

Vehicular Electronics –Supplier Issues–

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Centrality of Electronics

- General Motors Volt
 - 10 million lines of code!
- Automotive electric motors alone \$20 billion (*2012 projection*)
(just-auto.com: *not including starters, alternators*)
- High-end vehicles
 - Over 100 microprocessors, 30% of cost
- Global supply requirement
 - Global platforms \leftrightarrow single system
- Expertise and power
 - Will makers control?
 - Will standards arise (bus, architecture, core chips)

More, More and More

- More central
 - Essential to meet safety, emissions and efficiency standards
- More extensive
 - Range of applications within vehicles increasing
 - LED branding, active safety systems
 - Motors replacing hydraulic, vacuum, mechanical drivers
- More varied
 - Markets vary
 - US European Brazilian Chinese
 - Drivetrains multiplying
 - ICE (gas, diesel, ethanol, CNG)
 - Electrics (from micro hybrid to full BEV)

Historic origins

- Spark plug and magneto
 - Ignoring that largest segment in 1903 was BEVs!
- Soon added
 - Lights, starter motor, wipers, heater motor
- Eventually
 - Radio
 - Power windows
 - Other power accessories
- All simple electronics (transistors for radio)

Quantum jump

- ...no, not a quantum, much bigger!
 - Clean Air Law (Muskie Act), 1970
 - CAFE, 1977
 - Safety from 1973 US Passive Restraint mandate
- All required electronics
 - Emissions: Three-stage catalytic converters required proper oxygen level in exhaust to function well
 - Fuel Efficiency: constraints from CAFE
 - ➔➔ Early fuel injectors and engine control units
 - Safety: Airbags (mid-1980s)
- Enabled by
 - Early integrated circuits
 - Solid-state sensors

Today...

- **Passive safety restraints**
 - Multiple airbags & tensioning seatbelts
 - Sensors, control units, actuators, diagnostics, status displays
- **Active safety systems**
 - Electronic stability control, adaptive cruise control, backup blind spot detection, side blind spot detection, lane departure detection
 - Many more applications pending or in early roll-out, e.g. LED-based active lighting systems
- **Sophisticated drivetrain controls**
 - Multiple sensors linking engine and transmission
 - Electrically activated turbocharging
- **Additional energy saving components**
 - Electronic steering, rapid start/stop systems

Sum

- By 2005, already 35 engine & other control units in midsize Japanese cars
 - Not including those in audio systems and so on
 - Not including low-level switch controls
 - Freescale, NEC, Renesas, Infineon
 - Miles of wire
 - Millions of lines of code
- Essential to basic regulatory compliance
- Part of “branding” of vehicle

...Requiring

- More current and components
 - How package?
- More integration across systems
 - Computers, sensors, wiring
- More software
 - Quality control?
 - Who “owns” IP?
- New suppliers
 - New skill sets

Electronics pervasive in PACE Awards

- PACE is the ***Automotive News*** “supplier of the year” competition that focuses on innovation
- In 2010-11 some 15 of 35 finalists were for electronics
 - Semiconductors and their packaging
 - Software systems
 - Motors in various applications
 - Fuel handing (injectors, turbochargers)
 - Lighting
- In addition many innovations impossible
 - to develop without sophisticated engineering systems
 - to make without electronics-enabled production systems

As a judge I need to learn more electrical engineering!

Industry events as well

- Automotive World 2011 (Tokyo, January)
 - Conference focused on electronics
 - 3rd Int'l Automotive Electronics Technology Expo
 - 2nd EV & HEV Drive System Technology Expo
 - Also 1st Automotive Weight Reduction Expo (small)
 - 23,000 visitors
 - 2800 seminar participants
 - 301 exhibitors in 17 acres of exhibit halls

New technology

- New technologies abound
 - Lots of new suppliers
 - Lots of new monopolies
- How handle pricing?
- How make sure of quality?
 - Computers face neither automotive
 - thermal stresses nor
 - mechanical stresses nor
 - EMT stresses
 - Longevity expectations

Sourcing issues

- IC fabs entail economies of scale
 - Heavy reliance on ASICs
 - Engineers take pride in turning out new designs
 - Too easy to turn out one more design!
 - ➔ How manage?
 - Do you want to single source?
 - If not, then need industry standards...
 - ...so that volumes support use of multiple fabs
- How monitor chips suppliers use?

