

## The profound changes affecting the worldwide automotive electronics market

*The electronica trade show (Nov 9-12, 2010, Munich) will include  
the two-day electronica automotive conference*



### Introduction

During the past 60 years the automobile has evolved from a crude conveyance having no computers and simple point/condenser ignition to a sophisticated and capable traveling machine with twenty or thirty computers that control everything from ignition to heat and air conditioning, door window position and analog-style instrument panel. Manufacturers such as BMW, Porsche, GM, Honda, Audi, Ford and Toyota produce cars with a dazzling array of performance, features and options including safe and comfortable cabin, high-performance low-polluting engine, computer-controlled ignition, -transmission and -lighting, engine diagnostics, communications and entertainment, navigation, safety and emergency reporting. Today's sophisticated automobiles are available in a wide range of sizes, configurations, styling, color and finish.

Despite this technological progress, greater changes loom on the near horizon. The change is driven by the economic growth in emerging countries that threatens to turn the automotive industry upside down.

This paper covers some of the important aspects of this enormous change and its implications for the automobile industry.

A confluence of factors, ranging from the global economic slowdown to the shift of automotive prowess to China and other countries, promises to profoundly and permanently change the worldwide automotive electronics market. The balance either reached the proverbial tipping point last year (2009) or will do so this year.

China's recent purchase of Ford's Volvo brand is emblematic of this tidal change; a little known Chinese auto maker – Geely – bought Volvo for approximately \$1.8B. This purchase sends a signal that China is serious about becoming a major player in the international car market, and is making sure that its manufacturers have the resources to achieve its objective.



Figure 1 Chinese automaker Geely recently purchased Volvo for \$1.8B, signalling that China is very serious about becoming a major player in the worldwide automotive business

### Major automotive trends

There are two major trends taking place in the automotive industry;

1. The manufacturing “center of gravity” is moving away from the US and moving toward the “BRIC” countries of Brazil, Russia, India and China
2. Automobiles are increasingly becoming a platform for a wide variety of electronics, from engine control systems to information display systems

One author<sup>1</sup> terms the automotive industry's economic revolution “fundamental and irreversible”. This revolution will also create profound changes in numerous related industries. China is the primary catalyst behind the restructuring of the global automotive industry.

China's growing economic power and policy-driven emphasis on developing their auto industry are tipping the world balance towards China, while the US automakers' bloated costs, weakness and recent brush with bankruptcy is tipping the balance away from the US.

China's growing strength and influence is evident in their efforts to consolidate their auto industry. There are more than 150 registered vehicle manufacturers in China. In 2008, the top 10 manufacturers accounted for 83% of all vehicles sold. Consequently, the Chinese government has accelerated its efforts to consolidate the industry in order to achieve economies of scale.

The most sweeping proposal in this plan is their intention to consolidate the industry into a "top 10" group organized into 2 distinct "tiers". The tier 1 group consists of companies with an annual capacity of 2 million

units that are encouraged to acquire smaller automotive companies throughout China. Tier 2 consists of companies with an annual capacity of 1 million units that are encouraged to drive regional consolidation. GM is already one of the biggest automakers in China, with billions of dollars invested in joint ventures, and a record 1.09 million vehicles sold in 2008, up 6 percent from the year before. Like its global rivals, GM has been counting on the growth in China and other emerging markets to help offset losses elsewhere.<sup>2</sup>

A second trend is a major effort by non-Chinese companies to capitalize on China's enormous growth potential. The current economic slowdown, the most severe since the Great Depression, has an unusual beneficial effect: many companies are reassessing and reallocating their investments in order to maximize their financial return. In that process, China has become an investment target for many industries, automotive included.

While the GDP in Europe and the US has recently contracted, China's \$588B stimulus program, of which 45% was targeted at infrastructure development, has resulted in growth in many sectors of the Chinese market. China is extremely serious about becoming a significant player in the international car market, and that its companies command the resources and guts to make that goal a reality. China's recent purchase of Volvo continues a pattern of aggressive carmakers in emerging economies taking advantage of their weakened American competitors, buying assets to upgrade and expand their operations. India's Tata Motors bought Land Rover and Jaguar from Ford in 2008, and China's Beijing Auto agreed in 2009 to purchase technology from GM's Saab unit. Such transactions represent what may be an important long-term trend in the global car industry – the shift of focus to fast-growth emerging economies, such as China and India, both in terms of production and sales.

