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 ↔ 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/