Standards

- To what extent do systems need to be integrated?
 - Safety, navigation, engine control now all need to interact?
- Consortia to develop standards, software
 - Need for common bus, software standards as
 - Communication among subunits increases
 - Complexity increases
 - Autosar: Germany, 6 firms as start
 - now includes Ford Toyota PSA (plus German suppliers)
 - But tendency toward rival groups
 - Renesas Electronics consortium (multiprocessor chip)
 - JasPar: Japan, 11 firms

Afterthoughts

Centrality of Innovation

- US R&D
 - Department of Energy for batteries, other items
 - But integrated circuits? Sensors?
- Engineering capabilities
 - Strong in consumer-oriented software
 - *US shows as weaker in electronics in PACE*
 - *Impressionistic, not based on formal analysis*
 - *Small sample, biased by tendency for first adoption of many systems to be on high-end German vehicles due to European regulatory environment*

Afterthoughts

Who Benefits?

- Manufacturing often outside US?
 - Klier and Rubenstein data could help answer
 - Import data may not indicate automotive end market for individual electronic
 - Low level of Tohoku earthquake disruptions suggests robust supply chain for industry as a whole
 - Toyota and Honda are hard hit (*Nissan less so*)
 - Europeans, Detroit 3 appear largely unscathed
- Where is value added?
 - Design and intellectual property?
 - Individual specialized electrical components?
 - Systems assembly and supply

Summary

- Pervasive, and trend is towards more
 - Active instead of passive systems
 - Finer-grained control
- Replacement of mechanical, hydraulic, vacuum by electric
- Internal uses driven by regulation
 - External by branding and customer focus
- Major strategic issues for development & supply chain management

Issues common across all technologies, new and old

Addenda:

Consumer-visible systems

- Lights: interior, exterior
- Door locks / remote entry / remote start
- Trunk release (minivan automatic liftgates and doors)
- Seat adjustments, heating, etc
- Instrument panel: gauges, other functions
- Power windows, mirrors, sunroof, window heating
- Side mirrors: remote adjusting
- Rearview mirror: autodimming, HomeLink, compass...
- Wipers
- Air conditioning, heating (auto multizone...)
- Audio, DVD / broadcast
- Navigation
- Park assist
- And more

Addenda: 2010–11 electronics–related PACE finalists

Automotive News PACE “Supplier of the Year” *Innovation Award*

15 of 35 involve electronics!

- Bosch direct drive wipers
- Bosch P2 inline full hybrid electric motor
- Continental feedback accelerator pedal
- Continental brushless fuel pump
- Dassault engineering software integration for Ford
- Delphi GDI (gasoline direct injection) system
- Key Safety Systems inflatable rear seat belt
- Lear solid state “fuse-less” junction box
- Lear plug-in vehicle charging system
- OEConnection aftermarket parts software system for Ford (fordparts.com)
- OSRAM headlight high luminescence LED chip & package
- Mahle turbocharger electric waste gate actuator
- Valeo IML (insulated molded leadframe) power semiconductor (inverter) packaging
- Valeo BeamAtic automatic high beam headlight system
- Valeo direct drive wipers

Addenda:

Sections of Automotive World Exhibit Floor

- Embedded System & Software Semiconductors,
- Electronic Components & Devices
- Motor Technologies
- Testing, Inspection and Analysis Devices/Software
- Automotive Components & In-vehicle System
- Electronic Materials
- Manufacturing & Testing Equipment/Technology
- Drive System
- Rechargeable Batteries, Next-generation Batteries
- Inverters, Peripherals
- Materials
- Molding / Processing Technologies & Equipment

Addenda: Web links

- For more of my own analysis go to:
 - <http://autosandeconomics.blogspot.com/>
 - <http://japanandeconomics.blogspot.com/>
 - <http://usandeconomics.blogspot.com/>
- I will be happy to forward the syllabus of my undergraduate “Economics of the Auto Industry” course upon request.
- For PACE see
 - <http://autonews.com/pace/>