POWERTRAIN STRATEGIES
FOR THE 21ST CENTURY

FORECAST FOR THE NORTH AMERICAN AUTOMOTIVE INDUSTRY FOR 2015 AND 2020

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Acknowledgements

Our research team would like to acknowledge the efforts of our panel of experts who spent their time completing our survey. We would also like to thank our two corporate sponsors, Denso Corporation and the U. S. Environmental Protection Agency for their financial support. Finally, we would also like to thank our media sponsor, Ward’s Auto.com for their support in helping us connect with North American powertrain experts.

Foreword

The Powertrain Strategies for the 21st Century project is part of UMTRI-AAD’s Future Powertrain Program whose goal is to provide companies with intelligence about future directions in the powertrain strategies of manufacturers and suppliers, consumer views of alternative powertrains, and future directions in mobility and sustainability. The Powertrain Strategies for the 21st Century project an on-going, long term panel study that focuses on the future directions of powertrains. The insights are based on survey responses of global powertrain experts across Europe, North America, and Asia looking at the years 2015 and 2020 with a web-based survey of industry experts that aims to:

- Examine global powertrain strategies by surveying European, U.S., and Asian managers and engineers. Questions may include regional predictions of current and future powertrains by types of engines and transmissions; fuel-management systems; and any new technologies co-sponsors may suggest.
- Compare from a global perspective how regulatory regimes affect powertrains
- Benchmark current powertrain product development processes using financial, human resource, product development, and supply chain metrics.
- Explore how alternative powertrains, such as hybrids, advanced diesels, and fuel cells, will affect the powertrain product development process. Questions may include timing, cost tradeoffs, time to market, engineering and sourcing issues, and challenges for particular types of alternative powertrains.
- Develop a technology roadmap for powertrain and powertrain components over the next 15 years.

Process and Panel Characteristics

Using web-based survey tools and our industry databases we have gathered responses from slightly over 100 North American powertrain experts. As with all of our research projects, we guarantee respondents that their responses are treated confidentially, allowing them to express their opinions freely. We have grouped respondents into 3 groups: manufacturers (OEMs), suppliers, and other experts who represent government, academic, non-governmental organizations, and consultants.

Presentation of Results

The results of the survey are presented in the form of data tables and selected and edited comments of the experts.
Data Tables. Each question asked of the experts is presented, and their responses are reported as a weighted mean and as part of an interquartile range. For each overall question we asked the experts to rate how confident they were of their response on a five point scale, ranging from not confident at all to very confident. This rating is used in a univariate model using the weighted least squares method to weight each expert’s individual response, thus incorporating the experts own opinions of their confidence on their response into the group mean.

The interquartile range provides the reader a view of the range of unweighted responses to each individual question. A range that is relatively narrow can be considered one way of measuring consensus or uncertainty among experts about a particular issue. We report the first and fourth quartiles with the weighted mean representing a close estimate of the median response. By dividing all the responses into four equal groups, readers can determine not only the range of responses, but for questions related to company performance, the interquartile range represents best in class/worst in class comparisons.

Certain questions ask respondents to list other items such as fuels, powerplants, or energy storage devices that will play an important role in future powertrains. After the data table, we list these responses along with the percentage or rating the experts give to each of these items.

Selected and Edited Comments. One of the strengths of our survey method is the opportunity we give to our panelists to comment on the question or their response to a question. We encourage the panelists to contribute comments to explain their responses, and sometimes these comments provide insight into the logic behind particular responses.

If readers have any questions about the project or the survey, please contact Bruce M. Belzowski, Assistant Research Scientist, at 734-936-2704 or bbl@umich.edu.
# Table of Contents

## ACKNOWLEDGEMENTS AND FOREWARD

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

## STRATEGIC PLANNING FACTORS

1. Gasoline price forecast ..................................................................................... 5
2. CAFE standards ............................................................................................... 7
3. Fuel economy and vehicle purchasing ............................................................. 9
4. Federal regulations and legislative trends ...................................................... 10

## ALTERNATIVE POWERTRAIN TECHNOLOGIES

5. Fuels and powerplants for passenger cars and light trucks............................ 12
6. Consumer willingness to pay for advanced powertrains .................................. 16
7. Company barriers to introduction of new powertrain technology ................. 18
8. Energy storage ............................................................................................... 19
9. Hybrid electric/combustion system challenges ............................................. 20
10. Fuel cell system challenges ........................................................................ 22
11. Advanced diesel system challenges ............................................................ 24

