT (%)
• Consumer Fuel Price Sensitivity for Alternative and Non-Alternative Powertrains ($ per gallon)
• Manufacturers’ Willingness to Pay for Increased Fuel Economy ($)
• Ability of US and Foreign Manufacturers to Meet Future Emissions Regulations (Likelihood)
• Manufacturers’ Willingness to Pay for Reduced Emissions ($)
• Penetration of Different Powerplants in 2020 and 2025: PC and LT (%)
• Amount Consumers Will Be Willing to Pay for Alternative Powertrains in 2025 ($)
Survey Topics

- Increase in Fuel Economy Using New Technologies for ICEs in 2025 (%)
- Penetration of Diesel Technologies in 2025 (%)
- Penetration of Different Battery Technologies in 2025 (%)
- Contribution of Powertrain Electronics to Powertrain Costs in 2020 and 2025 (%)
- Penetration of Different Materials in Powertrains in 2025: PC/LT (%)
- Reduction of Vehicle Weight in 2025 (Likelihood)
Analysis Key for Previous Survey Comparisons

Results with this blue background are from the 2014-2015 PTS21 Survey

Results with this yellow background are from the 2012 PTS21 Survey
Fuel Prices
The predicted price of unleaded regular gas for 2020 and 2025 is expected to increase 11% and 28% respectively from 2014-2015.

Experts continue to see fuel price increases and are making decisions accordingly.

<table>
<thead>
<tr>
<th>Year</th>
<th>Price Per Gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014*</td>
<td>$3.36</td>
</tr>
<tr>
<td>2020</td>
<td>$3.76</td>
</tr>
<tr>
<td>2025</td>
<td>$4.31</td>
</tr>
</tbody>
</table>

*Source: Energy Information Administration (Jan–Dec ’14)
In 2012, experts predicted price of unleaded regular gas for 2016, 2020, and 2025, to increase 23%, 40%, and 67% respectively from 2012.

*Source: Energy Information Administration (Jan-Dec ’12)
The US has not reached the average price per gallon of fuel where fuel economy becomes a primary concern in new vehicle purchases.

**Consumer Fuel Price Sensitivity**

At **$4.55 per gallon**, consumers will make fuel economy a primary concern in new vehicle purchase.

Experts in **2012** reported that the price of gas would be **$4.85 per gallon**.

- These results will make the government’s mid-term review more difficult.
The US has not reached the average price per gallon of fuel where experts think consumers will consider purchasing a vehicle with an alternative powertrain

Consumer Fuel Price Sensitivity

At $5.01 per gallon, consumers will consider purchasing a vehicle with an alternative powertrain.

Experts in 2012 reported that the price of gas would be have to be $5.49 per gallon.

For 2015, EIA forecast average of $2.43 per gallon of gas.
Experts expect growth in the use of ethanol, diesel, and electricity by 2025 for passenger cars.
Experts in 2012 also expected growth in the use of ethanol, diesel, and compressed natural gas by 2025 for passenger cars. In addition, some experts expect electricity to make up a large percentage of fuel utilized by passenger cars in the years 2016 & 2025.
Experts expect growth in the use of ethanol, diesel, and compressed natural gas by 2025 for light trucks.
In 2012, experts expected growth in the use of ethanol, diesel, compressed natural gas by 2025 for light trucks. In addition, some experts expect electricity to make up a large percentage of fuel utilized by light trucks in the years 2016 & 2025.
Powerplants
Experts expect growth in all areas except spark-ignited powertrains for passenger vehicles.

- Spark-Ignited Engine: 68% (2020), 53% (2025)
- Hybrid: 20% (2020), 31% (2025)
- Advanced Diesel: 7% (2020), 9% (2025)
- Electric: 5% (2020), 3% (2025)
- Extended Range: 2% (2020), 3% (2025)
- Fuel Cell: 1% (2020), 1% (2025)

Hybrids (2025):
- Full: 8%
- Plug in: 9%
- Mild: 12%
- Diesel: 2%

Growth, but low penetration
In 2012 experts predicted, spark-ignited powerplants are predicted to drop to slightly less than 50 percent for passenger cars while hybrids and advanced diesels increase their share.

- Spark-Ignited: 74%
- Hybrid: 48%
- Advanced Diesel: 14%
- Electric: 12%
- Extended Range: 8%
- HCCI: 6%
- Fuel Cell: 1%

Hybrids (2025)
- Full: 9%
- Plug in: 6%
- Mild: 10%
- Diesel: 3%

Growth, but low penetration
Experts expect growth in all areas except spark-ignited powertrains for light trucks as hybrids and diesels increase significantly.

- Spark-Ignited Engine: 58% in 2025, 70% in 2020
- Advanced Diesel: 15% in 2025, 20% in 2020
- Hybrid: 14% in 2025, 21% in 2020
- Electric: 1% in 2025, 1% in 2020
- Extended Range: Less than 1% in 2025, Less than 1% in 2020
- Fuel Cell: Less than 1% in 2025, Less than 1% in 2020

Hybrids (2025):
- Full: 4%
- Plug in: 4%
- Mild: 10%
- Diesel: 3%
In 2012, experts predicted light trucks, increase their share of diesel and hybrid powerplants in 2025 at the expense of spark-ignited engines.

### Graph

- **Spark-Ignited**: 74%
- **Advanced Diesel**: 26%
- **Hybrid**: 17%
- **Extended Range**: 7%
- **HCCI**: 2%
- **Electric**: 1%
- **Fuel Cell**: 1%

**Hybrids**
- Full: 5%
- Plug in: 2%
- Mild: 7%
- Diesel: 3%
How much will consumers be willing to pay for alternative powertrains compared to spark-ignited engines in 2025

*2014 USD

- Pure Electric
- Diesel
- Hybrid
- Hydrogen
- CNG

$0  $500  $1,000  $1,500  $2,000  $2,500

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Conclusions
CAFE Midterm Review

- The midterm review report will discuss government experiments with new ICE technologies
- Will need to address the low cost of fuel and its affect on consumer purchase decisions
- Will need to address the effects of consumers purchasing more light trucks than passenger cars (due to lower fuel prices)

Survey Results

- Experts continually expect higher levels of electrification needed to meet government goals (at a higher cost than consumers seem willing to pay)
- Despite the dramatic increases in hybrids predicted for 2025, 96 percent of PCs and 99 percent of LTs will still use some sort of internal combustion engine
Consumer Price Sensitivity

- Consumers are willing to pay around $2,000 more for diesel and pure electric light trucks. $1,500 more for hybrid light trucks, about $1,200 more for hydrogen and about $800 for CNG light trucks.

- Price increases for all of the powertrains are much more than what manufacturers charge for these powertrains over spark-ignited powertrains, and also much more than it costs them to produce them.

- These results show the disconnect between consumer expectations and willingness to pay for new technologies and the actual cost of developing and producing these powertrains.

- This topic will most likely be an important topic of discussion during the CAFE Mid-Term Review in 2016-2017.
Powertrain Strategies for the 21st Century: Next Generation Electric Vehicle Strategies

“Focus on the Future”
UM Automotive Research Conferences

WELCOME!

The Link to Presentations Will Be Emailed This Weekend