### BRIC countries gain market share



Figure 2 A woman walks past a GM vehicle in Beijing. GM leads the chase for Chinese car buyers in order to meet its goal of doubling annual sales to 2 million within five years with products developed for "the most important growth market in the world", said GM China's president and managing director Kevin Wale.

The expectation is that "BRIC" nations (Brazil, Russia, India and China) will push aside the traditional automotive powerhouses North America, Europe and Japan, and that the "tipping point" of this shift will take place this year (2010)<sup>3</sup>

In 2009, Brazil's auto market grew 11 percent, India's 13 percent, and China's a staggering 42 percent—while Russia's market shrank by 48 percent. The first three markets will sustain relatively steady growth through 2014.

Within the BRIC countries, China will remain the largest auto market, expanding its share of total BRIC sales from 53 percent in 2008 to 61 percent in 2014. Brazil is the most mature and

stable of the BRIC markets and is likely to remain the second-largest of the four through 2014. India will grow rapidly and remain the third-largest BRIC market through 2013.

Russia is expected to rebound sharply. Although auto sales there dropped by 50% in 2009, the market will stabilize this year and sales there will grow by 15% annually over the next four years.

Automotive growth in the next decade within the BRIC countries will eclipse all other countries, growing at a rate of 3% to 15% a year and outstripping mature markets which will average a 2% rate.<sup>4</sup> By 2014 the BRIC countries will account for more than 30% of the world's auto sales, and provide significant opportunities for cost-effective R&D, sourcing, and manufacturing. In fact, the Asian markets will grow at a combined 4.7% compound annual growth rate over the next 10 years compared with just 2.9% in NAFTA.<sup>5</sup>

While virtually all multinational automotive OEMs and tier 1 suppliers have operations in the BRIC countries, they are failing to capture those markets' strategic potential because their operations are not broad enough—for example expanding their sales network beyond the largest cities or establishing engineering centers to develop local components.

Furthermore, in order to fully capitalize on these strategic opportunities, foreign automakers and suppliers must adapt their local facilities to suit the capabilities, consumer preferences and market development in each individual country.

Consumer demand will vary from country to country. Brazil is ripe for sales of hatchbacks and sporty pickups such as the Chevy Celta. India needs ultra-low-cost mini cars equipped to handle flooded roads with good air conditioning systems such as the better-equipped Tata Nano models. Russia wants sedans such as the Toyota Camry and sport-utility vehicles.

Vehicles with extended wheelbases, large trucks and cars equipped with entertainment and luxury items would appeal to Chinese consumers.



Figure 3 India's Tata Nano: forget air conditioning, power steering, bells and whistles; this immensely affordable basic model, which currently costs around \$2,500, is all about getting from point A to point B.

## Technology: promise and pitfalls

The microprocessor has brought about many new and helpful inventions to the music, knowledge, television and gaming businesses. Paradoxically, replacing the tried-and-true mechanical automotive controls with microprocessor-based drive-by-wire systems without the triply-redundant (and therefore expensive) backup systems found in modern airliners seems to invite disaster. Put another way, we may have reached a point of diminishing returns in which more automotive computers are lowering overall automobile quality and reputation.



Figure 4 Automobiles have evolved from crude conveyance having no computers and simple point/condenser ignition to a sophisticated and capable traveling machine with twenty or thirty computers that control engine ignition, engine monitoring, instrument panel functions, heating and air conditioning, entertainment, communication and navigation.

There is growing skepticism about the increasing use of electronic controls in automobiles, particularly when they affect the throttle, steering and brakes. Reports of automobiles that “develop a mind of their own” and fail to operate as the driver expects them to operate are growing. Besides the massive Toyota recall for computer controlled throttle issue, there is, for example, a report of a Mercedes CLK 230 that unexpectedly went to an uncommanded full throttle and “leapt about 15 feet before the engine stalled”. Clearly the automobile must reliably follow the drivers commands. There is little purpose in “rebooting” an auto computer system if an accident has already taken place.

Meanwhile, concerns are mounting that electronic throttles may be playing a role in sticking accelerator pedals, prompting the recall of about 2.3 million Toyota vehicles. The National Highway Traffic Safety Administration

(NHTSA) is reportedly looking into complaints about electronic throttle controls. A US House of Representatives committee is also probing these reports.

