Vehicle Technology and Consumers

“Focus on the Future” Automotive Research Conferences
John German
American Honda Motor Co., Inc.
November 10, 2008
Three powerful forces define Honda’s compliance strategy

1. Honda’s philosophy
2. The marketplace
3. Regulators – at both the federal and state level
Honda wants to be a company that society wants to exist

- Genuine concern for environmental and safety issues
- High targets, ‘Challenging Spirit’
- Pursuit of new technology
- Solutions that also satisfy customer needs
Wide FE Technology Application

2006 Model Year Data from the 2006 FE Trends Report, US EPA

*Pilot is larger and heavier than average mid-size SUV: 4750 ETW versus 4264 average
Hybrid Technology Expanded to our volume leader vehicle

1st: insight (Dec. 1999)
2nd: Civic Hybrid (Mar. 2002)
4th: Civic Hybrid (Nov. 2005)

Enhanced Fuel Economy for V6 engine

Higher power added to increase use of hybrid vehicles
Three powerful forces define Honda’s compliance strategy

1. Honda’s philosophy
2. The marketplace
3. Regulators – at both the federal and state level
Fleet Fuel Economy

Real Gasoline Prices and In-Use Fleet MPG
(2008 $ per gallon)

In-Use MPG from Transportation Energy Data Book: 2007
Gasoline Cost per Mile

Real Gasoline Cost for Cars - Cents per Mile
(2008 $ per gallon)

Jun 08
$4.07

Real Fuel Cost - % of Disposable Income

Real Fuel Cost of Driving a Passenger Car 10,000 Miles
% of Per Capita Disposable Income

BEA, Table 2.1, Personal Income and It's Disposition
In-depth interviews of 60 California households’ vehicle acquisition histories found *no evidence of economically rational decision-making about fuel economy.*

- Out of 60 households (125 vehicle transactions) 9 stated that they compared the fuel economy of vehicles in making their choice.
- 4 households knew their annual fuel costs.
- None had made any kind of quantitative assessment of the value of fuel savings.
The purchase importance of Fuel Economy did not change much from 2001 to 2007, despite 75% increase in fuel prices.
And only the Compact Car segments register a consistent, significant gain in the purchase importance of fuel economy.
Environmental Trends

Willing to Pay More for Environmentally Friendly Vehicle

Percent Agree Strongly (Top Box)

Year | Amount
--- | ---
2005 | $2.51
2006 | $2.74
2007 | $2.88
Consumers are, as a general rule, LOSS AVERSE

- Will decline a bet with even odds of winning $110 or losing $100.
- Gal (2006) shows that loss aversion can be derived from two simple postulates:
  - Consumers require a motive to act
  - Consumers have imprecise (fuzzy) preferences
Uncertainty about several key elements of the net present value calculation makes an expenditure on higher fuel economy a *risky bet*

- Sure, there’s a fuel economy label on every car but what MPG will *I* get?
- How long will my car last?
- How much driving will I do?
- What will gasoline cost?
- What will I have to give up to get better fuel economy?
  - and how much will it cost?
Hybrids: Who is the buyer?

Customer Profile

- Innovator
- Early Adopter
- Early Majority
- Majority
- Hanger-On

Increasingly risk averse

Insight-Prius-Civic
Since 1987, technological advances have been used to improve attributes other than fuel economy.

Car Data from EPA’s 2008 FE Trends Report

Fuel efficiency has increased by about 1.6% per year since 1987. However, this has mostly been used to increase other attributes more highly valued by the customer, such as performance, comfort, utility, and safety.
Customer Demand Summary

• Real fuel costs are low
• Most customers value other attributes higher than fuel economy
• Most customers are Risk Averse
Three powerful forces define Honda’s compliance strategy