## POWERTRAIN ENGINEERING AND SOURCING ISSUES

12. Global usage of engines and transmissions .................................................. 26
13. Powertrain design and engineering sourcing ............................................... 27
15. Powertrain component, sub-system/module, or complete system sourcing .... 29
16. Powertrain development by suppliers and manufacturers ............................ 30
17. Powertrain manufacturing by suppliers and manufacturers .......................... 31
18. Powertrain development cycles .................................................................... 32
19. Engine redesigns .......................................................................................... 33
20. Integrated company powertrain strategy ...................................................... 34

## POWERTRAIN AND DRIVETRAIN TECHNOLOGIES

21. Number of cylinders for passenger cars and light trucks .............................. 35
22. Penetration rates for diesel and spark-ignited engine technologies ............... 36
23. In-line and “V” engine valvetrain configurations ......................................... 37
24. Super-charged and turbo-charged engines ................................................... 38
25. Transmission mix for passenger cars and light trucks .................................. 39
26. Drivetrain configurations ............................................................................. 41
27. Electrical and electronic costs ...................................................................... 43
28. New powertrain technologies ...................................................................... 44

## HUMAN RESOURCE ISSUES

29. Human resource scarcity .............................................................................. 46
30. Transition from mechanical to electrical engineering ................................... 48
31. Organizational management of global powertrain development ................. 48
Each respondent/participant will have access to the results from all questions in the survey.
These results will be reported as industry means or medians and the participant will see their response next to the overall industry response.
They will also see any comments participants added to explain their response in the "Selected Edited Comments" section.

Below are three sample questions showing the format of the participant report.

**Question 1 - SAMPLE**

Please estimate United States retail fuel prices, per gallon, for 2015 and 2020, including fuel tax. (Please use constant 2005 dollars without adjusting for inflation)

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<tbody>
<tr>
<td>Regular</td>
<td>$2.35</td>
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<tr>
<td>Premium</td>
<td>$2.89</td>
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</tr>
</tbody>
</table>

**SELECTED EDITED COMMENTS - SAMPLE**

*Increase*

- Current U.S. gasoline prices are out of step with the rest of the world and unrealistically low. The demand for cleaner gasoline will cause prices to rise.
- Fuel tax may increase even if crude oil price remains constant
- Increase when requirements for global reductions are implemented
- Most of the increase will be due to taxation
- Unless there is an unpredictable "political event," I would expect only very modest increases in the cost of fuel as the global consumption increases. Previous predictions of increasing energy costs have proven unfounded at least so far, excluding short-term perturbations.

*Stay the Same*

- I anticipate a stable condition
- Unless there is a major disruption (e.g. another Middle East war), a significant increase in U.S. fuel taxes, which is politically unlikely, fuel prices will remain virtually unchanged.
Other

- Gasoline prices have no relationship to actual value but are the result of taxation and price setting by the federal, state, and local governments. The actual price of gasoline is less than bottled water.
- Some small but significant efforts to match world averages in order to ease national "peer pressure".
- The drivers for fuel price are largely outside the real of the automotive industry.
- The price of fuel is so political that it is impossible to predict.
- These numbers could change dramatically if OPEC ever gets their act together, or if there is real trouble in the middle east. (2 responses)
- This is solely dependent on fuel availability and OPEC

Question 2 - SAMPLE

What percentage of North-American produced spark-ignited engines for passenger-cars will be either supercharged or turbocharged in 2015 and 2020?

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<tbody>
<tr>
<td>Supercharged</td>
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</tr>
<tr>
<td>Turbocharged</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

SELECTED EDITED COMMENTS - SAMPLE

- Cost and CAFE are the issues
- Future emission standards may be more difficult to achieve with turbocharging (loss of heat energy for catalyst light off).
- Supercharging will remain a niche technology because of cost. Turbocharging will remain irrelevant because of emissions.
- This is highly dependent on fuel price or CAFE standards.
Question 3 - SAMPLE

Please give your expectations in months for current and future development cycles from concept approval through Job One of a new spark-ignited engine and its associated transmission and driveline; a diesel engine, transmission, and driveline, a hybrid engine, transmission and driveline, and a fuel cell engine, transmission, and driveline.

<table>
<thead>
<tr>
<th>Future Development Cycles</th>
<th>Median Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark Ignited Engine</td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td></td>
</tr>
<tr>
<td>Driveline</td>
<td></td>
</tr>
<tr>
<td>Diesel Engine</td>
<td></td>
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<tr>
<td>Transmission</td>
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<tr>
<td>Driveline</td>
<td></td>
</tr>
<tr>
<td>Hybrid Engine</td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td></td>
</tr>
<tr>
<td>Driveline</td>
<td></td>
</tr>
<tr>
<td>Fuel Cell Engine</td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td></td>
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<td>Driveline</td>
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</tbody>
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SELECTED EDITED COMMENTS - SAMPLE

- "Fast" product capability may be constrained by economic-payback life cycle
- Time to market is the issue