Automotive electronics will become even more pervasive as new hybrid, electric and fuel cell technologies are deployed in new cars.<sup>6</sup> Hence, the auto industry must boost its investment in consistent data collection methods, advanced analytics and new techniques for tracking design and manufacturing data to pinpoint which vehicle models need to be recalled.

### **Technology: electronic developments**

Last year, multi-national companies spent almost half a trillion dollars on R&D. A healthy percentage of that amount was spent on automotive research, just third behind the electronics and health care industries.<sup>7</sup> Further, China and India were the top net "importers" of R&D spending, receiving \$24.7 billion and \$12.9 billion, respectively from the 184 companies in the subset analysis, while spending far less on R&D abroad. Other top net recipients of foreign company R&D monies include Canada, Israel and the U.K. The top five importers accounted for close to 20% of all R&D export funding.

This R&D money funds new research. Consequently, automobile electronics have evolved over the years, becoming more reliable and less costly. Premium features such as navigation systems and personal computer interfaces that were financially justified only on high-end vehicles are now starting to appear on \$20,000 vehicles.

Starting in 2010, there are several new technologies which will appear in top-end automobiles.

- General Motors has reworked its current-technology 4.3 and 5.4L V8s to include variable valve timing. GM claims this technology improves fuel efficiency by about 2%, without the need to entirely redesign the drivetrain.
- Microsoft has become quite a player in the automotive world with Microsoft Auto, a dedicated computer software program. "Auto" is the program behind Ford's SYNC software that seamlessly integrates and manages electronic systems such as cell phones, audio systems and computer interfaces.

The trend toward more electronic content is accelerating with the introduction of hybrid and full-electric vehicles. This technology sector is strongly connected with the so called green movement and concerns about global warming.

### **Battery technology**

In gasoline-powered vehicles, the battery technology behind most conventional start/stop systems is not lithium-ion, NiMH or super capacitors. The workhorse lead-acid technology has come out a winner in terms of cost-effectiveness, configured as a separate battery that's used and maintained just for the start/stop system.

The typical battery management system consists of a shunt to measure current flow plus the electronics connected to the battery positive terminal. The system measures battery State Of Charge (SOC), State Of Health (SOH) and temperature. The system includes a means to maintain battery charge and health. For example, if the SOC determines that the battery has insufficient charge, the stop/start system is deactivated.

### **Sensors**

In automotive sensors, while sensors themselves are almost all analog, there is a broad trend from analog to digital signal interface. A new digital technology developed by the Hella Corp. allows the sensors to directly interface with such vehicle network systems as CAN and LIN. This technology was created for the transmission of accurate, high-resolution sensor data to an ECU. Hella says it's cheaper and simpler to send the data directly to the ECU than through the network protocols.

### **Emergency restraint**

Ford has developed an emergency restraint system in which the seat belts inflate in the event of an accident. The inflatable belts seem to reduce the incidence of minor injuries caused by conventional seat belts which can create non-uniform pressures during a crash resulting in “rope burn”.

### **Carbon footprint**

Also, Ford is now using a wheat straw filler instead of fiberglass or mineral fills for some of its plastics in an effort to reduce its carbon footprint. The first application is a storage compartment lid in the Ford Fusion and Ford Flex.

### **Electronic convenience features**

Also pushing new automotive technology are the continuing advances in electronic technology, especially in the information, convenience and entertainment areas. Integration of features such as personal computers and office electronics (e-mail, voice mail, conferencing etc. ) has transformed some vehicles into mobile office platforms. Other technologies, such as video imaging, blind spot detection and collision avoidance, are a transfer of technology from land-based systems to mobile systems.



Figure 5 The steering column of the new Lexus HS 250h sedan is equipped with an infrared camera that reads your face while you drive—detecting whether you are watching the road.

## Improving gas mileage

New standards will require manufacturers to reach 35.5 mpg Corporate Average Fuel Economy (CAFE) by 2016. In Europe, proposed requirements drastically reduce carbon dioxide (CO<sub>2</sub>) emissions. Since there is no practical technology to economically scrub CO<sub>2</sub> from the exhaust, manufacturers are looking for ways to reduce fuel consumption and introduce more electric-powered vehicles.

Pending US legislation, particularly in California, is likely to outlaw diesel engines for passenger car and light truck applications. Even the greenest of the Mercedes diesels cannot currently meet the proposed requirements.