1. Honda’s philosophy
2. The marketplace
3. Regulators – at both the federal and state level
New Vehicle Regulations

• Congress has established new CAFE standards
• Next Administration (and possibly Congress) will address GHG at the federal level
• California
  – The Pavley standards are on hold for the moment
    • EPA denied waiver – new Administration could reverse
    • Preemption issue still in litigation
  – Because of the direct relationship between CAFE and GHG reductions, California regulations would force even higher fuel economy than the new CAFE standards
  – ZEV mandate will require PHEVs/EVs/FCVs
New CAFE law is a game changer

- Honda supported new CAFE law, but it is very challenging
  - 35 mpg by 2020 overall
    - Annual improvement over twice historical rate
    - All must go to fuel economy, not other attributes
  - “Maximum feasible” standards through 2030

- NHTSA’s proposed 2011-15 standards very stringent
  - Average 4.5% annual increase
  - Only 3.3% annual increase needed to reach 35 in 2020

- Attribute-based standards fundamentally alter the competitive landscape
  - No advantage to making smaller vehicles – just results in a higher standard to meet
  - Regulating technology, not fuel economy
Honda’s Powertrain Progress for CO2 reduction

No single solution – multi-pronged approach

- Research for mass production
- FCV development for future
- HEV expansion
- Clean diesel
- High efficient gasoline engine
- Base engine improvement

- Global IMA
- Accord IMA
- Civic IMA
- Insight IMA
- Civic GX CNG
- Diesel
- Gasoline HCCI
- Gasoline DI
- Cylinder deactivation
- i-DSI
- i-DSI
- i-VTEC
- V6
- Civic
- i-IMA
- Insight
- i-IMA
- Civic GX
- CNG
- High efficient gasoline engine
- Base engine improvement
- FCV development for future
- HEV expansion
- Clean diesel
- No single solution – multi-pronged approach
- Honda’s Powertrain Progress for CO2 reduction
Basic Hybrid System Designs

1) Belt-Driven Alternator/Starter

2) Integrated Motor Assist

3) Power-Split

GM/BMW/Chrysler 2-mode is a power-split variation
## Hybrid System Attributes

<table>
<thead>
<tr>
<th></th>
<th>Stop/start</th>
<th>Regen brake</th>
<th>Alternator support</th>
<th>Launch/Power assist</th>
<th>Electric drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS</td>
<td>12v</td>
<td>Yes</td>
<td>Limited</td>
<td>Limited</td>
<td></td>
</tr>
<tr>
<td>belt-driven</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>alternator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>starter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42v</td>
<td></td>
<td>Crank to idle</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Limited</td>
</tr>
<tr>
<td>IMA</td>
<td>&lt;100v</td>
<td>Crank to idle</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>integrated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>motor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>assist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;100v</td>
<td></td>
<td>Crank to idle</td>
<td>Extended</td>
<td>Moderate</td>
<td>Limited</td>
</tr>
<tr>
<td>Powersplit</td>
<td>&gt;100v</td>
<td>Crank to idle</td>
<td>Extended</td>
<td>Moderate</td>
<td>Extended</td>
</tr>
</tbody>
</table>

**Benefits, complexity, and cost increase together**
Evolutionary Direction of Hybrid Technology

Cost reduction and performance enhancement

* US Combine mode

Hybrid Technology

CO₂ reduction rate (%)
IMA System Overview

IMA: Integrated Motor Assist

Main

High-efficiency engine

Auxiliary power

Motor-assist mechanism

IMA battery

Inverter

Honda Hybrid System

- i-VTEC IMA: 3-stage VTEC + motor
- Certified as an AT-PZEV
- EPA city/highway rating of 40/45 mpg

2008 Civic Hybrid & IMA System
Hybrid Technology Expanded to our volume leader vehicle

1st Insight
- All new 2009
- More affordable

Dec. 1999

2nd Civic Hybrid

Mar. 2002

3rd Accord

Dec. 2004

4th Civic Hybrid

Nov. 2005

5th Insight

2009

6th CR-Z

2010-11

Enhanced Fuel Economy for V6 engine

Dec. 2004

Higher power added to increase use of hybrid vehicles