Manufacturers are looking at four technologies to achieve the CAFE standards:

- variable valve timing
- variable displacement
- turbocharging
- gasoline direct injection (GDI)

Also, within a decade most cars will have either 4-cylinder engines displacing about 2.0L or V6 engines displacing 2.5 to 3.0L. Their output will be about the same as today's V6s and V8s.

There will be new internal combustion technologies. Atkinson and Miller cycle engines, for example, save fuel by using variable valve timing technology to modify the traditional Otto cycle. In the Scuderi Engine, firing After Top Dead Center (ATDC) is accomplished by using a combination of high-pressure air in the transfer passage and high turbulence in the power cylinder, and allowing an enormous 75:1 compression ratio.

## Pedestrian safety

Volvo's pedestrian safety system consists of a camera located behind the rear-view mirror that looks forward. The camera has a 45° field of view and can see down the road 500 or 600 ft. Also included is a radar-based sensor system located behind the grille. Software scans the digital images for human forms. If the camera spots a pedestrian, the system begins automatic braking. If the vehicle is traveling slower than 16 mph, it will be brought to a complete stop. If it's going faster, the speed will be reduced by 16 mph to alert the driver of the pedestrian.

## 3D GPS readouts

NAVTEQ's new GPS includes a 3-D feature to help drivers navigate complex interchanges, called *spaghetti junctions*. The issue is that drivers in urban areas often get to multiple-level interchanges and are unsure which ramp to take. At 60+ mph, there isn't much time to decide which way to go. This mapping technology is designed to guide them through those mazes.

## Other new electronic automotive features

- Remote starting from a keyfob, presently available on high-end automobiles, is becoming commonplace and probably will be adopted across all vehicle lines.
- Automatic engine shutdown and restart is believed to yield about 20% average fuel savings in city driving.
- LED headlighting is slowly gaining acceptance in high-end automobiles. LED headlights are considerably more expensive than conventional high-intensity discharge (HID) and filament lighting. At the same time they are lighter, require less power compared to a similar-output incandescent lamp, and offer a futuristic appearance that enhances the auto's desirability.
- LED tail lighting is also slowly gaining acceptance in high-end automobiles. The Cadillac Sport Wagon taillights contain more than 40 LEDs plus the electronic converter necessary to power them.
- LED instrument panel and interior lighting is quickly displacing incandescent lighting.
- An ultrasound-based sensor system located in the sides of the rear bumper warns the driver of other vehicles in close proximity when pulling out of a parking spot. The system is active at speeds up to 5 mph. If another car is too close, a yellow caution light illuminates within the rear-view mirror assembly.
- Likewise, once vehicle speed exceeds 15 mph, the auto software takes information from the backup sensors and processes it to provide blind-spot warnings. This system warns drivers who might not see everything in the lane next to them. To avoid changing lanes they can be warned by the system when it's not safe to change lanes.
- A back-up camera. This system places a small video screen in the rear-view mirror system. It's the display for a rear-looking camera system intended to help drivers back up safely.
- Automatic parking assist software. This technology uses data from the same ultrasonic sensors used for the blind spot and backup safety technology to locate vehicles ahead of and behind the driver's vehicle when parallel parking. Once located, it's possible to turn the vehicle over to the automatic parking assist software which will determine the needed steering angles and then control the vehicle through the parking sequence without driver input. This feature has been especially popular in areas with extreme parking density problems, such as in urban areas of Europe, Japan and, to a lesser extent, the U.S.



Figure 6 Automatic assist promises to make parallel parking much easier, particularly in regions such as Japan and Europe where parking space is more limited.

## Technology: promising future developments

As governments become more serious about the environment, global warming and oil depletion, some have started to carefully consider the imminent collapse of their traditional automaking industries as manufacturing centers move from the US and Europe to China and India. Laws passed in 2009 allow huge government financing and tough new rules to boost EV sales. In addition, all car makers must offer electric versions in their lineups or face economic sanctions.<sup>8</sup>

Some factors that point to a promising automotive future include

- safe lithium batteries that will last 10 years
- special lithium battery chargers that charge in minutes
- affordable and luxury pure EV cars with 250 mile range
- an upcoming wide choice of plug-in hybrids
- new, promising future battery chemistries

Off-grid energy harvesting used for battery charging:

- Solar cells located on the vehicle that generate part of the electrical needs
- Transparent solar cells over windows
- Thermoelectric converters using hybrids EV engine heat and exhaust
- Mechanical converters generating electricity from shock absorbers

In addition, electric energy storage is improving using better supercapacitors and “supercabatteries”, a hybrid of a conventional battery and a supercapacitor.

Together, these present and future technologies plus other developments provide a credible technological roadmap for electric cars, particularly now the funding is available.

## Electric vehicles

In 15 years, by 2025, electric cars will make up 35% of all cars produced. Of that percentage, 25% will be hybrid electric and 10% will be pure electric.<sup>9</sup> This forecast is based on the exponentially expanding number of hybrids being offered, with the present cumulative number of hybrids models numbering about 100. Also, the dollar investment in hybrid component development and end-product buyer subsidies is increasing. By 2025 there will be a wide selection of both hybrid and pure EV models to choose from.

At the same time there are factors limiting EV growth. Consumers generally avoid the additional cost of EVs

despite their environmental advantages. To generate widespread acceptance, governments must offset the higher purchase price with subsidies and incentives. In the West, governments have concentrated on rescuing traditional banks and car companies, not preventing the drying up of venture capital essential to the start-ups that will provide vehicles and their components of the future.

Fuel cells are always 10 years away despite their technical promise of high energy density. And the environmental advantage of electric automobiles is offset, to some degree, by the emissions of coal- and gas-fired electric generating plants producing the energy to recharge the auto batteries.

## Conclusion

The worldwide automobile industry is now going through a change as profound as Henry Ford's mass production line for his new automobile. The BRIC countries are poised to eclipse the traditional automotive powerhouses North America, Europe and Japan, and that the "tipping point" of this shift is now taking place. In addition, automobiles are quickly becoming more electrified, from their instrumentation and control to their propulsion. The automotive market today is both fluid and dynamic, and the only guarantee is that consumers should expect to embrace change.



Figure 7 BMW introduced an all-electric version of the hot-selling two-door Mini Cooper at last year's Los Angeles Auto Show. BMW- which owns the popular British brand - initially plans to lease 500 "Mini Es" to US customers. Nearly 10,000 U.S. drivers applied to pay \$850 a month for a year-long contract. This will test BMW's ability to market an EV in the auto market.



## About the author

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## About electronica

electronica ([www.electronica.de/en](http://www.electronica.de/en)) is the world's leading trade fair for electronic components, systems and applications. It has been held every two years in Munich since 1964 and presents innovations from the entire range of products and services in the electronics industry. electronica is the most important international meeting-point for the electronics industry. electronica 2008 was attended by around 73,000 visitors and almost 2,800 exhibitors. The total amount of exhibition space was 1,722,000 square feet

The show includes the first-class Automotive Conference which will be the center of further topics regarding auto industry changes.

hybridica, international trade fair for the development and manufacture of metal-plastic hybrid components, has been staged concurrently with electronica since 2008 and produces numerous synergy effects.

## Appendix

Acronyms and terms used in this report

ATDC	After Top Dead Center
BRIC	The nations of Brazil, Russia, India and China
EV	Electric Vehicle
GDP	Gross Domestic Product
NAFTA	North American Free Trade Agreement between the United States, Canada, and Mexico creating a trilateral trade bloc in North America

<sup>1</sup> (Series starting) September 29, 2009, Gasgoo.com, The eight overarching China automotive trends that are revolutionizing the auto industry by Bill Russo

<sup>2</sup> Feb. 4, 2009 AP China poised to be world's largest auto market; Slump in U.S. sales has make country catch up quicker than anticipated

<sup>3</sup> Jul 1, 2008 Global Auto Industry to Reach Tipping Point in 2010 as Economies Rise, Fall, Mack Chrysler and Roger Schreffler, WardsAuto.com

<sup>4</sup> January 21, 2010 report by the Boston Consulting Group

<sup>5</sup> Global Insight forecast

<sup>6</sup> Report by Joe Barkai, an auto industry analyst with IDC Manufacturing Insights

<sup>7</sup> October 21, 2008 release, "Booz & Company Study Finds Top Corporate Spenders on R&D Boosted Investment to Nearly Half a Trillion Dollars in 2007"

<sup>8</sup> Dr. Peter Harrop, Chairman, IDTechEx, Cambridge, UK, US Tech March 2010

<sup>9</sup> IDTechEx estimates